ISSN P - 0973-5666
ISSN E - 0973-5674

Volume 3 | Number 1 | Jan - March 2009

Indian Journal of Physiotherapy and Occupational Therapy

An International Journal

website: www.ijpot.com

Indian Journal of Physiotherapy and Occupational Therapy

www.ijpot.com

Contents

Volume 3, Number 1 January - March 2009

INDIAN JOURNAL OF PHYSIOTHERAPY AND OCCUPATIONAL THERAPY

Print-ISSN: 0973-5666 **Electronic - ISSN:** 0973-5674, **Frequency:** Quarterly (4 issues per volume).

"Indian journal of physiotherapy and occupational therapy" An essential indexed peer reviewed journal for all Physiotherapists & Occupational therapists provides professionals with a forum to discuss today's challenges - identifying the philosophical and conceptual foundations of the practics; sharing innovative evaluation and tretment techniques; learning about and assimilating new methodologies developing in related professions; and communicating information about new practic settings. The journal serves as a valuable tool for helping therapists deal effectively with the challenges of the field. It emphasizes articles and reports that are directly relevant to practice. The journal is now covered by INDEX COPERNICUS, POLAND. The journal is indexed with many international databases.
The journal is registered with Registrar on Newspapers for India vide registration DELENG/2007/20988

Website : www.ijpot.com

Editor

Dr. Archna Sharma
Head, Dept. of Physiotherapy
G.M. Modi Hospital, Saket
New Delhi - 110 017

Printed, published and owned by

Dr. Archna Sharma

Printed at

Process & Spot
C-112/3, Naraina Industrial Area, Phase-I
New Delhi-110 028

Published at

407, Hawa Singh Block
Asiad Village, New Delhi-110049

The comprehensive exposure index (CEI) model for the assessment of exposure to risk factors of UEMSD

[*]SA Moussavi-Najarkola

[*]Dept. of Occupational Health, School of Medical Sciences, Shahid Beheshti of Medical University (SBMU), Tehran, Iran, [*]Dept. of Occupational & environmental Health, School of Medical Sciences, Tarbiat Modares University (TMU), Tehran, Iran

Abstract

The $UEMSD_s$ is a significant problem to ill health and associated costs; therefore, in order to protect workers from disorders produced by risk factors, there is a need to introduce a model for the assessment of risk factors featuring work-related $UEMSD_s$. The CEI model is utilized by taking into consideration ten variables for repetitive tasks. Single and total percentage agreement for any item was obtained higher than 60% and all kappa factors for strength of agreements were gained rather than 0.20. Emphasizing on percentage agreement, most items were either close to or above 60%. All kappa factors for all assessment items gained higher than 0.60 and the test-retest agreements were all statistically significant. In laboratory study, for all tasks and assessment items, the percentage agreements were reached close to and above 60%. In field study, for all assessment items, the percentage agreements were obtained higher than 70%. The Kappa factors for all action levels were above 0.60 and percentage agreements for all action levels were reached to higher than 75%. Inter-observer and intra-observer reliabilities and validity tests' agreement levels were obtained "acceptable" according to Landis and Koch and Baty et al. classifications. By increasing work experience and submitting training about assessment items, both Cohen's Kappa analysis factors and percentage agreement were enhanced. The model is found to be sensitive for assessing the interventions and changes in exposure and assessment items before and after ergonomic interventions. The model is also indicated to be highly reliable, valid and applicable for a vast range of tasks and jobs include e.g. weaving and textile industries, manufacturing industries, carpentry, steel industry, post offices, service industry, electronic industry, shopping and marketing, agriculture and farming industry, tailoring & sewing, barberry, bakery, bricklaying, etc. Assessment reliabilities, validities and exposure index applicability's will be improved with enhancing training and guiding to use the CEI model and elevating experience in making assessment process.

Keywords

Comprehensive Exposure Index; CEI; $UEMSD_s$; Repetitive Tasks; Ergonomic Risk Factors Assessment

Corresponding Author:

SA Moussavi-Najarkola

Tel: +98 124 338 2196, Fax: +98 152 552 2390
Mobile: +98 911 126 7137
E-mail: moussavi.samn@yahoo.com
mosavi58@gmail.com, a.moussavi@modares.ac.ir

1. Introduction and aim

Utilizing different ergonomically risk assessment models presented in the various literature, it has been attempted to initiate and introduce a method that doesn't have shortcomings of previously presented methods, and it can also be capable of quantifying, evaluating and recognizing risk factors featuring work-related musculoskeletal disorders ($WMSD_s$) and classifying repetitive tasks[1]. Musculoskeletal disorder of the upper limbs that is considered to be "work-related", is generally multi- factorial in character[2].

This paper which takes into consideration the most recent and significant contributory risk factors, intends to provide and submit a set of definitions, criteria and procedures useful to describe and, wherever possible, to evaluate those work situations that can represent a biomechanical , physiological , and dynamical overload for the different structures and segments of the upper limbs[3].

The aim of this paper is to briefly describe a preliminary study about a upper extremity musculoskeletal risks assessment model for identifying safe and hazardous tasks/jobs in view of inducing upper limb disorders (ULD_s) and preventing such disorders and protecting workers from such disorders, and finally, diminishing high risk level tasks/jobs to acceptable level by redesigning hazardous tasks/jobs and suggesting automatically ergonomic designing solutions.

In most previously risk assessment tools, it was assumed to have been taken into consideration contributory risk factors individually instead of jointly and simultaneously. For example, Hagberg et al. (1995) concluded that there was a storage of effective and recognized analytical and practical methods for the concise assessment of exposure[5], but there were partial exceptions to this approach, so that Drury (1987) proposed a method for calculating the total daily number of harmful movements for the wrist taking into account factors such as force, repetitiveness and posture[6]; Silverstein et al.(1986) supplied criteria for depicting risk at least relative to the factors of repetitiveness and force; Tanaka and McGlothlin (1993) also proposed an integrated model for assessing repetitiveness, force and posture in the determination of risk for $WMSD_s$[8]; Dempsy (1999) submitted a threshold value for force for preventing musculoskeletal compression[9]; and finally, Occhipinti (1998) suggested a method (concise exposure index) for assessing exposure to repetitive movements of the upper limb by taking into consideration frequency, exertion, posture, recovery period, and additional elements[10].

Such approaches tend to highlight only the presence, versus the absence, of significant exposure (Keyserling and Stetson 1993, Moore and Garg 1995)[11,12]. Also, Li and Buckle (1999) have proposed a checklist of 15 items to assess risk exposure to back, shoulder/arm, wrist/hand and neck

encompassing ratings of posture, movement frequency, weight handled, duration, exertion, vibration, and stress[13].

It must be stressed that at least among the most recent models presented, there is a progressing tendency to reproduce the concepts and methods adapted to the NIOSH equation model for assessing manual material handling/ lifting tasks (Waters et al. 1993)[14].

The comprehensive exposure index (CEI), therefore, is a method for evaluating risk factors featuring repetitive tasks by using MMH_s method (Waters et al. 1993), SI method (Moore and Garg 1995)[12], OCRA method (Occhipinti 1998)[10], CEN (1993)[15] and kilbom (1994)[16] investigations. Thereby the aim of the method is to identify a procedure for calculating a comprehensive exposure index for assessing upper extremity musculoskeletal disorders ($UEMSD_s$) or distal upper extremity (DUE). In other words, the CEI method proposed by the author seems to be the most completely and perfectly exposure index that must be researched by parallel and subsequent study.

2. CEI model and its framework

The proposed comprehensive exposure index is based on the following premises:

a) The CEI is a figure that can be used for the assessment of manual material handling system for light hand activity in repetitive tasks.
b) The model can be employed for evaluating the upper extremity musculoskeletal disorders ($UEMSD_s$) or distal upper extremity (DUE).
c) In other models, some items or factors such as age factor, parts weight, and effective items have not been considered, but the CEI model took into consideration additional or effective items, that it seems to be the most important preference of the CEI method.
d) In the CEI model, various risk factors associated with work-related upper extremity musculoskeletal disorders (such as force exertion, posture of upper limb, frequency, duration and speed of force exertion, task duration, part weight, recovery periods, age factor, and effective items) are simultaneously and jointly concurred, but in most models, different risk factors has individually been considered.
e) Other preferences of the CEI model, perhaps, can be presenting a classification of four levels that steers us to determine safe tasks and correct hazardous tasks.
f) The CEI model submits automatically proposal ergonomic designing solutions and classifies tasks to identify the tasks with different risks.
g) The model proposes four exposure levels that each of them can be diminished to lowest risk level (safe level or the level without any risk factor).
h) The CEI method is a corrected and combined model that can strongly be referred as upper limb assessment index.

For achieving the mentioned premises, the author proposed a model that it seemed to be more factual and realistic technique for assessing upper limbs musculoskeletal disorders. Therefore, the comprehensive exposure index (CEI) is calculated from following formula, so that it is obtained from multiplying ten parameters. In practice, the following overall formula is used:

$$CEI = \sum_{i=1}^{n} FE \times PU \times FF \times DF \times TD \times SF \times PW \times RP \times AF \times EI$$

In which:
$i_{=1,\ldots,n}$ = number of tasks featuring risk factor producing upper extremity disorders during the relative shift ;
FE = force exertion; is calculated according to table 1;
PU = posture of upper limbs; that is obtained from table 2;
FF =frequency of force exertion per minute; is estimated from table 3;
DF = duration of force exertion in percent; is determined on the basis of table 4;
TD = task duration per day in hours; is achievable from table 5;
SF = speed of force exertion; is gained according to table 6;
PW = parts weight; can be calculated by estimating weight of objects that must be handled or lifted and obtaining corresponding multiplier factor from table 7;
RP = lack of recovery periods; is calculated by knowing number of hours without adequate and sufficient recovery periods or rest intervals and is obtained from table 8;
AF=age factor; the factor can be determined by accounting number of life years of the person and comparing to table 9;
EI = effective items; these factors involve several items that have not been taken into consideration in nine previous items and are obtained from table 10.

Thereby, the comprehensive exposure index (CEI) is obtained by setting up steps of the above formula as a score with a range indicating the severity of exposure and its level.

Theoretically, the calculated comprehensive exposure index is interpreted on the basis of the following classification which obtained from empirical studies and physiological, biomechanical, and epidemiological principles, which include:

I) level 1 (safe level or green zone)

A CEI score of < 2 indicates that situations are acceptable and it isn't necessary to correct the being conditions.

II) Level 2(uncertain level or yellow zone)

A CEI score of 2 to 4 indicates that incidence rate of $UEMSD_s$ is negligible, and further investigations are needed and changes may be required.

III) Level 3 (slight risk level or orange zone)

A CEI score of 4 to 6 indicates that incidence rate of $UEMSD_s$ is fairly high, and engineering control measurements and corrections are required soon.

IV) Level 4 (significant risk level or red zone)

A CEI score of > 6 indicates that incidence rate of $UEMSD_s$ is high and considerable, thus engineering control measurements and workstation designing are required immediately.

3. Introduction of variables involved in calculating the CEI model

For easier calculation of corresponding exposure index, the brief definitions and descriptions about variables involving in the CEI formula have been submitted.

a) Force Exertion (FE)

The following definitions have been submitted for force exertion:

- The amount of physical effort required to perform a task or maintain control of equipment[1,2].
- Force depends upon type of grip, weight of the object, body posture, type of activity, and duration of task[2].

Force exertion may be depended on static or dynamic contractions[1]. The need to exert force during work-related activities may be related to the handling, lifting, lowering, moving or holding objects, or keeping a part in a given position. For example, lifting 75 pounds for one time or 55 pounds for more than l0 times per shift or 25 pounds below the knees or above shoulder height, pinching 2 pounds for 2 or more total hours per shift[3].

The required force for performing various occupational actions is a critical and effective factor producing $WMSD_S$. The rate of exerted load or force on hand muscles can be exceeded of hundreds of pounds.

The force exertion can be estimated by Borg CR-l0 scale or by knowing the percent of Maximum Voluntary Contraction (%MVC) from table 1[12].

The table 1 has been derived from the model of CEN investigation (1993)[15] and SI method (1995)[12].

b) Posture of Upper Limbs (PU)

An awkward posture includes the following items:

- Repeated or prolonged reaching, twisting, turning and bending hands, working with hands or arms, or holding fixed positions, working with wrist bent for 2 hours per day[4].
- Potential fixed: turn or move the work, use frequent mini-breaks, integrate the work with other tasks to avoid prolonged use of the awkward posture[3,5].
- Pressing the upper limbs against a hard or sharp edge can result in placing too much pressure on nerves, tendons and blood vessels.
- Using the plan of hand as a hammer regularly or typing while resting arms or wrists on the hard desk edge[1].
- Armstrong et al. (1993) expressed prolonged exposure to repetitive forceful exertion of the hand and wrist, especially in awkward postures, is strongly associated with tendon and nerve damage at the wrist and hand[17].

The upper limb disorders may be attributable to occupational, non-occupational and individual factors[2]. In the CEI method, posture of upper limbs includes hand & fingers, wrist, forearm, elbow, arm, and shoulder. The author proposes a score 4 for each of the above parts and every part is divided into four awkward posture items. Thereby every part of upper limbs (i.e. shoulder) can be received a maximal score 4. The items which must be attended include[10]:

- Hand & fingers:
  1) Pinch grip
  2) Tight grip
  3) Hook grip
  4) Palmar grip
- Wrist:
  1) Flexion
  2) Extension
  3) Radial deviation
  4) Ulnar deviation
- Forearm:
  1) Supination
  2) Pronation
  3) Radial deviation
  4) Ulnar deviation
- Elbow:
  1) Supination
  2) Pronation
  3) Flexion
  4) Extension
- Arm:
  1) Abduction
  2) Contracting arm for a long term
  3) Turning inward
  4) Turning outward
- Shoulder:
  1) Abduction
  2) Pulling forward
  3) Pulling backward
  4) Holding at higher than shoulder level for a long term[3].

Finally, the multiplier factor for awkward posture of upper limbs obtains from the following table that has been extracted from CEN (1993)[15] and kilbom (1994)[16] proposals and SI method(1995)[12].

c) Frequency of Force Exertion (FF)

Frequency or repetition is defined as:

"Doing the same motions over and over again places stress on the muscles and tendons."

The severity of risk depends on how often the action is repeated, the speed of the movement, the number of muscles involved and the required force. For example, steady computer use for 4 hours per day; or a repeated cycle of motions for 2 or more times per minute[1,3].

The success of the psychophysical approach with manual handling tasks led to the application of this approach to the repetitive motion tasks of the hands and wrists[2].

Repetitiveness can be used to characterize tasks for assessment. For this, a repetitive task for the upper limbs can be defined as an activity of at least an unbroken hour in which the subject carries out a similar series of work cycle of relatively brief duration[4]. Once repetitive tasks are submitted to analysis, there is the more important problem of quantifying and assessing repetitiveness[18].

Table 3 has been extracted from CEN (1993)[15] and kilbom (1994)[16] studies and OCRA method (1998)[10] for gaining the multiplier factor for frequency of force (FF).

Table 1: Parameter for obtaining the multiplier factor for force exertion (FE).

Rating criterion	Light	Somewhat hard	Hard	Very hard	Near maximal	Maximal
Mean of force exertion perceived (according to Borg)	0-2	3	4-5	6-7	8-10	10<
Mean of force exertion in % of MVC	0-20	30	40-50	60-70	80-100	100<
Multiplier factor	1	3	6	9	13	17

Table 2: Parameters for determining the multiplier factor for posture of upper limbs (PU).

Rating criterion	Very good	Good	Fair	Bad	Very bad
Score of upper limb posture	≤ 4	5-8	9-12	13-16	16 <
Multiplier factor	1	1.25	1.5	1.75	2.5

Table 3: Parameters for determining the multiplier factor for frequency of force (FF) exertion.

Frequency of force exertion per minute	< 4	4-8	9-14	15-19	19 <
Multiplier factor	0.5	1	1.5	2	3

d) Duration of Force Exertion (DF)

Duration of force exertion illustrates biomechanical and physiological stresses related to time of maintaining a force exertion and it is characterized as a percent of performing time of force exertion per a work cycle[3]. Thereby, the exertion cycle and average exertion cycle time must be determined[1]. For measuring average exertion cycle time, an ergonomist or job analyzer must observe a job for an enough time for obtaining a compliance of job requirements[5]. Observed time is measured by a stopwatch. Average exertion cycle time is gained by dividing observed time into number of counted force exertion in a given period[12]. Percent of force exertion duration is yielded from the following formula[12]:

$$\text{Percent of force exertion duration} = \frac{\text{Average force exertion per cycle}}{\text{Average exertion cycle time}} \times 100$$

By calculating percent of force exertion duration, the multiplier factor for duration of force exertion is resulted from table 4[12]. Table 4 is extracted from CEN (1993)[15] and Kilbom (1994)[16] studies.

e) Task duration per day (TD)

Task duration shows the total performing time of a task per day[3,5]. This variable is measured and expressed in hour[3]. The calculated task duration for a person illustrates the time that a person (muscles, tendons and ligaments) is involved for doing a corresponding task in a shift or rather than a shift[12].

Kilbom (1994) expresses "no quantitative recommendations can be given concerning maximal acceptable duration of repetitive work per day, or acceptable rate of movements or contractions per time unit"[16].

Table 5 is used for obtaining the multiplier factor for task duration (TD) that is extracted from CEN (1993)[15], Kilbom (1994)[16] studies, SI method (1995)[12] and OCRA method (1998)[10].

f) Speed of Force Exertion (SF)

Speed of force exertion is the observed velocity of corresponding task or job that is taken into consideration due to its effects on force exertion[12]. In other words, by increasing speed of force exertion, the Maximum Voluntary

Table 3: Parameters for determining the multiplier factor for frequency of force (FF) exertion.

Frequency of force exertion per minute	< 4	4-8	9-14	15-19	19 <
Multiplier factor	0.5	1	1.5	2	3

Table 4: Parameters for determining the multiplier factor for duration of force exertion (DF).

Duration of force exertion (%)	< 10	10-29	30-49	50-79	79 <
Multiplier factor	0.5	1	1.5	2	3

Table 5: Elements for obtaining the multiplier factor for task duration (TD).

Task duration per day	Hour	< 1	1-2	2-4	4-8	8 <
	Minute	< 60	60-120	120-240	240-480	480 <
Multiplier factor		0.25	0.50	0.75	1	1.5

Contraction (MVC) is diminished and range of EMG is progressed[18].The speed of force exertion is conceptually estimated by an ergonomist or job analyzer[18]. For achieving an optimum and suitable conditions, the exertion speed should be maintained in the range of »Very slow, Slow, or Fair«[12].

By emphasizing on CEN (1993)[15] and paying attention to Kilbom (1994)[16] studies and SI method (1995)[12], it has been submitted a table for gaining the multiplier factor about force exertion speed. Table 6 represents the multiplier factor for speed of force exertion (SP).

g) Part Weight (PW)

Weight of the object is the most important characteristic of manual material handling system and it is involved in producing upper extremity disorders and other cumulative Trauma disorders (CTD_s)[14]. Waters et al. quantified that in manual handling system for assessing upper extremity, the weight of object or load between 0.5 to 4 kg is the critical range of inducing alterations in upper limb musculoskeletal system that can exacerbate incidence rate of upper extremity musculoskeletal disorders ($UEMSD_s$)[14].

An object with weight higher than 4 kg would have been impressed on the neck, upper limbs and other upper parts of the body[18].

Table 7 extracted from HSE guidance[19], Kilbom (1994)[16] and Work safe (2000)[20] studies for taking into consideration the effect of part weight in the assessment of the upper limb exposure.

h) Lack of Recovery Periods (RP)

Recovery period is defined as "period of time between or within cycles, during which no repetitive movements are carried out[10]. It consists of relatively long pauses after periods of mechanical movements during which the metabolic recoveries of the muscles can be taken plac"[10]. Lack of recovery periods can lead to create "Oxygen Debt" phenomenon and produce accumulation of Lactic acid and induce muscle fatigue[4]. For this, by predicting formal and informal rest intervals between work cycles during corresponding tasks can prevent from inducing muscle fatigue and upper extremity musculoskeletal disorders ($UEMSD_s$)[1,3,5].

Table 8 has been derived from CEN (1993)[15] and Kilbom (1994)[16] studies and utilizing OCRA method[10] and it can be used for achieving the multiplier factor of lack of recovery period (RP).

Table 6: Elements for quantifying the multiplier factor for speed of force exertion (SF).

Speed of force exertion	Very slow	Slow	Fair	Fast	Very fast
Compared to MTM	≤ 80	81-90	91-100	101-115	115 <
Perceived speed	Extremely relaxed pace	Taking one's own time	Normal speed of motion	Rushed, but able to keep up	Rushed and barely or unable to keep up
Multiplier factor	1	1	1	1.5	2

Table 7: Elements for quantifying the multiplier factor for part weight (PW).

Part weight (kg)	< 0.5	0.5-1	1-2	2-4	4 <
Multiplier factor	1	1.5	2	2.5	3

Table 8: Elements for determining the multiplier factor for lack of recovery periods (RP).

Lack of enough recovery periods (hour)	0	1	2	3	4	5	6	7	8
Multiplier factor	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3

Table 9: Elements for achieving the multiplier factor for age factor (AF).

Age rating (year)	d" 40	41-50	51-60	60 <
Multiplier factor	0.6	0.8	0.9	1

i) Age Factor (AF)

Age factor is the most important point in surveying force exertion and biomechanical models[18]. The age has a direct relation with force exertion and Maximal Aerobic Capacity (MAC) in hand activities[4]. For example, a forty-year old person has the maximal power for doing actions, but after the age of forty, his capability and power is slowly decreased and this reduction is maximized at the age of sixty[18]. The European Coal & Steel Community (ECSC) (1994) certificated and verified the impact of age factor on inducing and exacerbating upper extremity musculoskeletal disorders[21,22,23]. Table 9 is extracted from ECSC for obtaining the multiplier factor about age variable.

j) Effective Item (EI)

The effective items are factors that have the indirect effects on the incidence rate of upper extremity disorders[10]. These items may be present in repetitive tasks, but not necessarily or always[10]. Their type, intensity and duration lead to an increased level of overall exposure[2]. These items are considered to be relevant in the production and development of $WMSD_s$[3]. They are always work-related, and must be taken into consideration when assessing exposure[5]. For taking into account an item, it must have an association with $UEMSD_s$ occurrences, so that it would have been a collective impact rather than an individual impact[10]. For obtaining the score of an effective item, a score 1 is allocated to any item whenever that item is present[10].

Then, the obtained scores are added together and the corresponding multiplier factor is determined by table 10 that is extracted from CEN (1993)[15] and Kilbom (1994)[16] studies and OCRA method (1998)[10]. These items include[10]:

- Extreme precision at working
- Unsuitable lighting (low or high)
- Exposure to heat
- Carelessly
- Economic problems
- Background of $UEMSD_s$
- Localized compression on upper limb
- Lack of training
- Secondary job
- Reach limit
- Clearance
- Humidity
- Poor size or shape of parts
- Presenting vibration
- Exposure to cold
- Presenting noise
- Low experience

Table 10: Elements for determining the multiplier factor for effective items(EI).

Score of effective items	0	1-4	5-8	9-12	12 <
Multiplier factor	1	1.5	2	2.5	3

- Familiar problems
- Contact stress
- Sharpness of object surface
- Rapid twisting/turning movements
- Overtime
- Slippery level
- Poor packaged goods or poor handles
- Chemical components and poisons
- Hand-arm vibrations

4. Development of the CEI

It is generally agreed that work-related musculoskeletal disorders ($WMSD_s$) is characterized as multi-factorial occupational problem[24]. Many epidemiological studies have linked the musculoskeletal disorders development to various risk factors[25,26,27,28]. Findings from several scientific studies have classified these risk factors into physical[29], psychosocial/organizational[30,31,32], and individual[33] occupational 'risk factors' for the development of work-related musculoskeletal disorders(WMSD).

Several ergonomic techniques have been developed for assessing exposure to musculoskeletal disorders risk factors[34]. Many of the posture–based observational techniques which have been provided are only strictly applicable in very limited circumstances and they have shortcomings and limitations. Based on aforementioned research findings and current techniques reviewed, it was gained a strategy and policy for the development of the CEI technique, so that:

a) Is applicable to the complete range of manual tasks
b) Provides an integrated assessment of various risk factors
c) Provides an independent assessment of disorder risk to different body regions
d) Provides an overall risk assessment which allows prioritisation of tasks and submits suggested action levels
e) Facilitates effective targeting of controls by providing an indication the relative severity of different risk factors within a task
f) Is suitable for use by workplace staff with minimal training and equipment
g) Is very quick and easy to use
h) Is able to identify high risk manual handling and repetitive tasks

4.1. Applicability of the CEI

The CEI model has been utilized in several in studies performed by the author (unpublished reports) that they showed that the CEI tool could be used in many of repetitive single or multiple tasks/jobs without any limitation. In most cases the aim of studies has been to identify and assess the risk factors of upper extremity musculoskeletal disorders and injuries for one individual employee. A more detailed and general purpose was to assay, measure and investigate the reliability and validity of various survey risk factors involving in calculating the CEI Score. The studies have been

Table 11: Inter-observer reliability on assessment items as specified in the CEI.

Assessment items	25 totally observers		5 observers without any experience		5 observers with 2 years' experience		5 observers with 4 years' experience		5 observers with 6 years' experience		5 observers with 7-8 years' experience	
	Kappa	Percentage agreement	Kappa	Percentage agreement	Kappa	Percentage agreement	Kappa	Percentage agreement	Kappa	Percentage agreement	Kappa	Percentage agreement
Force exertion	0.46	80.1%	0.36	76.1%	0.39	77.4%	0.43	79.5%	0.46	79.9%	0.56	83.6%
Upper limb posture	0.45	82.5%	0.29	71.3%	0.31	81.6%	0.36	83.3%	0.54	85.2%	0.68	86.5%
Force frequency	0.47	68.6%	0.33	61.5%	0.41	63.6%	0.43	67.2%	0.48	69.4%	0.52	74.2%
Duration of force exertion	0.42	71.3%	0.34	62.4%	0.35	67.6%	0.38	71.3%	0.41	74.2%	0.57	76.3%
Task duration	0.35	70.1%	0.28	63.8%	0.31	67.6%	0.35	69.6%	0.37	70.1%	0.43	72.9%
Speed of force exertion	0.50	79.5%	0.31	69.7%	0.33	73.5%	0.39	77.2%	0.41	81.6%	0.52	83.7%
Parts weight	0.42	86.4%	0.32	81.3%	0.36	81.9%	0.38	86.2%	0.43	85.4%	0.55	87.2%
Lack of recovery periods	0.47	75.8%	0.27	63.7%	0.30	76.2%	0.34	73.5%	0.66	78.6%	0.69	81.8%
Age factor	0.81	94.8%	0.65	85.2%	0.73	89.5%	0.79	97.3%	0.83	98.6%	0.96	99.8%
Effective items	0.39	67.4%	0.32	63.1%	0.34	63.5%	0.38	66.7%	0.39	68.4%	0.45	73.5%

performed in different branches and fields, e.g. weaving and textile industries, manufacturing industries, carpentry, steel industry, post offices, service industry, electronic industry, shopping and marketing, agriculture and farming industry, tailoring & sewing, barbery, bakery, and bricklaying.

4.2. Reliability and validity tests of the CEI

4.2.1. Inter-observer reliability test of the assessment items

For avoiding errors in reliability assessment test process, 31 various tasks were randomly selected from 31 different jobs involving manual handling tasks with varied part (load) weights. The ergonomically field study was included static and repetitive tasks, highly repetitive tasks, repetitive tasks with low, moderate and high force exertions, sedentary or standing tasks, and non- repetitive tasks with low, moderate and high force exertions. The video-tape–recordings with slow- motion playing were also used to obtain a confirmation of the assessment of the relative observer. Several pilot tests quantified that taking assessment duration of 5-7 minutes could be sufficient for completing the assessment process by most observers. 25 observers (practitioners) comprising of 5 general observers without any years' experience in the ergonomic assessment tests from usual populations and of 20 professional observers with 2, 4, 6 and 7-8 years' experience in the ergonomic assessment tests from the whole world departments of ergonomics and occupational Health were selected randomly. Mean age of all observers was 39.8 years (SD=12.7, Range=21-57). Exception of non-experienced observer (5 observer without any experience), the average experience of the experienced observer group was 4.9 years (SD=3.2, Range=2-8). 25 participated observers were divided into five groups, and each observer of any group made assessment process of the various tasks in both field and video-tape-recording assessment ways separately. Table 11 shows the results of intra-observer reliabilities on assessment items used in calculating the CEI score. It was observed that by increasing work experience and submitting training about assessment items, the both Cohen's Kappa analysis factors[35] and percentage agreement were enhanced. According to Landis & Koch classification[35], single and total percentage agreement for any item was obtained higher than 60% and all kappa analysis factor for strength of agreements were gained rather than 0.20 ("Fair" to "almost perfect" agreement). With emphasis on percentage agreement, it is clear that most items were either close to or above 60%. According to Landis and Koch[35] and Baty et al.[36,37] can be considered as "acceptable".

4.2.2. Intra-observer reliability test of the assessment items

The same observers participated in a test-retest procedure for assessing the same tasks (31 aforementioned tasks) twice in 4–week interval. Table 12 illustrates the results from intra-observer reliability test on assessment items utilized in calculating the CEI score. The table indicates that all kappa statistical analysis factors for all assessment items gained higher than 0.60 ("substantial" to "almost

Table 12: Intra- observer reliability on assessment items as specified as in the CEI.

Assesssment items	25 totally observers		5 observers without any experience		5 observers with 2 years' experience		5 observers with 4 years' experience		5 observers with 6 years' experience		5 observers with 7-8 years' experience	
	Kappa	X^2 significant level	Kappa	X^2 significant level	Kappa	X^2 significant level	Kappa	X^2 significant level	Kappa	X^2 significant level	Kappa	X^2 significant level
Force exertion	0.71	P=0.008	0.61	P=0.003	0.65	P=0.022	0.73	P=0.002	0.74	P=0.037	0.79	P=0.025
Upper limb posture	0.81	P=0.031	0.73	P<0.001	0.77	P=0.011	0.80	P=0.001	0.83	P=0.001	0.89	P=0.001
Force frequency	0.77	P=0.006	0.69	P=0.001	0.71	P=0.008	0.77	P=0.033	0.80	P=0.011	0.85	P=0.005
Duration of force exertion	0.80	P=0.036	0.70	P=0.004	0.75	P=0.013	0.78	P=0.002	0.86	P=0.038	0.91	P=0.019
Task duration	0.83	P=0.017	0.76	P=0.013	0.79	P=0.004	0.83	p<0.001	0.86	P=0.001	0.90	P=0.008
Speed of force exertion	0.88	p<0.001	0.79	P=0.045	0.86	P=0.003	0.89	P=0.021	0.90	P=0.013	0.94	P=0.001
Parts weight	0.79	P=0.028	0.71	P=0.017	0.74	P=0.014	0.78	P=0.001	0.79	P=0.039	0.96	P=0.005
Lack of recovery periods	0.81	P=0.007	0.69	P=0.021	0.77	P=0.005	0.79	P=0.016	0.83	P=0.001	0.89	p<0.001
Age factor	0.82	P=0.003	0.72	P=0.002	0.76	P=0.001	0.81	P=0.023	0.86	P=0.003	0.93	P=0.041
Effective items	0.86	P=0.045	0.80	P=0.015	0.82	P=0.020	0.85	P=0.032	0.90	P=0.041	0.93	P=0.033

Table13: Agreement between observers' assessment and detailed video analysis of assessment items as specified in the CEI.

Assessment items	Percentage agreement between observers' assessment and SIMI analysis (laboratory study)	Percentage agreement between observers' assessment and video analysis (field study)
Force exertion	88.5%	81.4%
Upper limb posture	95.2%	79.6%
Force frequency	79.3%	85.3%
Duration of force exertion	93.2%	88.1%
Task duration	69.9%	83.3%
Speed of force exertion	77.5%	89.4%
Parts weight	89.3%	73.6%
Lack of recovery periods	71.3%	82.4%
Age factor	91.4%	89.6%
Effective items	75.1%	83.2%

Table 14: Agreement between observers' assessment on verifying the CEI action levels.

CEI score	CEI action level	Equivalent SI score	Equivalent OCRA score	Observers'assessment	
				Kappa	Percentage agreement
< 2	Acceptable	< 3	< 1	0.67	83.2%
2-4	Investigate further	3-5	1-2	0.63	75.9%
4-6	Investigate further and change soon	5-7	2-4	0.81	86.4%
> 6	Investigate further and change immediately	> 7	> 4	0.79	91.1%

perfect" agreement), and the test-retest agreements were all statistically significant. On the basis of Landis and Koch[35], these Kappa analyses can be taken into consideration as "acceptable".

4.2.3. Validity test of the assessment items

A validity test was conducted with the same observers assessing the same set of 31 various tasks by comparing the observers' assessment on simulated tasks with computer–assisted 3D (dimensional) motion analysis utilizing the SIMI system[34,38,39,40] (laboratory study). The same observers also participated in the field study by comparing observers' assessment on the same set of 31 various tasks with video-tape-recording analysis of the relative tasks. Table 13 shows the percentage agreements between observers' assessment and video analysis of assessment items utilized in calculating the CEI score. As it is observed, in laboratory study, for all tasks and for all assessment items, the percentage agreements were reached close to and above 60%. In field study, for all assessment items, the percentage agreements were obtained and calculated higher than 70%. On the basis of Landis and Koch[35] and Baty et al.[36,37] can be attributed as "acceptable".

4.2.4. Validity test of the CEI action levels

25 aforementioned observers assessed 31 various mentioned tasks by the comprehensive exposure index (CEI). Of the pen-paper based observational methods available, two upper limb assessment tools including the Occupational Repetitive Actions (OCRA) index developed by Occhipinti & and Colombini in 1998[10] and the Strain Index (SI) developed by Moore and Garg in 1995[12] were selected to compare with the CEI model. An identical set of tasks (31 chosen tasks with different ergonomically characteristics) were thus assessed by observers utilizing CEI, OCRA and SI models. Since purpose of the validity test was to develop, and then, to verify an action for the CEI model, the observers determined and assessed the action levels of the CEI model by taking into consideration the need of ergonomic changes and further investigations. Finally, the practitioners compared the CEI score and its action levels with OCRA and SI Scores and their action levels and determined Cohen's Kappa statistical analysis factor for quantifying the strength of observers' percentage agreements. Table 14 shows agreement between observers' assessment on the CEI action levels. It is observed that the Kappa analysis for all action levels were above 0.60 ("substantial" to "almost perfect" agreement) and percentage agreements for all action levels were reached to higher than 75%. According to Landis and Koch[35] and Baty et al.[36,37], these agreements can be regarded as "acceptable".

5. Conclusions

The Comprehensive Exposure Index (CEI) method is a model for assessing exposure to various risk factor producing work-related upper extremity musculoskeletal disorders in repetitive tasks. The author submitted the CEI method in this paper and it seems to be the most completely method. For designing the method, it was utilized from many methods such as OCRA method[10], SI method[12], CEN (1993)[15] and Kilbom (1994)[16] studies and ECSC (1994) directive publications[21,22,23]. It must be emphasized that a CEI score of > 2 must be considered to prevent the incidence of $UEMSD_S$ (a prudential approach). The method can be used for classifying safe and hazardous tasks and submitting engineering designing solutions for correcting awkward workplace situations. The model requires reliability and validation, particularly by means of a parallel and continuous study of induced upper extremity musculoskeletal disorders in groups of exposed workers. This model takes into consideration various risk factors in calculating the index, and needs to perform parallel investigations for finding more reasonable relation between clinical effects and calculated index scores. Based on results obtained from tests, the model is found to be sensitive for assessing the interventions and changes in exposure and assessment items before and after an ergonomic intervention. The model is also per indicated to be highly reliable, valid and applicable for a vast range of tasks and jobs. It is suggested that assessment reliability, validity and exposure index applicability will improve with enhancing training and guide to use the CEI model and elevating experience in making assessment process. Test results obtained so far showed that the CEI model has gained "acceptable" inter-observer, intra-observer and validity agreement level and its applicability has been significantly widespread.

References

1. Nordin M, Andersson G (1997). *Musculoskeletal Disorders in the workplace: Principles and practice*. Mosby–year Book Inc.
2. Buckle P, Devereux J (2002). The nature of work–related neck and upper limb musculoskeletal disorders. *Applied ergonomics*, *33(3)*:207-17.
3. Bernard BP (1997). *Musculoskeletal disorders & workplace factors: A critical review of epidemiological evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back pain*. 1st ed. Department of Health and Human Services (DHHS) NIOSH Press, Cincinnati, Ohio, USA, pp.: 183-97.
4. Putz-Anderson V(1994). *Cumulative trauma,a manual for musculoskeletal disprders of the upper limb*. Taylor & Francis Publishing. London. UK.
5. Hagberg M, Silverstein B,Wells R, et al. (1995). *Identification, measurement and evaluation of risk*. In: *work-related Musculoskeletal Disorders*. *A Reference Book for Prevention*. Eds, I Kuorinka and L Foreier. Taylor & Francis Publishing. 1st Ed. London and Philadelphia. UK.
6. Drury CG (1987). A biomechanical evaluation of the repetitive motion injury potential of industrial jobs, *Seminars on Occupational Medicine*. *2*: 41-49.
7. Silverstein BA, Fine LJ, Armstrong TJ (1986). Hand-wrist cumulative trauma disorders in industry. *British Journal of Industrial Medicine*, *43*: 779-784.
8. Tanaka J, Mcglothin JD (1993). A conceptual quantitative model for prevention of work-related carpal tunnel syndrome. *International Journal of Industrial Ergonomics*, *11*: 181-193 .
9. Dempsey P G (1993).A critical review of biomechanical, epidemiological, physiological and psychological criteria for designing manual materials handling tasks. *Ergonomics*, *41*: 73-88.
10. Occhipinti E (1998). OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs. *Ergonomics*, *41*: 1290-1311.
11. Keyserling WM, Stetson DS, Silverstein B, et al.(1993).A check list for evaluating ergonomic risk factor associated with upper extremity cumulative trauma disorders. *Ergonomics*, *36*: 807-831.
12. Moore JS, Garg A (1995). The strain index: a proposed method to analyze jobs for risk of distal upper extremity disorders. *American Industrial Hygiene Association Journal*, *56*: 443-458.
13. Li G, Buckle P (1999). *Evaluating change in exposure to risk for musculoskeletal disorders-a practical tool*. HSE Books CRR 251/1999.
14. Waters TR, Putz-Anderson V, Garg A, et al. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*, *36*: 749-776.
15. CEN (1993). *Safety of machinery. Human physical performance. Part 3: Recommended force limits for machinery operation*. Draft PR EN 1005-3,CEN.
16. Kilbom A (1994a). Repetitive work of the upper extremities. Part 1:Guidelines for the practitioner.Part 2:The scientific basic (knowledge base) for the guide. *International journal of Industrial Ergonomics*, *14*:51-86.
17. Armstrong TJ, Buckle P, Fine LJ, et al. (1993). A conceptual Model For Work-Related Neck And Upper–Limb Musculoskeletal Disorders, *Scandinavian Journal Of Work*, *Environment And Health*, *19*:73-84.
18. Karwowski W, Marras WS (1999). *The occupational Ergonomics Handbook*. CRC Press LCC. 1st Ed.
19. HSE (1998). *Manual handling: Guide on regulations*. 2nd Ed. HSE Books. London, UK.
20. Worksafe WA (2000). *Code of practice: Manual handling*. Worksafe Western Australia. 1st Ed.Queensland, Australia.
21. Mital A, Nicholson AS, Ayoub MM (1997). *A guide to Manual Material Handling*. Taylor & Francis Ltd. 2nd Ed. pp. 13.
22. EC Council Directive L156,160, C77 (1994). *Official Journal of the European Communities*. pp. 9-13, 39.
23. Aresini GA (2000). *Regulatory issues in occupational ergonomics.* In: *Occupational ergonomics: work-related musculoskeletal disorders of the upper limb and neck*. Eds, F Violante, T Armstrong, A Kilbom. Taylor & Francis Publishing. 1st Ed. London & New York. UK & US. pp.210-216.
24. Van der Beek AJ, Frings-Dresen MHW (1998). Assessment of mechanical exposure in ergonomic epidemiology. *Occupational and Environmental Medicine*, *55*: 291-99.
25. Stok SH (1991). Workplace ergonomic factors and the development of musculoskeletal disorders of the neck and upper limbs: a meta- analysis. *Am J Ind Med, 19:87-107*.
26. Hoogendoorn WE, Van Poppel MN, Bongers PM, et al. (2000). Systematic review of psychosocial factors at work and private life as risk factors for back pain. Spine. *25*: 2114-2125.
27. Bongers P, Kremer AM, Ter laak J (2002). Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow or hand/wrist?: a review of the epidemiological literature. *American Journal of Industrial Medicine*, *41*: 315-342.
28. Simoneau S, St.-Vincent M, Chicoine D (2003). *Work-related musculoskeletal disorders (WMSD$_s$): a better understanding for more effective prevention*. Technical guide RG126-ang. IRSST.Queó bec.
29. Winkel J, Mathiassen SE (1994). Assessment of physical workload in epidemiologic studies: concepts, issues and operational considerations. *Ergonomics*, *37*: 979-988.
30. Bongers P, De winter C, Kompier M, et al. (1993). Psychosocial factors at work and musculoskeletal disease. *Scandinavian Journalof Work , Environmental & Health*, *19*: 297-312.
31. Winkel J, Westgaard R (1992). Occupational and individual risk factors for shoulder–neck complaint. Part II. The scientific basis (literature review) for the guide. *International journal of industrial ergonomics*, *10*: 85-104.
32. Devereux JJ, Rydstedt L, Kellym V, et al. (2004). *The role of stress and psychosocial work factors upon the development of musculoskeletal disorders*.Health & Safety Executive Research Report 273.
33. Armstrong TJ, Buckle P, Fine LJ, et al. (1993). A conceptual model for work-related neck and upper–limb musculoskeletal disorders. *Scandinavian Journal of work, Environment & Health*, *19*:73-84.
34. Li G, Buckle P (1999a). Current techniques for

assessing physicai exposure to work-related musculoskeletal risks, with emphasis on posture-Based methods. *Ergonomics*, *42(5)*:674-695.
35. Landis R, Koch G (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*: 159-174.
36. Baty D, Buckle PW, Stubbs DA (1986). *Posture recording by direct observation, questionnaire assessment and instrumentation: a comparison based on a recent field study*. In: *The Ergonomic of Working Postures*. Ed_S, EN Corlett, I Manenica, JR Wilson. Taylor & Francis Publishing. 1st Ed. London. UK.
37. Ketola R, Toivonen R, Viikari-Juntura E (2001). Inter-observer repeatability and validity of an observation method to assess physical loads imposed on the upper extremities. *Ergonomics*, *44(2)*:119-31.
38. Hindle RJ, Pearcy MJ, Cross AT, et al. (1990). Three–dimensional kinematics of the human back. *Clinical Biomechanics*, *5*: 218-228.
39. Rodgers MM, Tummarakota S, Lieh J (1998). Three-dimensional dynamic analysis of wheelchair propulsion. *Journal of Applied Biomechanics*, *14*:80-92.
40. Pearcy MJ, Gill JM, Hindle RJ, et al. (1987). Measurement of human back movements in three dimensions by opto-electronic devices. *Clinical Biomechanics*, *2*: 199-204.

Assessment of the cardiovascular fitness of non-exercising subjects using six minute walk test

Aparna Sarkar, Shaily Razdan, Harshita Sharma, Sakshi Bhatia, Nitesh Bansal, Suman Kuhar
Amity Physiotherapy College, AMITY Campus, K Block, Ground Floor, Sector 44, Noida, Uttar Pradesh, India

Abstract

In order to assess the cardiovascular fitness of non exercising healthy adults, a standardized 6- min walk test was conducted on 15 healthy men and 15 healthy women, aged 40 to 50 years. Heart rate, blood pressure, respiratory rate and the degree of dyspnea (Borg scale) were determined before and after the test. Mean 6MWD+/- SD was 611m+/-33.45 for males and 550m+/-45.4 for females. The 6MWD was significantly less for men and women who were heavier and shorter. The difference in observed cardiovascular parameters before and after the test was also higher in females than males. The subjective sensation of dyspnea as measured by Borg Scale was also higher in females than males. These differences may be used to individualize the exercise protocols for males and females and also to highlight the importance of regular exercise.

Key words

Cardiovascular fitness, heart rate, blood pressure, 6MWT, 6MWD

Introduction

Fitness is a general term used to describe an individual's ability to adapt to stressors or requirements of their lifestyle or the demands posed during exercise. Aerobic fitness is a function of the ability of the heart to pump oxygen to the organs & the ability of the organs to use the oxygen. The Physiotherapists frequently interact with the clients who are physically deconditioned or have sedentary lifestyle. Such individuals present low cardiovascular fitness and exhibit early fatigue. The incidence of such situations is highly prevalent in urban population. The physiotherapists are often faced with the need to assess a person's cardiovascular fitness without sophisticated laboratory equipments.

There are various methods utilized for assessing the cardiovascular fitness. As it may be inappropriate to present sedentary non exercising individuals to exhausting maximal workloads during exercise testing. Simple sub maximal field tests may be utilized. The assessment of individual's response to exercise is an important clinical tool, as it provides global examination of the respiratory, cardiac & metabolic systems. The current gold standard of assessing the aerobic exercise response is the incremental cardiopulmonary exercise test.

Corresponding Author:

Dr. Aparna Sarkar

Senior Lecturer, Amity Physiotherapy College, Noida
asarkar@amity.edu

However, as most daily activates are performed at sub maximal levels of exertion, sub maximal functional tests are most appropriate & allow a better reflection of physical capability. The 6 MWT, which is easy to perform & cost effective, has been proposed as the best indicator of functional capacity among all sub maximal tests. Also a large number of people can be tested & extreme accuracy is not required. Also there are few risks involved during course of testing and these tests are of equal importance in all the age groups with validity tested by various studies. Increasingly, low activity levels are becoming the norm within the healthy population. Decline in physical activity has been observed in every segment. More than 50% of persons of 65 years & older are reported to have a sedentary lifestyle. Similarly, young adults are also reported to have a sedentary lifestyle.

The importance of physical activity in maintaining & improving cardiopulmonary fitness & reducing the risk of Type II diabetes mellitus & cardiac events, such as myocardial infraction, stroke & sudden death cannot be overstated. Recent studies have demonstrated that individuals with average cardiopulmonary fitness have 50% reduced incidence of mortality & mortality from cardiac events as compared to the ones with low fitness levels. Thus field tests provide baseline information that permits the identification of improvements in cardiopulmonary fitness resulting from therapeutic interventions. These field tests are also of much value as the deconditioned patients may not tolerate the metabolic demands of maximal exercise testing. Physical fitness is the ability to function effectively in physical work, training & other activities and still have enough energy left over to handle emergencies which may arise. The assessment of an individual's fitness is an important clinical tool as it provides a global examination of individual's response to exercise and hence allows the examination of respiratory, cardiac and metabolic systems.

There are several modalities available for the objective evaluation of the functional exercise capacity. The most popular cardiac tests in order of increasing complexity are stair climbing, a 6 MWT, a shuttle walk test, detection of exercise induced asthma, a cardiac stress test (eg. Bruce protocol) and a cardiopulmonary exercise test. However, as most of the daily activities are performed at sub maximal levels of exertion, sub maximal functional tests are more appropriate & allow a better reflection of physical capability[1].

The modality used should be chosen based on clinical question to be addressed and on the availability of resources. The most popular cardiac tests in order of increasing complexity are stair climbing, a 6MWT, a shuttle walk test, detection of exercise induced asthma, a cardiac stress test (Bruce protocol) and a cardiopulmonary exercise test. However as most of the daily activities are performed at

sub maximal levels of exertion, sub maximal functional tests are appropriate and allow a better reflection of physical capacity[1].

In early 1960's Balke developed a simple test to evaluate the functional capacity by measuring the distance walked during a defined period of time[2]. A 12-minute field test was then developed to evaluate the level of physical fitness of healthy individuals[3]. The walking test was also developed to assess disability in patients with chronic bronchitis[4]. In an attempt to accommodate persons with respiratory disease or for whom walking 12-minutes was very exhaustive. A 6-minute walk test was developed and was found to perform as well as the 12-minute walk test[5]. A recent review of functional walking tests concluded that "the 6-minute walk test is easy to administer, better tolerated and more reflective of ADL's than other walk tests[6].

Various studies have been conducted in the past with the aim to evaluate the functional capacity and to determine the factors affecting the results of the test. Carre F. et al in 2003 compared the heart rate, distance walked, the speed and VO2 max during the 6MWT with the treadmill test and concluded that 6MWT is a sub maximal form of exercise as it corresponds to 79.6 +/- 4.5% of Vo2 max, 85.8+/- 2.5% of heart rate (maximum) and 78 +/- 6.3% of heart rate reserve[7]. A multicentre study on healthy children by A.M Li et al was conducted in 2004 with the aim to assess the reliability and validity of 6MWT.

The 6MWT which is easy to perform and cost effective has been proposed to be the best indicator of functional capacity among all the sub maximal tests[8]. The distance covered in 6 minutes (6MWD) has been shown to predict morbidity and mortality from cardio respiratory diseases[9]. With a good quality assurance program, the patients tested by same person, short term reproducibility of 6MWD is excellent[10].

For men:

6MWD = (7.57 x height (in cm)) - (5.02 x age) - (1.76 x wt) - 309

For women:

6MWD = (2.11 x height (in cm)) - (2.29 x wt) - (5.78 x age) + 667

These reference equations may be used to compute the percent predicted 6MWD for individual adults performing the test for the first time, using the standard protocol.

Another study by Paul Enright et al was conducted on elderly >68 years which revealed the mean 6MWD to be 344 m. Independent general correlates of shorter 6MWD included: older age, higher weight, larger waist, depression and decreased mental status[3]. James roush et al in 2001 attempted to establish reference values of 6 MWT for children (10-12 years) and to determine the relationship between BMI and walking distance[12]. Marina Aiello et al in 2003 investigated the effect of anthropometrics on healthy Caucasians 20-50 years old for women and men respectively. VAS rating was seen to be higher in females than males[13].

Similar study was conducted by Gosselink R and coworkers on healthy subjects aged 50-85 years and reproduced similar results i.e. mean 6MWD was greater in males than in females[14]. Grinod D et al have shown that performing a 6MWT in a group will facilitate the distance walked[15]. Besides this differences in the population sampled, type and frequency of encouragement, corridor length and number of practice tests also account for reported differences in 6MWD in healthy persons[16].

Methods & methodology

A. Design

It is an experimental prospective analysis of the effect of age, weight and sedentary lifestyle on the cardiovascular fitness of the non-exercising subjects of the age group 40-50 years.

B. Subjects

30 healthy untrained, sedentary male (age 44.1+/-3.69) and female (age 43.7 +/-3.21) participated in the study.

C. Inclusion Criteria

- The subject must be in the age group of 40-50 years.
- The subject must be able to comprehend to spoken English or Hindi, as the medium of instructions and communication.
- The subject must be ready to take the physical tests, during the course of study.

D. Exclusion criteria

- The subject must not be diagnosed previously for any cardio respiratory system diseases.
- The subject must not be having fever or common cold on the day of examination.
- The subject must not be having habits of substance abuse such as cigarette smoking or tobacco use.
- The subject must not be previously declared unfit for any type of exercise or physical activity.
- The subject must be free from lower limb injuries or diseases
- Subjects having heart rate <50 bpm or >100 bpm at rest and BP >140/90 mm Hg.

Six minute walk test (6 MWT)

Walk tests are simple, in expensive & safe, tests for the measurement of functional exercise capacity of an individual. The walk tests are time based tests that measure the distance covered in specific time period. The test measures the distance that the patient can quickly walk on a flat, hard surface in a period of 6 minutes. It evaluates the global & integrated responses of all the systems of the body. The self paced 6 MWT assesses the sub maximal levels of functional capacity. Most patients do not achieve maximal exercise capacity during 6 MWT, instead choose their own intensity of exercise & are allowed to stop and rest during the test. The advantage of the test includes easy administration, minimal equipments, & a high degree of validity & reliability.

Procedure

The 6 min walk test was conducted according to the standardized protocol. Subjects were instructed to walk from one end to the other of a 100-ft hallway at their own pace, while attempting to cover as much distance as possible in the allotted 6 min. Subjects are permitted to slow down, to stop, and to rest as necessary but were instructed to resume walking as soon as possible. Heart rate, blood pressure,

respiratory rate and dyspnea as measured by Borg scale were assessed at the start and end of the 6 min walk test. Subjects were also asked at the end of walk whether they had experienced any of the following symptoms: dyspnea, chest pain, lightheadedness or leg pain[17].

Statistical analysis

Paired T test was used to analyze the difference in the observed values before and after six minute walk test. T test was also used to analyze the difference in the observed values among males and females. Pearson's correlation coefficient was used to establish correlation between BMI and 6MWD. The level of significance was considered at the p< 0.001.

Results

A total number of 30 subjects were recruited which included 15 males and 15 females of mean age=+/- SD 44.1+/-3.69 and 43.72+/- 3.21 respectively. None of the subjects was a smoker and a thorough history and physical examination was done to rule out any cardiovascular disease. The study revealed that the mean B.M.I. was 24.76+/-1.61 for males and 25.20+/1.86 for females [fig 1]. Of all the subjects included 30% of females and 70% of males had a normal B.M.I. whereas 70% of females and 30% of males were overweight. Fig 2 showed mean 6MWD+/- SD was 611m+/-33.45 for males and 550 m+/-45.4 for females. Studied showed a strong correlation was established between BMI and 6MWD (r= -.81,p<0 .001) for males and (r = -.85, p <0.001) for females.

The mean differences observed in cardiovascular parameters eg. Heart rate, respiratory rate, blood pressure before and after the test was also higher in females than males as depicted in fig no.3.

The difference was found to be statistically significant as measured by the t-test. The subjective sensation of dyspnea as measured by Borg Scale was also higher in females than males. Fig no. 4 & 5 showed that there was a significant differences (p<o.oo1) in heart rate & respiratory rate before & after exercise in both male & female.

The increase in systolic blood pressure after exercise in female was more in comparison to male. Diastolic blood pressure was raised more in female than male after exercise.

Table 1: Comparison of mean values +/- SD of observed mean distance walked and the mean +/-SD of B.M.I of the age group (40-50 years) of male & female.

Gender	Mean age	Mean distance walked	Mean B.M.I. Values
Male (n=15)	44.1+/-3.69	611m+/-33.45	24.76+/-1.61
Females(n=15)	43.72+/- 3.21	550 m+/-45.4	25.20+/1.86

Discussion

The present study indicated that the 6MWT can be performed very safely and is a quick measure of functional status of our body. In addition it has been demonstrated that the test is valid, as a significant correlation was established with workloads, heart rate, oxygen saturation and dyspnea responses when compared to standard bicycle ergometry and treadmill tests in middle aged adults and elderly persons[18]. The 6MWT which is easy to perform and cost effective has been proposed as the best indicator of functional capacity among all sub maximal exercise tests[19]. Understanding and knowing the baseline values of distance alked in six minutes (6MWD) for healthy subjects may provide an important data on healthy individuals. It also helps to compare the values for persons with disabilities to normative values of healthy adults of their age and to highlight the importance of physical activity in sedentary lifestyle.

It was noted from the present study that the age and the B.M.I. were independently associated with the distance walked. The gradual reduction of skeletal muscle mass and strength with age may probably account for shorter distance walked. A taller height is associated with a longer stride which makes walking more efficient, therefore resulting in longer distance walked by taller subjects. Obesity increases the workload for a given amount of exercise, hence resulting in shorter distance walked in participants with a higher B.M.I. Gender is also a strong determinant of the 6MWD. The distance covered by males and their exercise capacity is more than the females as observed from fig 2. Also the subjective feeling of dyspnea after the test was greater in females than males.

Sedentary lifestyle is one of the 5 major risk factors (along with hypertension, hyperlipidemia, smoking and

Fig. 1: Comparison of BMI (kg/m2) in male & female.

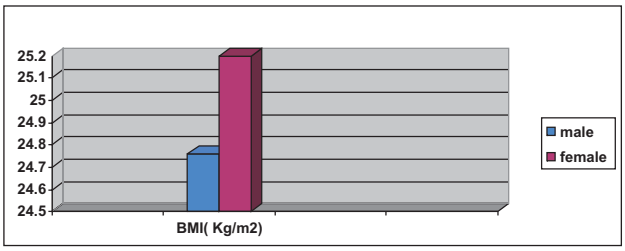


Fig. 2: Comparison of 6MWD (mts) in male & female.

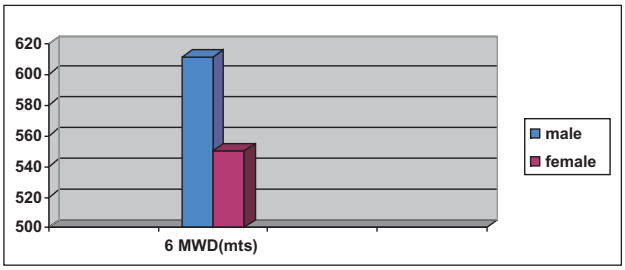


Fig. 3: Mean difference between HR, RP, SBP & DBP before and after 6 MWT in males and females.

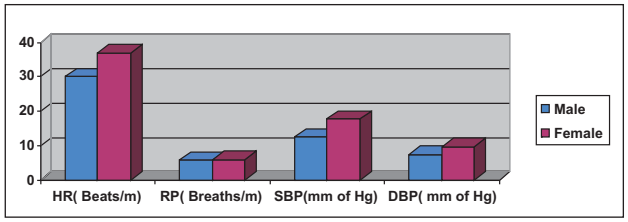


Fig. 4: Comparison of Heart Rate (HR), Respiratory Rate (RP), Systolic BP (SBP) & DBP (Diastolic BP) before and after exercise in males.

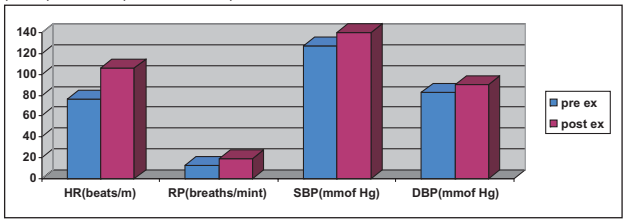
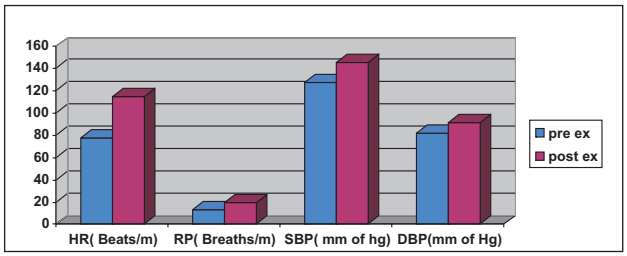


Fig. 5: Comparison of Heart Rate (HR), Respiratory Rate (RP), Systolic BP (SBP) & DBP (Diastolic BP) before and after exercise in females.



obesity) for cardiovascular disease. Evidence from many studies shows that reducing these risk factors decreases the chance of having a heart attack. Regular exercise has a favorable effect on many of the established risk factors of the cardiovascular disease. People who have a good cardiovascular fitness capacity show a less increase in the cardio respiratory parameters on exercise than a person who has lower levels of fitness. From our study it was clear that people with sedentary lifestyle had a poor cardiovascular fitness capacity.

A person can improve his aerobic capacity and endurance by a regular cardiovascular fitness program. Improving fitness is a slow process. The factors to be considered for the development of C-V fitness are FITT (F= frequency, I= intensity T= time of exercise, T= type of exercise). Age can be a factor as most people show smaller improvements as they age due to the lower exercise intensities they must start at. As a person stays with the cardiovascular program their cardiovascular capacity will increase. These gains will be at a higher level in the beginning and begin to level off as the training continues. Setting goals and a progression plan will help to improve fitness levels over time.

Conclusion

The guidelines for 6MWT procedures published by the American Thoracic Society should be strictly followed as even a small difference in instructions may cause variations in the results. The independent correlates of 6MWD include age, height, B.M.I., gender. The values for 6MWD were found to be higher for males than females. A significant correlation has been found between B.M.I. and the 6MWD.

Sedentary lifestyle is a major risk factor for cardiovascular disease. Regular exercise can improve cardiovascular fitness and reduces the risk of heart disease. An individualized cardiovascular training program should be formulated and progression should be made gradually. The cardiovascular fitness training has a direct positive effect on muscular endurance and indirect effect on strength and flexibility. Benefits of regular exercise on cardiovascular risk factors are: increase in exercise tolerance, reduction in body weight, reduction in blood pressure, reduction in blood cholesterol and increase in insulin sensitivity.

References

1. Wasserman K, Hansen JE, Sue DY, Casaburi R, Whipp BJ. Principles of exercise testing and interpretation, 3rd edition. Philadelphia: Lippincott, Williams & Wilkins; 1999.
2. Balke B. A simple field test for the assessment of physical fitness. *CARI Report* 1963; 63:18.
3. Cooper KH. A means of assessing maximal oxygen intake: correlation between field and treadmill testing. *JAMA* 1968;203:201–204
4. McGavin CR, Gupta SP, Mc Hardy GJR. Twelve-minute walking test for assessing disability in chronic bronchitis. *BMJ* 1976;1:822–823
5. Butland RJA, Pang J, Gross ER, Woodcock AA, Geddes DM. Two-, six-, and 12-minute walking tests in respiratory disease. *BMJ* 1982; 284:1607–1608.
6. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties functional walk tests used in the cardio respiratory domain. *Chest* 2001; 119:256–270.
7. Cooper KH. A means of assessing maximal oxygen intake: correlation between field and treadmill testing. *JAMA* 1968;203:201–204
8. Nixon PA, Joswiak ML, Fricker FJ. A six-minute walk test for assessing exercise tolerance in severely ill children. *J Pediatr* 1996;129:362–366
9. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systemic overview of the measurement properties of functional walk tests used in the cardio respiratory domain. *Chest* 2001;119:256–270
10. Enright PL. The six-minute walk test. *Respir Care* 2003;48:783–785
11. Fletcher GF, Balady G, Froelicher VF, Hartley LH, Haskell WL, Pollock ML. Exercise standards: a statement for healthcare professionals from the American Heart Association: writing group. *Circulation* 1995; 91:580–615
12. Enright PL, McBurnie MA, Bittner V, Tracy RP, McNamara R, Newman AB, the Cardiovascular Health Study. The six minute walk test: a quick measure of functional status in elderly adults
13. Guyatt GH, Pugsley SO, Sullivan MJ, Thompson PJ, Berman LB, Jones NL, Fallen EL, Taylor DW. Effect of encouragement on walking test performance. *Thorax* 1984;39:818–822
14. Roberts CM, Bell J, Wedzicha JA. Comparison of the efficacy of a demand oxygen delivery system with continuous low flow oxygen in subjects with stable COPD and severe oxygen desaturation on walking. *Thorax* 1996;51:831–834
15. Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. *Eur Respir J* 1999;14:270–274
16. Bland JM, Altman DG. Measuring agreement in method comparison studies. *Stat Methods Med Res* 1999;8:135–160
17. ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med* 2002;166:111–117
18. Peeters, P, Mets, T The Six minute walk as an appropriate exercise test in elderly patients with CHF. J Gerontol 1996.51A, M147- M151
19. Solway S, Brooks D, Lacasse Y, Thomas S, A qualitative systemic overview of the measurement properties of functional walk tests used in cardio respiratory domain. Chest 2001; 119: 256-270

Relationship between q-angle and patellofemoral pain syndrome

Shabnam Joshi*, Bhawna**

*Lecturer, Student**, Department of Physiotherapy, Guru Jambheshwar University of Science and Technology, Hisar

Abstract

Patellofemoral pain syndrome is common problem among young and active individuals. The aetiology of PFPS has been attributed to biomechanical abnormalities. Q-angle is an important clinical tool to assess the biomechanics of patellofemoral joint.

Purpose of the study

To investigate whether Q-angle abnormalities are present in patients with PFPS.

Methods

The study includes 30 subjects, 15 patients diagnosed with PFPS and 15 gender matched control subjects that did not have PFPS. The data has been analysed using SPSS10.0 version software. The comparison of Q-angles between various groups has been done using t test.

Results

The comparison of Q-angles for PFPS and control group in supine position using independent t-test showed no significant results. However the Q-angles for two groups showed significant differences in standing position. A comparison of q-angles in supine and standing position using paired t-test showed significant difference.

Conclusion

It can be concluded that Q-angle invariably remains an important clinical test for the diagnosis of PFPS. Test performed in standing position can give significant findings about the morbid status compared to the classical method of performing the test in supine position. Q-angle changes on change of position from supine to standing due to linked biomechanics of lower extremity.

Keywords

Q-angle-Quadriceps muscle pull angle, PFPS-patellofemoral pain syndrome.

Overview

In the absence of other pathology, anterior or retro patellar pain which exacerbates during sustained sitting, kneeling, ascending or descending stairs, and squatting is defined as patellofemoral pain syndrome. The term PFPS is now commonly used in preference to the ambivalent term chondromalacia patellae although the terminology and nomenclature are constantly changing. PFPS is a common source of anterior knee pain in young and active individuals. The condition is common among young women in India. The aetiology of the PFPS is not clearly understood but the condition has been mainly attributed to malalignment of the lower extremity and/or patella, muscular imbalance of the lower extremity and overactivity. The high incidence of disease among active individuals support that overactivity is an important factor in PFPS. The Indian lifestyle puts a lot of stresses on the knee joint causing knee pain and early degeneration of joint. Muscle imbalances have proven to exist with PFPS but there is a need to clarify whether a specific disturbance in muscular activation is a cause or an effect of PFPS. Classical orthopaedic literature attributes the condition to biomechanical factors that alter tracking of patella with the femoral trochlear notch contributing to increased patellofemoral contact pressure. In the absence of any aetiology clinicians tend to perform an extensive physical examination that generally includes multitude of impairment measures. The structural and postural alterations that have been linked to PFPS are femoral anteversion, Q angle, tibial torsion and excessive foot pronation. In the weight bearing position the lower extremity joints function in a close kinetic chain thus the abnormality at the level of foot, tibia or hip can be carried to knee. The Q angle is defined as the angle between the quadriceps muscle (primarily the rectus femoris) and the patellar tendon and represents the angle of quadriceps muscle force.

The Q angle becomes one important clinical tool to asses the biomechanics of patellofemoral joint. It has been reported that an excessive Q angle is the cause of PFPS. However the recent studies on the topic have failed to establish a positive relationship. Caylor et. al[1] reported that increased Q angle was not responsible for anterior knee pain syndrome. Thomee R[2] et al found no radiographic signs of malalignment in patients with PFPS. Eckhoff et. al[3] found knee version a unique morphologic characteristic of knee with anterior pain. The present study focuses to establish a relationship between the much used clinical measurement of Q angle and PFPS. The purpose of this study was to investigate whether Q angle abnormalities are present in patients with PFPS.

Methods

Subjects

Subjects included 30 individuals: 15 patients with a diagnosis of PFPS referred to physical therapy and 15 gender matched control subjects that did not have PFPS. Subjects in the PFPS group were included in the study if they were of age between 20-35 years; were diagnosed by a medical doctor; had retropatellar pain; had pain at least in

two of the following - prolonged sitting, ascending and descending stairs, squatting, kneeling; have a current episode of pain. Subjects with PFPS were excluded from the study if they had any of the following:

1. History of patellar dislocation.
2. Knee surgery in past 2 years.
3. A concomitant diagnosis of bursitis, arthritis, ligament injury, peripatellar tendonitis, plica, Osgood schlatter disease.
4. A concomitant musculoskeletal or neurological impairment in the involved lower extremity that influences the gait.
5. Pregnant.

Subjects in PFPS group were tested for impairments in only one lower extremity. The patient's self reported most affected side was considered to be the affected side for subjects with bilateral symptoms. All the subjects who fulfilled the inclusion criteria signed an informed consent.

Procedure

Data for each subject were collected during a single session. A standardized physical examination was performed to rule out presence of any ligamentous or meniscal injury.

The physical examination was performed and the tightness in hamstrings, rectus femoris, tensor fascia latae and gastrocnemius was noted. The results were recorded as the tightness positive or negative. The four commonly used diagnostic tests for PFPS namely vastus medialis coordination test, patellar apprehension test, eccentric step test and Clarke's test were performed and results noted in assessment form. The foot posture was noted on the basis of assessment of the footwear of the subject. The Q-angle was measured in standing and supine.

Q-angle in supine[4] **-** To measure the Q angle, start with the patient's knee and hip in extension, and the quadriceps muscle relaxed. First, place the center axis of a long-arm goniometer over the center of the patella. Next, palpate the proximal tibia and align the lower goniometer arm along the patellar tendon to the tibial tubercle. Take the upper arm of the goniometer and point it directly at the anterior superior iliac spine (ASIS). The small angle measured by the goniometer is the Q angle

Q-angle in standing **-** The subjects were made to stand on a stool bare feet in a normal relaxed stance. The reference points were kept the same as used for Q-angle measurement in supine lying.

A mean value of three readings was recorded as the final value. The Q angle was measured using International standard SFTR pocket goniometer. The measurement of Q angle clinically is considered reliable. Tomish DA et. al[5] tested the intratester and intertester reliability of the goniometric, plurical and visual estimation measurement techniques on 27 healthy subjects. The results suggest that both clinical estimation and instrumented measurement of patellofemoral alignment may be reliable.

Sara A. Piva et. al[6] performed a comprehensive study to test the reliability of measures of impairments associated with PFPS. Moderate values of reliability were observed for measures of Q angle, tibial torsion, hip external rotator strength, lateral retinacular tightness which warrants some caution when interpreting the findings of these results.

In the end the patients were given an information handout and the relevant exercises demonstrated to the patient.

Data analysis

Data analysis has been done using SPSS 10.0 version software. Q angle ranges for various groups was established by calculating the mean and standard deviation for each group. Data for men, women and entire population in both cases and control groups were analysed separately.

Comparison of Q angle of patients suffering from PFPS and normal subjects has been done using the independent t-test. The statistical significance was set at ($p<0.05$) level. Comparison of Q angle in supine and standing has been done using the paired t-test. The percentage sample having various foot types has bean calculated and mean Q angle for each group was determined in both standing and supine position.

Results

The descriptive statistics of Q angle of various groups in supine and standing have been calculated. The minimum, maximum, mean and standard deviation values have been calculated for each group (table 1). Fig. 1 shows all the values in graphical form.

Means and standard deviations of Q angles with respect to gender have been calculated and are shown in (table 2). A comparison of Q angles for PFPS and control group in supine position using independent t-test showed no

Table 1: Q angle measurements of various groups.

	N	Mean	Standard Deviation
Q-Supine	30	14.9277	3.1513
Q-Standing	30	20.999	3.4723
Q-Supine PFPS	15	15.2147	2.8546
Q-Standing PFPS	15	22.4607	3.4346
Q-Supine Normal	15	14.6407	3.4994
Q-Standing Normal	15	19.5373	2.9325

Fig. 1: Q angle of various groups.

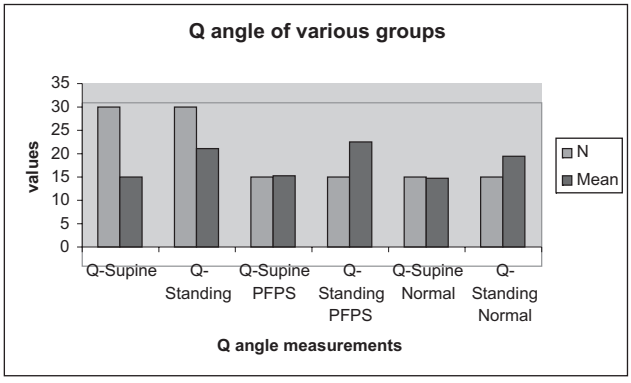


Table 2: Mean Q angles with respect to gender.

	Q-Supine		Q- Standing	
	Mean	Standard Deviation	Mean	Standard Deviation
Males PFPS	12.784	0.8512	20.692	2.1634
Females PFPS	16.43	2.7258	23.345	3.6964
Females Total Sample	16.347	2.6319	21.9685	3.4214
Females Normal	16.264	2.6793	20.592	2.6151
Males Total Sample	12.089	1.9862	19.06	2.8054
Males Normal	11.394	2.6351	17.428	2.5237

Table 3: T test results of comparison of Q angles of PFPS and healthy subjects.

Independent Samples Test

	PFPS Mean±SD	Healthy Mean±SD	t-value	p-value
Q- supine	15.2147±2.8546	14.6407±3.4994	0.492	.626
Q- standing	22.4607±3.4346	19.5373±2.9325	2.507	.018

Table 4: T test for comparison of mean Q angles in various positions.

	Supine Mean±SD	Standing Mean±SD	t-value	p-value
Q- angle	14.9277±3.1513	20.999±3.4723	13.430	.000

significant results (table 3). A comparison of Q angles for PFPS and control group in standing using independent t-test showed significant difference in the Q angle of patients and normal subjects (table 3). A comparison of Q angles in supine and standing position using paired t-test showed significant difference (table 4). Various foot types in sample are shown in table 5. Mean Q angles for each foot type in standing and supine position has been calculated (table 6).

Discussion

The mean q angle in supine position for men, women and total sample is 12.09±1.98, 16.26±2.67 and 14.92±3.15 respectively which is within the normal ranges. The patients with PFPS have a q angle of 12.78±.85 and 16.43±2.72 for males and females respectively. The corresponding control group has a q angle of 12.08±1.98 and 16.26±2.67 for males and females. The above data shows that there is not much difference between the two groups. The total mean q angle of PFPS group came out to be 15.21±2.85 and the mean q angles of the control group in supine position is 14.67±3.49. To compare the two groups student's t-test was applied. The value of t came out to be .532 which is less than the table value thus we accept the null hypothesis that there is no difference in q angle in people with and without PFPS. The results show that the measurement of q angle in the supine position is not significant when performing the clinical examination for PFPS. Caylor D et. al[1] in their study of establishing relationship between q angle and anterior knee pain syndrome produced similar results that no significant difference was found between asymptomatic and symptomatic subjects.

The mean q angle in standing position for men, women and total sample is 19.06±2.80, 20.59±2.65 and 20.99±3.47 respectively. The PFPS and non-PFPS groups have mean q angle of 22.46±3.43 and 19.53±2.93 respectively. Student's t-test was utilized for comparison of means. The value of t came out to be 2.101 which is greater than the table value for given sample thus we reject the null hypothesis. The difference in both the groups is statistically significant. This means that there is difference in q angles in people with and without PFPS in standing position. Sutlive et. al[7] in their study measured the q angle in standing position however it is difficult to avoid contraction of quadriceps in standing rather than supine position. Contraction of quadriceps affect the position of patella and hence q angle. The reliability of measuring q angle in standing position is not well established.

The means and standard deviations of q angle in supine and standing positions are 14.92±3.15 and 20.99±3.47 respectively. The increased q angle in the standing position is worthy of comment. When the lower extremity is in functional position i.e. the person is standing the joints of

Table 5: various foot types in sample.

foot type	males	females	Total
normal	4	9	13
supinated	3	1	4
pronated	3	10	13

Table 6: Q angles for various foot types.

foot type	Q supine	Q standing	Difference
normal	13.91	21.51	7.6
supinated	14.13	20.47	6.34
pronated	15.77	23.55	7.78

lower extremity works in a closed kinematic chain. Any alteration in position of one joint is biomechanically carried to all the joints of lower extremity. When the foot is supinated ther occurs an internal tibial torsion shifting the tibial tuberosity medially, there is femoral neck retroversion thus decreasing the q angle. The opposite sequence of events occurs when the foot is pronated. In the functional position 2-8 of calcaneal varus is considered normal thus increasing the q angle in standing position. Powers et. al, suggested that subjects with PFPS had higher incidence of rearfoot varus.

In the present study the sample was classified broadly into three foot types normal, supinated and pronated depending upon the shoe wear out patterns. Out of 30 subjects, 13 had normal foot type 4 were classified as supinated and 13 under pronated foot type. In the sample taken females had a greater incidence for pronated feet than males. Out of a total of 13 subjects having pronated foot 10 were females.

The difference in q angles by change in position from supine to standing came out to be 7.6, 6.34 and 7.78 for normal, supinated and pronated foot types. The less increase in q angle by change in positions in subjects with supinated foot is due to the linked biomechanics and decreased q angle due to foot supination as discussed earlier. However, not much difference is present in subjects with normal and pronated foot types. This may be because of the reason that the exact degree to which foot pronation was present was not measured by shoe wear out patterns. Shoe wear out patterns do not provide detail information about the foot posture but can provide useful information to the clinician examining patients with PFPS as soft foot orthoses have proved to be effective in treatment of PFPS.

The limitation of this study is that the sample taken is small so the results cannot be generalized to the entire population. Future studies are required with a larger sample and blinding the tester to the subject. The use of specific method to find out the exact degree of foot pronation can be another area which requires further study.

Conclusion

The study was designed to find out role of Q angle in PFPS. Interestingly, our results have shown a significant difference in Q angles of patients with and without PFPS when measured in standing position. However, no differences were found in Q angles of the groups in supine. From the interpretation of the data it can be concluded that Q angle invariably remains an important clinical test for the diagnosis of PFPS. The test performed in standing position can give significant findings about the morbid status compared to the classical method of performing the test in supine position.

On change of position from supine to standing the Q angle increases due to the effect of linked biomechanics of lower extremity.

Foot position significantly affects the Q angle with foot pronation increasing and foot supination decreasing Q angle. Thus while examining a patient with PFPS we should take into consideration the foot type and biomechanical measures like Q angle.

References

1. Caylor D, Fites R, Worrell TW: The relationship between q angle and anterior knee pain syndrome, J orthop sports phys ther 1993, 17(1) 11-16.
2. Thomee R, Renstrom P, Karlsson J, Grimby G: PFPS in young women. A clinical analysis of alignment, pain parameters, common symptoms and functional activity level, Scand J Med Sci Sports 1995, 5(4): 237-44.
3. Eckhoff DG, Brown AW, Kilcoyne RF, Stamm ER: Knee version associated with anterior knee pain, Clin. Orthop Relat Res 1997, (399): 152-5.
4. Magee DJ. Orthopedic Physical Assessment. Philadelphia: WB Saunders, 1987:296.
5. Tomish DA, Nitz AJ, Threlkeld AJ, Shapiro R: Patellofemoral alignment reliability 1996, 23(3) 200-8.
6. Sara R Piva, Kelly F, James J Irrgang, S Jones, B R Hondo, D A Browder, J D Childs: Reliability of measures of impairments associated with patellofemoral pain syndrome, BMC Musculoskeletal disorders 7:33, 2006.
7. Sultive TG, Mitchell SD, Maxfield SN, McLean CL, Neumann JC, Swiecki CR, Hall RC, Bare AC, Flynn TW: Identification of individuals with patellofemoral pain whose symptoms improved after a combined program of foot orthosis use and modified activity: A preliminary investigation, Phys Ther 2004,84: 49-61.

Mirror therapy in stroke rehabilitation

Deepti Goel*, Sharad Goel**

*M.P.T, Neuro, Lecturer, Banarsidas Chandiwala Institute of Physiotherapy, New Delhi, **M.P.T, Neuro, Senior Physiotherapist, Physiotherapy Deptt., Sarvodaya Hospital, Faridabad

Overview

Mirror Therapy is a form of Imagery in which a Mirror is used to convey visual stimuli to the brain through observation of one's unaffected body part as it carries out a set of movements. It was first described by V.S Ramachandran[7]. The underlying Principle is that movement of the affected limb can be stimulated via visual cues originating from the opposite side of the body. Hence, it is thought this form of Therapy can prove useful in Stroke patients who have lost movements of an arm or leg.

Key words

Stroke, Mirror Therapy, Visual Feedback

Introduction

Mirror Therapy helps in Stroke Rehabilitation. Stroke Rehabilitation has been revolutionized in the last decade through a combination of new techniques looking at brain recovery. Advances in basic sciences and clinical research are beginning to merge and show that the human brain is capable of significant recovery after Stroke, provided that the appropriate treatments and stimuli are applied in adequate amounts and at the right time[6]. What is particularly exciting is the introduction of new therapies to further enhance the recovery. One of the newest therapy currently under study is Mirror Therapy in Stroke Rehabilitation. Individuals with Hemiparesis typically demonstrates spasticity, muscle weakness and a persistent deficit in Movement co-ordination. Such in-coordination occurs at least in part because the neural circuitry responsible for mediating an action intention, and an executed action that precisely reflects that intention, is no longer intact either as a consequence of brain injury or secondary to immediate disuse[1,5]. Visual Stimuli enhances Neuroplastic changes within the brain. Evidence of cortical reorganization of primary somatosensory cortex by visual feedback.(*Mai Hofner et al 2003-04).* When normal somatosensory feedback is missing, visual feedback restores the information flow from the posterior parietal cortex to the Pre-motor cortex (*Altschuler et al, 1999)* Recruiting the Premotor Cortex or rebuilding the Motor Programme in the Premotor cortex by Providing Visual feedback could reduce pain and facilitate the limb movement*(Rothgangel, 2004)* To achieve visual feedback, patients can be treated with Mirror Therapy in which their limbs are separated by a Mirror. By looking in the Mirror at the unaffected side, patients can be 'fooled' in believing that the affected limb is moving effortlessly **(***Ramachandran and Hirstein, 1998)*[11].

Mental images of movement can be generated independent of overt behavioral output of a paretic limb. Humans are equipped with a simulation network that positions the motor system in anticipation of movement execution and provides the self with information about the possibility and meaning of upcoming actions[2,4]. The processes underlying motor imagery are similar to those active during actual movement. Actions generated using motor imagery adhere to the same rules and constraints that physical movement's follow and the neural network involved in motor imagery and motor execution overlap, primarily in the premotor and parietal areas, Basal Ganglia and Cerebellum[5].

How it's used

Using a Mirror Therapy is easy, by placing the affected limb(hand or foot) in the mirror box and unaffected limb in front of the mirror. Then using both limbs to do the gentle symmetrical exercises. It is very important to practice symmetrical movements only when the using the mirror. Asymmetrical movements for e.g. keeping the hand still and moving the hand outside the box or vice versa, may make the condition worse. Some patients may find using the Mirror difficult at first and more painful. If you find this then consider practicing to visualize moving the limb first, think about easy movement initially such as clenching of toes or fingers and then move onto visualizing more complex and this may take several weeks. Improvement comes with repeated exercises. This Mirror box is made up of high quality polystyrene mirror which is foldable, making it truly portable, collapsible and light weight, this helps the patient to do exercises wherever and whenever patient wish.*(V.S Ramachandran)*

Literature review

Various Research groups described the use of Mirror Therapy For Stroke Rehabilitation:

Yavuzer G., Selles R., Sezer N., Sütbeyaz S., Bussmann J.B., Köseoglu F., Atay, M.B., Stam H.J.(2008)

40 patients, mean age 63.2, within 12 months post stroke were recruited and randomized to one of two treatment groups. The mirror group (n=20) participated in non-paretic side wrist and finger flexion and extension movements (while viewing a mirror image of the non-paretic limb in a mirror placed vertically between hands) in conjunction with standard rehabilitation. The control group (n=20) underwent standard rehabilitation in conjunction with a placebo version of the mirror treatment described above, where the mirror treatment was the same except that the unreflective side of the mirror was used. The treatments were carried out through a period of 4 weeks with a follow-up at 6 months (both real and placebo mirror treatments were 30 minutes per day, and standard therapy was 5 days per week, 2-5 hours per day). Assessments at baseline, 1 month (post-treatment) and 6 months (follow-up) were obtained on hand and upper extremity motor recovery as measured by the Brunnstrom stages, on hand related function as measured by the self-care items of the Functional Independence Measure, and on spasticity as measured by the Modified Ashworth Scale. Immediately following treatment, patients who received mirror therapy in addition to conventional therapy showed significant improvement in scores of the Brunnstrom stages for the hand and upper extremity as well as in the FIM self-care score (all p<.01). The above measures also showed statistical significance in favour of the mirror group for between-group differences measured from post treatment to 6 months follow-up (all p <.05). No significant between-group differences in improvement were found at either measured time for spasticity (p=0.925 - 4 weeks, p= 0.875 - 6 months follow up)[12].

Sütbeyaz S., Yavuzer G., Sezer N., Koseoglu B. F. (2007)

40 patients, mean age 63.5, within 12 months post stroke were recruited and randomized to one of two treatment groups. The mirror group (n=20) underwent non-paretic ankle dorsiflexion movement (while viewing a mirror image of the non-paretic limb in a mirror placed on the mid- sagittal plane and imagining it to be the paretic limb that was moving) in conjunction with standard rehabilitation. The control group (n=20) underwent standard rehabilitation in conjunction with a placebo version of the mirror treatment described above, where the mirror treatment was the same except that the unreflective side of the mirror was used. The treatments were carried out through a period of 4 weeks with a follow-up at 6 months (both real and placebo mirror treatments were 30 minutes per day, and standard therapy was 5 days per week, 2-5 hours per day). Assessments at baseline, 1 month (post-treatment) and 6 months (follow-up) were obtained on lower-extremity motor recovery as measured by the Brunnstrom stages, on motor function as measured by the functional Independence Measure, on spasticity as measured by the Modified Ashworth Scale, and on walking ability as measured by the Ambulation Categories. At 1 month, patients showed significant improvements in all categories and continued to improve to follow-up. Statistical analysis for between-group differences was only provided for improvement from baseline to follow-up (6 months). At follow-up the mirror therapy group showed significantly more improvement compared to the control group according to the Brunstrom lower limb stages (p=.002) and the Functional Independence Measure score (p=.001). No significant between-group differences in improvement were found for spasticity (measured by the Modified Ashworth Scale, p = .102) or walking abilities (measured by the Functional Ambulation Categories, p = .620)[9].

Garry M.I., Loftus A., Summers J.J. (2004)

8 neurologically healthy individuals performed index-thumb opposition on one hand in each of the 4 following conditions: active (viewing the active hand), inactive (viewing the inactive hand), central (viewing a piece of tape midway between the hands) and mirror (viewing the mirror image of the active hand in a mirror placed in the mid-sagittal plane). A TMS pulse was aimed at the subjects' primary motor cortex in order to induce a muscle contraction of the contra lateral hand (inactive hand), in the conditions measured above, and at rest. The occurrence and the intensity of the muscle contraction, and thus of M1 activity, were measured using EMG of the first dorsal interossei muscle. The mirror condition yielded the best results in terms of excitability, and reached statistical significance (p < .05) when compared to all studied conditions other than the active condition (p=0.069) which approached significance. This observation suggests that watching the mirror image of the active hand superimposed over one's inactive hand increases the likelihood of a contraction to being produced by TMS of the primary motor cortex (M1 area), implying that the activation threshold of the M1 motor neurons is decreased by mirror therapy in healthy subjects[3].

Stevens J.A., Stoykov P.M.E. (2003)

Two individuals with post-stroke upper limb hemiparesis, 14 months post-stroke (patient #1) and 6 years, 2 months post-stroke (patient #2) received a motor imagery training program: imagining movements of the wrist (extension, pronation, supination) and receiving mental stimulations of reaching as well as manipulating objects using a mirror box apparatus (the patient sits perpendicular to a mirror and watches their non-paretic arm move through space, while using the mirror to imagine that it is their paretic arm that is moving). This one hour training program was done 3 times per week for 4 consecutive weeks. The outcome measures include two standardized clinical assessments (Fugl Meyer Upper Extremity Motor Function Test, arm and hand dimension of the Physical Impairment Inventory of the Chedoke-McMaster Stroke Assessment), grip strength, wrist movement and 3 standardized measures of wrist functionality (Jebsen Test of Hand Function: light object, Jebson: heavy object, Jebson: card turning). Both patients showed an improvement (no p value indicated) in the performance of their paretic limb after the intervention, with patient #1 showing greater improvement. These improvements for both patients remained stable at 3 months follow-up[10].

Sathian K., Greenspan A.I. & Wolf S.L. (2000)

A 57 year old male, 6 months post-stroke who reported difficulty moving his right side, and right-sided paraethesias, received a program consisting of weekly physical therapy visits at home (intensity of intervention is unknown). The initial intervention was to use a "motor copy" strategy that involved using a mirror to attempt bimanual upper extremity movements. As a progression to this intervention, the patient closed his eyes and focused on somatosensory cues from the intact limb and residual cues from the affected one. As the patient's motor function began to improve, daily activities using the affected limb (forced use) were implemented.

Outcome measures were grip strength, shoulder flexibility and time to complete common daily tasks (e.g.. pick up a pen, fold a towel into quarters etc). Following this progressive regimen, the patient improved in all these areas and was better able to use his affected hand in daily activities, such as dressing and inserting a key in a lock with greater precision and ease of movement[8].

Discussion

The purpose of this article is to synthesize the relevant literature about Mirror Therapy in order to facilitate its integration into Physical Therapist Practice. The literature suggests that the encouraging effects of Mirror Therapy improves the functional outcomes after Stroke by Facilitating Plastic re-organization of the cortex in the brain in response to visual feedback. Thus, Mirror may provide a valuable tool to access the Motor network and improve outcome after stroke.

References

1. Beer RF, Dewald JP, Rymer WZ. Deficits in the coordination of multijoint arm movements in patientswith hemiparesis:evidence for disturbed control of limb dynamics. Exp Brain 2000;131:305-19.
2. Decety J, Grezes J. Neural mechanisms subserving the perception of human actions. Trends Cogn Sci 1999;3;172-8.
3. Garry M.I, Loftus A, Summers J.J (2004); Mirror on the wall; viewing a Mirror reflection of unilateral hand movements facilitates ipsilateral M1 Excitability. Exp Brain, 163, pp 118-122.
4. Jeannerod M. Neural simulation of action; a unifying mechanism for motor cognition. Neuro image 2001;14;S103-9.
5. Jennifer A. Stevens, phD, Mary Ellen Phillips Stoykov, MS.OTR/L; using Motor imagery in the Rehabilitation of Hemiparesis : Archieves Phys Med Rehabilitation:july 2003;vol.84;1090-2.
6. Robert W.Teasel, MD Lalit Kalra, MD: What's new in Stroke Rehabilitation; American Heart Association; inc: 2004:35;383-385.
7. Ramachandran VS, Rogers-Ramachandran D. Synaesthesia in phantom limbs induced with mirrors. Proc R Soc Lond B Biol Sci 1996;263;377-86.
8. Sathian K: Greenspan A.I & Wolf S.L (2000): Doing it with mirrors: A Case study of a novel approach to Neurorehabilitation: Neurorehabilitation neural repair, 14(1), 73-76.
9. Sutbeyaz s., Yavuzer G., Sezer N., Koseoglu B.F.(2007); mirror Therapy enhances lower extremity motor recovery & motor functioning after Stroke: Archieves Phys Med Rehabilitation, 88, 555-559.
10. Stevens J.A., Stoykov P.M.E. (2003). Using motor imagery in the rehabilitation of hemiparesis; Arch Phys Med Rehabil, 84(7), 1090-2.
11. Y.I.G. Vladimir Tichelaar, jan H.B Geertzen, Doeke Keizer and C.Paul Van Wiligen: Mirror box therapy added to cognitive behavioral therapy in three chronic complex regional syndrome type1 patients; international journal of rehabiitation Research 2007,30;181-188.
12. Yavuzer G., Selles R., Sezer N., (2008); Mirror therapy improves hand function in Subacute Stroke; Archieves Phys Med Rehabilitatiion,89, 398-398.

Orofacial pain management: A physical therapy perspective

Deepti Chhabra*, Preeth Cherian**

*Lecturer, College of Applied Education and Health Science, Meerut, UP, **Asst.Prof. MCOAHS, Manipal

Introduction

The presentation of head and neck pain is a complex area of clinical practice. It can involve symptoms arising from a great number of sites relating to conditions of dental, musculoskeletal and upper respiratory systems[3]. As the pain of this distribution is orofacial, the dental surgeons more often see it than the physiotherapists.

The term Craniomandibular Dysfunction (CMD) is being used to describe the complex condition involving abnormal jaw mechanics, associated with facial pain incorporating dysfunction of masticatory muscles and temporomandibular joint (TMJ).

Such kind of pain syndromes is commonly encountered in daily practice of physiotherapy. But, these syndromes are often poorly managed and misdiagnosed because of the failure of clinicians to recognize and appreciate the significance of muscular dysfunction in the presentation of their patient's sign and symptoms. However, evaluation of the voluminous literature reveals a strong myofascial component to the syndrome, involving not only the masticatory muscles, but also those of the cervical region as well. In this study we have reviewed the role of cervical and masticatory muscle in the development of orofacial pain and the effectiveness of trigger point release therapy in such syndromes.

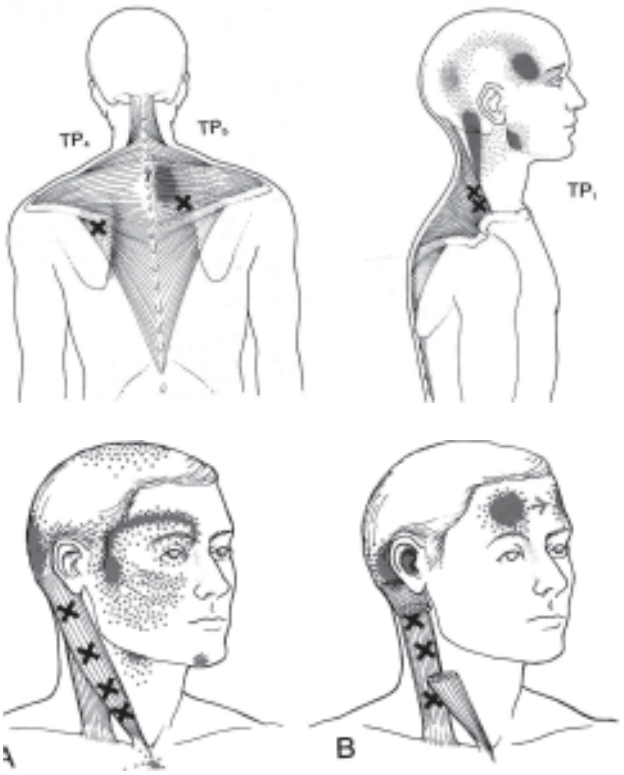
Patient History

The patient was a 22 yr old female, a student, referred to the physiotherapy department by the Orthodontics department. She described her pain as being primarily located in cheeks, neck and upper back. Along with this she complained of frequent headaches and a feeling of fullness in the ears. She was not able to eat solid food and could not sustain her routine activities for more than thirty minutes due to early fatigue of masticatory muscles. Pain was dull, aching and constant in nature which was further aggravated by stress or any other activity and rest relieved it. She had positive history of night Bruxism[1] (grinding or gnashing of the teeth when not masticating or swallowing).

On observation her attitude revealed following findings:
Forward head posture (FHP),
Protracted shoulders and,
Short neck.

Musculoskeletal examination revealed tightness of moderate degree bilaterally in the following musculature-sternocleidomastoid, scalenes, suboccipital, trapezius (all fibers) and pectorals. Cervical mid-end range of motion was limited due to pain. There was limited mouth opening of three centimeters.

On palpation, trigger points were found in sternocleidomastoid, masseter, pterygoid, and Trapezius, as illustrated below:



She was using a night splint designed by orthodontics department for Bruxism.
Visual Analogue Scale (VAS) score for jaw pain was 5
Visual Analogue Scale (VAS) score for neck pain was 5
Temporomandibular dysfunction (TMD) score[4] was 14

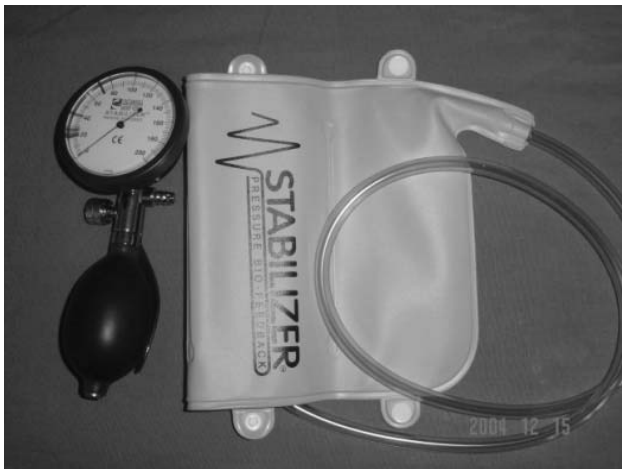
Treatment

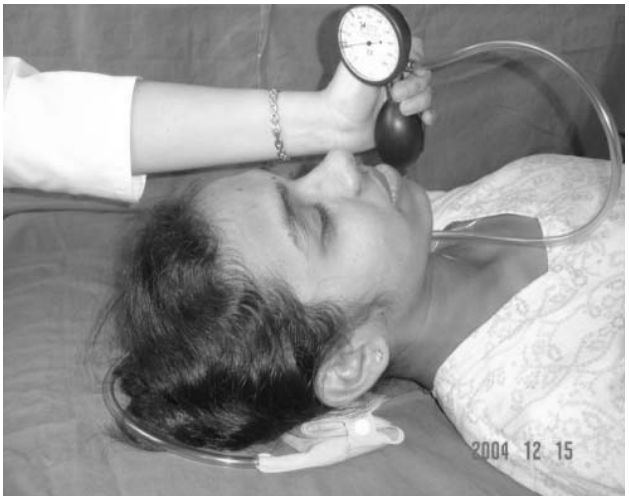
The patient was seen for a period of seven visits consecutively (except Sundays).

The first treatment session began with heat application followed by trigger point release, which included graded ischemic compression to taut bands in the suboccipital, upper and middle trapezius. This release was followed by the application of Muscle Energy Techniques (MET). Cervical retraction exercises were taught using pressure biofeedback (Chattanooga). Postural correction was also emphasized.

On day two, the same protocol was followed. The patient complained of slight increase in the neck pain and on re-assessment VAS was 7.

Day three, the same treatment was continued VAS score returned to 5. More aggressive home exercise programme (HEP) was prescribed which included cervical and shoulder retraction exercises, self-stretching for pectorals and trapezius[1].





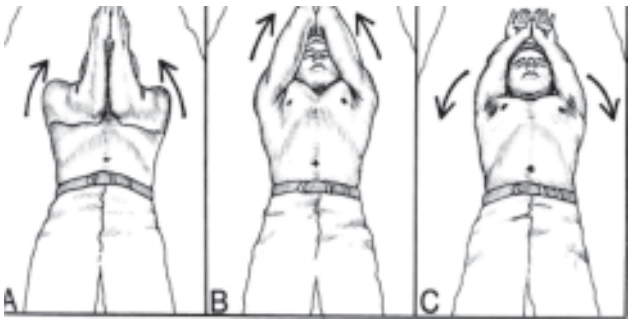
The trapezius muscle self-stretching was taught in the following manner:

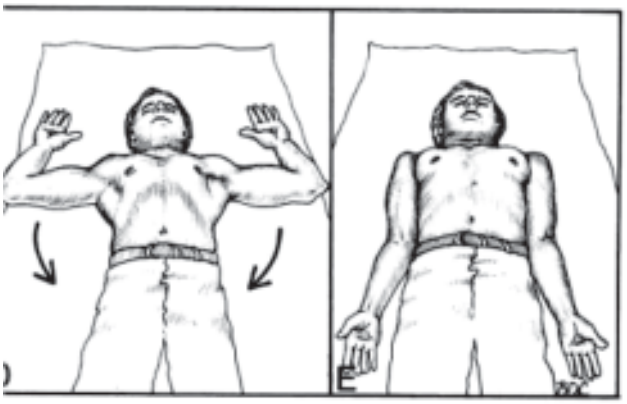
Upper trapezius- passive side-bending neck exercises.

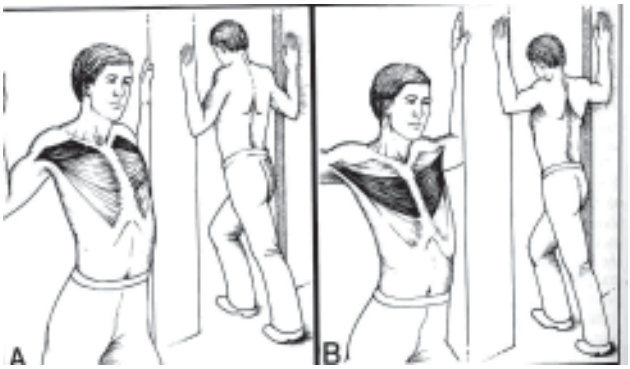
Middle and lower trapezius- patient lies supine on the floor. Place the elbows, forearms and palms of the hand together in front of the abdomen. Keep elbows tightly together for a count of ten while raising forearm over face. Then, drop forearms past the ears to the floor. Keeping the back of elbows and wrist in contact with the floor, swing the arms down against the sides of the body. Pause and relax, repeat the cycle.

The doorway stretches were taught for all the fibers of pectoralis muscle.

Day four, same treatment continued and trigger point release of sternocleidomastoid and lower trapezius also added followed by MET.







Day five, same treatment continued.

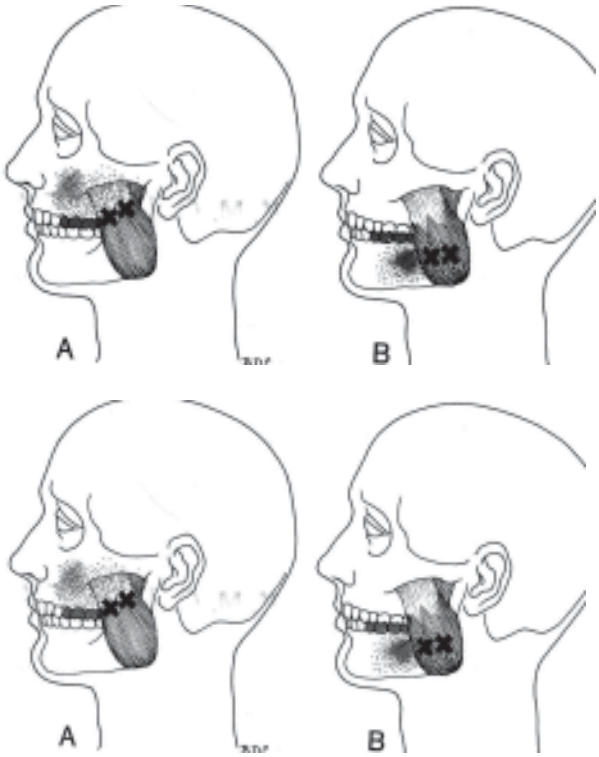
Day six and seven, TrP release of masseter was also done (Travell & Simons suggests that for TrP release of this muscle, the jaws are propped open with the muscle on a tolerable stretch and release is done using pincer grip. Since, our patient had painful limitation of mouth opening;

Day four, same treatment continued and trigger point release of sternocleidomastoid and lower trapezius also added followed by MET.

Day five, same treatment continued.

Day six and seven, TrP release of masseter was also done (Travell & Simons suggests that for TrP release of this muscle, the jaws are propped open with the muscle on a tolerable stretch and release is done using pincer grip. Since, our patient had painful limitation of mouth opening;

Patient was re-assessed and asked to come for the follow-up after two weeks.



The three theories proposed for the etiology are[3]

1) **Muscular:** this theory strongly argued by Travell & Simons, looks at the problem from the perspective of muscle imbalance, focusing mainly on masticatory musculature. These muscle changes do not necessarily involve increased EMG activity. The results of tight musculature leads to altered TMJ mechanics, including hypomobility and increased wear on the joints elsewhere in the body and eventual degenerative changes. Malocclusion can result from tightened muscles as the normal synergist-agonist relationship is disturbed, leading to a loss of smooth coordinated movement.
2) **Psychological:** this theory proposes that most of the symptoms are due to stress, tension, or emotional disturbances, leading to increased muscular activity as seen in bruxism especially in night. Bruxism and clenching eventually lead to changes in the dentition and muscles thus causing TMJ disorders, muscular imbalance and eventual malocclusion.
3) **Malocclusion:** use of splints, which prevents premature contact thus, giving considerable relief to patient, strongly supports this theory. Some authors believe that occlusal disharmony is the cause of muscular dysfunction. The cause of premature contact can be due to trigger points in the masticatory muscles therefore it is very important to relieve all these trigger points before splinting.

The results are summarized in the table given below:

Outcome Measures	0 week	1 week	3 week	6 week
Jaw Pain (VAS)	5	1	1	0
Neck Pain (VAS)	5	1	0	0
Headache Mouth opening	frequent 3cm	frequency ↓ 5cm	frequency↓↓ 5cm	frequency ↓↓ 5cm
Diet	liquid	semi solid	semi solid	semi solid
Fatigue	severe	moderate	nil	nil
TMD score	14	——-	——	4
TMD (SIS)	20	——-	—-—	3
TMD (SFS)	31	——-	——-	3

NB: i. TMD scores were taken pre-intervention and at final follow up i.e. at sixth week, only.
ii. TMD Symptom Intensity Scale (SIS)[4]
iii. TMD Symptom Frequency Scale (SFS)[4]

Outcome

Every treatment session began with re-assessment, however, for analysis purpose data were recorded before treatment, after 1week, 3 weeks and 6 weeks

Discussion

The cervical musculature is a well-known source of head and neck pain and in particular trigger point activity of these muscles quite often presents as head and facial pain and sometimes with symptoms of cervical region itself. Trigger points of this region have been well documented as a source of referred pain to head and face. Head posture can also influence the stomatognathic function and 'Sliding Cranium Theory' supports this by explaining how head posture may perpetuate, if not initiate, orofacial pain.

Haygure et al, 1992, in their study have clearly demonstrated the relationship between head and masticatory muscle imbalance and that FHP is often seen in patients with orofacial pain[3].

This study thus analyses and outlines the effect of cervical spine involvement on mandible positioning and movement. It is therefore critical that both cervical and masticatory muscles are examined for shortening and TrP activity. This study opens avenues into further double-blinded comparative trials in the treatment of OFP using various modalities and techniques thus adding new dimensions to the management of this complex condition, which is often an enigma to treat.

References

1. Myofascial Pain and Dysfunction-The Trigger Point Manual, Janet G. Travell; Davis G. Simons.
2. Clinics in Physical Therapy–Temporomandibular Disorders 2nd edition, Steven L./ Kraus.
3. Andrew J Gallagher-The Myofascial Component of Facial Pain, golden-orb.com/pain-education/100136.php
4. J Orthop and Sports Phys Ther, Vol. 34, No. 9, Sep 2004.

Different therapeutic responses to the clinical treatment of elephantiasis

José Maria Pereira de Godoy*, Maria de Fátima Guerreiro Godoy**

*Livre Docente of the Cardiology and Cardiovascular Surgery Department of the Medicine School in São José do Rio Preto (FAMERP), Brazil: Professor of the Graduation and Post Graduation Courses of FAMERP, ** Post Doctorate student of the Strictu Senso Post Graduation Course of the Medicine School in São José do Rio Preto and professor of the Lato-Sensu Post Graduation Course on Lymphovenous Rehabilitation of FAMERP, Brazil

Abstract

The objective of the present study is to report on different responses to intensive clinical treatment of elephantiasis. The cases of three patients who were submitted to intensive clinical treatment for elephantiasis of the lower limbs are reported. The patients were treated for weekly periods with intervals between to permit the skin to adapt to the new size. The first, a 24-year-old patient who had suffered from lymphedema since the age of 12 and presented with an initial leg circumference of 89 cm, was submitted to intensive treatment for six to eight hours per day for one week. In the first week the patient lost 20 cm in circumference and 10 kg in weight. In the following sessions, the losses were smaller, but continuous and varied according to the treatment. The second, a 42-year-old patient who had also suffered from lymphedema since the age of 12, had been submitted to surgeries that led to the development of intense fibrosis of the limb. For this patient the reductions were smaller, varying around 2 cm per month, even so the improvement was progressive. The third patient was 42 years old and had suffered from lymphedema since the age of 12 and presented with an initial leg circumference of 94 cm. In the first week the patient lost 20 cm in circumference and 12 kg in weight. In the following sessions, the losses were smaller, but continuous and varied according to the treatment. In conclusion, in the clinical treatment of elephantiasis, the therapeutic responses are different with fibrotic lymphoedema being more difficult to treat than fibroedematous lymphoedema.

Key Words

Elephantiasis, lymphedema, intensive treatment, evaluation.

Introduction

Lymphedema is a chronic disease characterized by the abnormal accumulation of fluids and other substances in the tissues resulting from a failure in the lymphatic drainage system associated with proteolysis of the cell interstice and mobilization of macromolecules such as hyaluronic acid[1,2].

Over the last few years, clinical treatment has been recommended as the main approach to lymphedema[3,4] following the basic principles of an association of therapies including: manual[5-8] and mechanical[9,10] lymph drainage, bandaging[11,12], medications to prevent infections[13], exercises [16,17] and continuous psychological guidance[18,19].

Elephantiasis is the most advanced form of lymphedema, where the dimorphism of the limb is a notable characteristic. Clinical treatment becomes more complicated due to the difficulties encountered. Intensive outpatient treatment for six to eight hours daily may be a therapeutic option permitting large volumetric and anthropometric improvements within a few days. The aim of this study is to emphasize different responses to intensive clinical treatment of elephantiasis in an outpatients' clinic.

Case Report 1

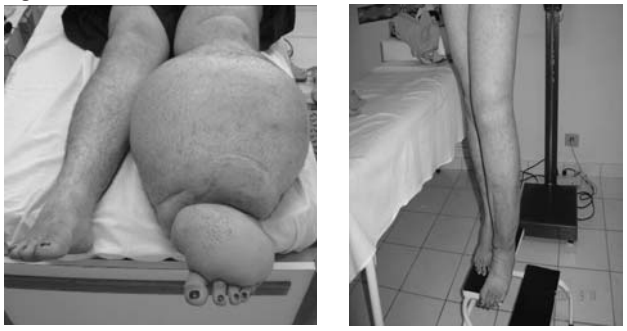
A 24-year-old woman referred by social services of her home town arrived in the outpatients' clinic with a history of lymphedema of the left leg since the age of 12 years. She reported that she had been successfully submitted to several types of treatment. In the initial perimetry evaluation, her leg had a circumference of 89 cm at its greatest diameter and presented much deformity (Fig. 1A).

The patient was submitted to intensive treatment of six to eight hours daily for one week, which included: manual lymph drainage using the Godoy Technique[6-8], mechanical lymph drainage using the RAGodoy® apparatus[9,10] and compression with a low-elastic stocking made of a cotton-polyester (*gorgurão*) material[20]. In the first week she lost 20 cm in perimeter and 10 kg. In the following weeks the losses were less however the decrease in the size of the limb was continuous with variations depending on the intensity of treatment. At this moment after 4 weeks of treatment the difference between the legs is 675 grams (Fig. 1B).

Case Report 2

In this case of a 42-year-old patient, with lymphedema since the age of 12, the patient underwent the surgical implantation of threads at age 16 resulting in rejection and

Fig. 1: A and B. After and before treatment.



Corresponding Author:

José Maria Pereira de Godoy

Rua Floriano Peixoto, 2950
São José do Rio Preto, SP, Brazil
Zipe code 15020-010
godoyjmp@riopreto.com.br

infection of the threads which needed to be removed. Subsequently, the patient was unsuccessfully submitted to several types of clinical treatment and recently was attended in the Outpatients Clinic. A physical examination identified intense fibrosis characterized by hardness on palpation without the formation of pitting on depression (negative *Godet* sign) or verrucosity in the foot. An intensive course of treatment was performed for six hours per day, however the patient only presented with small, albeit continuous, losses of about 2 cm monthly and currently after two years of treatment there is a difference of 540 grams between the two legs. Initially treatment was daily for a period of one year. Subsequently, the program was changed to two sessions per week and currently she is submitted to one monthly session with the volume of the limb showing improvements at every evaluation.

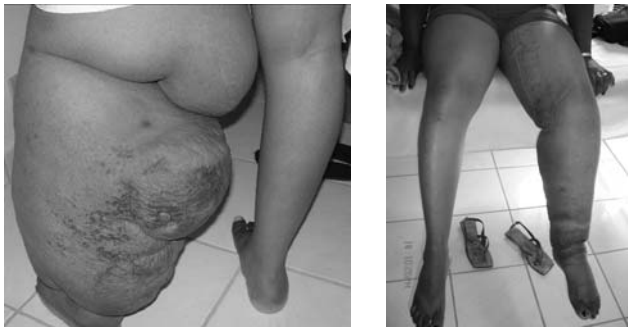
Case Report 3

A 42-year-old female patient was consulted in the clinic with a history of lymphedema of the leg since the age of 12 years old. She was unsuccessfully submitted to several types of treatment and the lymphedema evolved to elephantiasis. The leg had a circumference of 94 cm in the initial perimetric evaluation. The patient underwent intensive treatment of six to eight hours daily (manual lymph drainage using the Godoy Technique, mechanical lymph drainage using the RAGodoy® apparatus and compression using a stocking made of a cotton-polyester (*gorgurão*) material) and lost 20 cm of circumference and 12 kg in the first week of treatment. The losses were continuous during the treatment. Fig. 2A and 2B show the leg at the start of treatment and during the treatment, respectively. Currently the difference between legs is 1200 grams.

Discussion

Intensive treatment is a therapeutic option that allows considerable volumetric and perimetric reductions within a short period of time. These case reports show differences in the clinical response to the same treatment strategy for Grade III lymphedema (elephantiasis). Note with the edematous pattern of Cases 1 and 3, the reduction was significant within a short period of time (20 cm) and Case 2 where the losses were smaller and almost insignificant compared to the other two cases. These reports demonstrate that although all patients presented with Grade III lymphedema (elephantiasis) the stages were probably histologically different; the degree of fibrosis seems to be an important factor in the therapeutic response. One of the main hypotheses to justify large volumetric reductions in just a few days may be the mobilization of macromolecules such as, for example, hyaluronic acid. Hyaluronic acid is produced in the cell interstice and follows the same route as high-molecular-weight proteins, which are drained by the lymphatic system. This acid has a receptor in the endothelium of lymph nodes with around 85% being lysated during this passage[21,22]. The characteristic of these acids is that they can retain 100 times more water than their dry weight. This datum suggests that intensive treatment should be individually analyzed for each patient. A positive therapeutic response was observed in all three cases, but maintenance is important even when weight losses are small. Over time these small losses become significant and may even reach a total resolution of the edema.

Fig. 2: A and B. Show start of treatment and during the treatment.



In Grade I and II lymphedema, total reduction occurs within a few days, however maintenance is necessary for more days to remove subclinical lymphedema. Before solving the problem of subclinical edema the treatment should not be interrupted in order to prevent the early relapse of edema.

The intensive treatment in this work consisted of manual lymph drainage using the Godoy Technique, mechanical lymph drainage using the RAGodoy® apparatus and compression stockings made of a cotton-polyester material. The outpatient program was well tolerated by the patients and represents a new option to treat this disease. Losses in intensive treatment are limited by the formation of cutaneous folds that lead to pinching the skin during the use of compression stockings or bandaging, which in turn leads to pain and patient intolerance. In this case, the form of treatment should be changed from intensive to intermittent (weekly, two-weekly or monthly). This strategy permits readjustment of the skin with physiological retraction thereby possibly avoiding surgical resection. In this period the use of compression should be compulsory and continuous, preferably both during the day and at night. Additionally the patients should be recommended to perform daily myolymphokinetic exercises.

This type of treatment has been performed for four years now and the patients have benefited in a relatively short period of time, enabling them to perform their day-to-day activities close to normal. These results are easy to reproduce and have been replicated in other treatment centers.

Conclusion

In conclusion the clinical treatment of Grade III lymphedema (elephantiasis) produces different clinical responses with more difficulties when the lymphedema is predominantly fibrotic compared to fibroedematous. Maintenance of the treatment is essential.

References

1. Foldi M, Foldi E, Kubik S. Lymphostatic Disease. In Textbook of Lymphology for Physicians and Lymphedema Therapists Munich: Urban & Fischer, 2003.p.231.
2. Godoy JMP, Godoy MFG, Braile DM, Testoni B, Sanches RG. Dynamic evaluation of working pressures with gorgurão sleeves used in the treatment of lymphedema of the arm. Journal of Phlebology and Lymphology 2008; 1(1):5-7.

3. Casley-Smith JR, Boris M, Weindorf S, Lasinski B. Treatment for lymphedema of the arm—the Casley-Smith method: a noninvasive method produces continued reduction. Cancer. 1998 Dec 15;83(12 Suppl American):2843-60.
4. Ciucci1 JL, Krapp JC, Soracco JE, Ayaguavella J, Marcovecchio LD, Salvia C, et al.. Changes in clinical management and the evolution of an interdisciplinary therapeutic approach: 640 lymphedema patients over 20 years J Vasc Bras 2004;3(1):72-6.
5. Foldi M, Foldi E, Kubik S. Lymphostatic Disease. In Textbook of Lymphology. For Physicians and Lymphedema Therapists. Munich: Urban & Fischer, 2003 p.280.
6. Pereira de Godoy JM, Braile DM, de Fatima Guerreiro Godoy M. Lymph drainage in patients with joint immobility due to chronic ulcerated lesions. Phlebology. 2008; 23(1):32-4.
7. Godoy Godoy JMP, Godoy MFG. Lymphatic drainage. A new concept. J Vasc Br 2004; 3(1):77-80.
8. Godoy JMP, Braile DM, Godoy MFG. A Thirty-month Follow-up of the Use of a New Technique for Lymph Drainage in Six Patients. European Journal Vascular Endovascular Surgery 2002, 3: 91-3.
9. Godoy MFG, Godoy JMP, Braile DM. Desarrollo y evaluación de un aparato para el drenaje de edemas. Angiología 2006; 58(6):505-7.
10. Godoy JMP, Godoy MFG. New apparatus for mechanical lymph drainage in association of therapies in treatment of lymphoedema. Acta Phlebol 2005;6:125-8
11. Godoy JMP, Godoy MFG. Assessment of inelastic sleeves inpatients with upper limb lymphoedema. Indian Journal of Physiotherapy and Occupational Therapy 2007;1(4):3-5.
12. Thomas O' Donnell. Principles of Medical and Physical Treatment. In Browse SN, Burnand KG, Mortimer OS Disease of the Lymphatics. London: Arnold, 2003. p.167.
13. Badger C, Seers K, Preston N, Mortimer P. Antibiotics / anti-inflammatories for reducing acute inflammatory episodes in lymphoedema of the limbs. Cochrane Database Syst Rev. 2004;(2):CD003143.
14. Godoy MFG. Activities of daily life in the treatment of lymphedema. Lymphology 2002/03; 35(Suppl 2): 213-5.
15. Godoy MFG, Godoy JMP, Braile DM. Pilot study with Myolymphokinetic activities in the treatment of lymphedema after breast cancer. Indian Journal of Physiotherapy and Occupational Therapy 2008; 2 (3):17-19.
16. McKenzie DC, Kalda AL. Effect of upper extremity exercise on secondary lymphedema in breast cancer patients: a pilot study. J Clin Oncol. 2003 Feb 1;21(3):463-6.
17. Ogawa Y, Hayashi K. 99mTc-DTPA-HSA lymphoscintigraphy in lymphedema of the lower extremities: diagnostic significance of dynamic study and muscular exercise. Kaku Igaku 1999;36(1):31-6.
18. McWayne J, Heiney SP. Psychological and social sequelae of secondary lymphedema. Cancer. 2005 Jun 20;104(3):457-466.
19. Pereira de Godoy JM, Braile DM, de Fátima Godoy M, Longo O Jr. Quality of life and peripheral lymphedema. Lymphology. 2002 Jun;35(2):72-5.
20. Artíbale MES, Godoy JMP, Godoy MFG, Braile DM. A new option for compression in the treatment of lymphedema in children. J Vasc Br 2005; 4(3):311-3.
21. Liu N. Metabolism of macromolecules in tissue. Lymphat Res Biol. 2003;1(1):67-70.
22. Liu NF, Zhang LR, Li SL, Cao WG, Zhang DS, Cao YL. Metabolism of hyaluronic acid and extremity lymphedema. Zhonghua Zheng Xing Wai Ke Za Zhi. 2004 Mar;20(2):113-6.

Comparative evaluation of physiotherapy and pharmacotherapy in the management of temporomandibular joint myofascial pain

Venkatesh G Naikmasur[1], Kruthika S. Guttal[2], Puneet Bhargava[3], Renuka J Bathi[4]

[1]Professor and Head, Department of Oral Medicine and Radiology, SDM College of Dental Sciences & Hospital, Dharwad 580 009, [2]Assistant Professor, Department of Oral Medicine and Radiology, SDM College of Dental Sciences & Hospital, [3]Former Post-graduate, Department of Oral Medicine and Radiology, SDM College of Dental Sciences & Hospital, [4]Former Professer, Department of Oral Medicine and Radiology, SDM College of Dental Sciences & Hospital

Abstract

Objectives: The present study is a prospective study carried out to evaluate the efficacy of physiotherapy methods like ultrasound, transcutaneous electrical nerve stimulation, low intensity light amplification by stimulated emission of radiation and compare the same with pharmacotherapy comprising of analgesics and muscle relaxants, in the management of temporomandibular joint myofascial pain.
Methods: A total of 40 patients included in the study. Subjects were randomly assigned to one of the two groups, each group consisting of 20 subjects. Subjects of Group A received a combination of muscle relaxants and analgesics and Group B subjects received, ultrasound, transcutaneous electrical nerve stimulation, or light amplification by stimulated emission of radiation. All the patients were evaluated for subjective and objective symptoms at baseline and then following one, four, eight, and 16 weeks post treatment. All the subjects were evaluated with visual analog scale, Global Pain Impact scale scores, number of tender muscles, and maximum comfortable mouth opening.
Results: The parameters evaluated revealed significant improvement in Group B following treatment and also during the follow period as compared to Group A subjects.
Conclusion: Physiotherapy, having the advantages of better patient compliance and lack of adverse side effects, can be considered as primary treatment modality of patients with myofascial pain.

Key words

Myofascial pain, physiotherapy, pharmacotherapy, Ultrasound, LASER, TENS.

Introduction

The term "temporomandibular disorder" [TMD] was suggested by Bell[1]. It is a collective term embracing a number of clinical problems that involve the masticatory musculature, the TMJ, and associated structures, or both[2].

Temporomandiublar joint disorders have been recognized as the most common non-tooth related chronic orofacial pain conditions that confront dentists[3]. Symptoms associated with TMDs are common in general population with 20 to 85 percent of the population known to present with symptoms like pain in the TMJ and masticatory muscles, and restricted mouth opening[4]. To date, there have been many synonyms for myofascial pain, including facial arthromylagia, TMJ dysfunction syndrome, myofascial pain dysfunction syndrome, craniomandibular dysfunction, and myofascial pain dysfunction[1]. Currently the preferred term, according to the Research Diagnostic Criteria developed by Dworkin and co-workers[5] is "Myofascial pain". Myofascial pain [MFP] is the most common disorder causing chronic pain in head[6]. Accordingly MFP is pain of muscle origin including a complaint of pain as well as pain associated localized areas of tenderness to palpation in muscle[5].

The dentist plays a significant role, in the diagnosis and management of such patients, as most patients present with variety of symptoms ranging from pain in and around the orofacial region to restriction of mouth opening. Appropriate diagnosis is essential to differentiate pain of dental origin from that of TMJ and masticatory muscles to chart out the appropriate treatment plan fro such patients. Many times an interdisciplinary approach will be required.

The conservative treatment modalities to manage such patients include occlusal splints, analgesics, muscle relaxants, tranquilizers, exercises, joint and muscle injections, physical therapy, psychological counseling, and placebo[7]. Irrespective of the chosen modality of treatment, the goal of treating would be to decrease pain, reduce loading of the masticatory system, and restore mandibular movements and oral function[8].

Physiotherapy is chosen for the treatment of dysfunctions in the orofacial region for its unique reasons; it is relatively simple and non-invasive, has a low cost as compared with other treatments, and allows for an easy self-management approach which means that the patient is actively involved in his own treatment, being responsible for his or her well-being. It allows good communication with the patient, improving the patient's confidence in the care provider, being the basis of a positive coping[2]. The various forms of physiotherapy include rest, thermal modalities [superficial heat and cryotherapy], ultrasound, shortwave diathermy, transcutaneous electrical nerve stimulation [TENS], transcutaneous muscle stimulation, biofeed back training, massage, active movements [exercise], passive movements, acupuncture, and low intensity light amplification by stimulated emission of radiation [LASER][9].

The present study was aimed to assess the effectiveness of physiotherapy methods like TENS, ultrasound, low intensity LASERS and exercises, massage, and hot compresses in myofascial pain patients and to compare same with pharmacotherapy comprising of a combination of muscles relaxants and nonsteroidal anti-inflammatory drugs [NSAID].

Corresponding Author:

Dr. Kruthika Satyabodh

Assistant Professor
Department of Oral Medicine and Radiology
SDM College of Dental Sciences and Hospital
Dharwad 580 009, Karnataka, India
Phone: 91 836-2467676, Fax: 91 836-2467612
Email: drkruthika@yahoo.co.in

Materials and methods

Subject selection

The prospective study was conducted in the Department of Oral Medicine and Radiology SDM Dental college and Department of Physiotherapy SDM Medical college Dharwad. The experimental protocol for this study underwent review and approval by the ethical committee of the institution. Each patient was fully informed about the condition consent was obtained before inclusion in the study.

Subjects to participate in the study were to have a primary diagnosis of MFP of masticatory muscles according to RDC TMD[5]. Patients diagnosed with myofascial pain, approaching the outpatient department, were selected for the study from the period of November 2004 to March 2006. Patients having the condition for at least three months were included in the study. All the patients presented with three or more of the following signs and symptoms: pain on palpation of associated muscles [muscles of mastication, sternocleidomastoid, trapezius muscles], limited mouth opening, intermittent clicking of the joint, and absence of radiographic changes in the TMJ.

Patients excluded from the study were those with occlusal disharmony, were undergoing orthodontic treatment and/or occlusal corrections, had undergone treatment for the same within six months of present diagnosis, had any form of arthritis affecting the TMJ, or failed to attend regular follow-up.

Screening Procedure

A detailed history regarding onset, duration, and progress of symptoms was recorded at the time of diagnosis. The data also included type of pain, its severity and pain response to chewing, speech, and swallowing. Intensity rates of pain were recorded on a visual analog scale of 100mm long continuum and the extremes were labeled as no pain and worst possible pain[10]. The impact of pain on the global functional ability related to jaw use was assessed using a six-point Global Pain Impact [GPI] scale[11]. This was followed by a thorough examination of the TMJ, muscles of mastication, and neck muscles, recording of Maximum comfortable mouth opening. Temporomandibular joint examination included assessment of clicking, tenderness at rest and during various jaw movements and deviation of the jaw during opening and closing movements. Tenderness of muscles of mastication and the neck muscles was assessed by means of digital palpation, resistance testing, and functional manipulation of muscles[12]. The tenderness in the muscle was recorded as being present or absent.

40 patients meeting the criteria were randomly assigned into two groups, Group A or Group B. Group A patients received a drug combination of muscle relaxants and analgesics comprising of ibuprofen 400mg, paracetamol 325mg, and chlorzoxazone 250 mg, orally as twice daily dosage for a period of five days. Following which the patients were asked to terminate the intake of medication. During the follow up weeks, patients reporting with episodes of pain were advised to continue the same medication with prior consent from the clinician. All patients received the same combination of medication.

Group B patients were treated with either one or combination of the three treatment modalities, TENS, ultrasound, or LASER. The appropriate modality to be instituted was decided by the physiotherapist. Four patients received TENS, four received ultrasound, 11 received helium-neon [He-Ne] LASER therapy, and one of them received a combination of ultrasound and TENS.

Transcutaneous Electrical Nerve Stimulation

The TENS unit with four electrode attachments was employed. Electrodes were placed over the area of maximum muscle tenderness. The current frequency set at 2Hz and pulse duration of 0.02ms. The pulse strength was increased slowly, until the patient could tolerate without pain. Maximum benefit was obtained after 25 to 30 minutes at which time the treatment was terminated.

Ultrasound- 0.8W/cm^2 of frequency in pulsed mode of 3MHz was applied for four minutes . The applicator was moved in smooth overlapping sweeps or circles at rates of few cm/sec over areas of 25 to 40cm^2 it was applied for three most tender points.

Helium-Neon LASER

The trigger points were identified by palpation. The wavelength of LASER was 632.8nm which was used in a pulsed mode of 30-40HZ. The dose range was between 2-4J/cm^2. The head of the instrument was held perpendicular to and in slight contact with skin. The treatment was applied over three or more Trigger points (TrPs).

The treatment duration was five days for all the modalities following which the patients were advised to practice exercises, massaging of muscles and to apply moist heat to the affected regions during exacerbations of symptoms.

Massage Therapy

Self-massage was limited to the painful or tense masseter and temporalis muscles [ease of accessibility]. The patients were also asked to apply moist heat pads on the painful area when the symptoms exacerbate. Heat application [moderately warm] was advised to be applied bilaterally for 20 minutes once a day[2].

The oral physician who diagnosed the condition was instrumental in the follow-up, and the prior mentioned parameters were assessed at baseline, one week [following completion of treatment session], four, eight, and 12 weeks following treatment sessions, for all the subjects.

Statistics

The statistical evaluation of data was performed with data program stat 9.2 version. All the data was analyzed by one blinded researcher.

First means and standard deviations of VAS, GPI scores, and number of tender muscles were determined [Table 1]. The baseline values of maximum comfortable mouth opening between the two groups were tested by one way analysis of variance [Table 2a]. Analysis of co-variance was used to assess significant difference between the two groups taking baseline scores as covariance [Table 2b]. Student's t-test [paired and unpaired] was used to compare the treatment outcome between the two groups. The level of statistical significance was set as a two-tailed P value of 0.05. $P<0.05$ was considered to be significant. The values are presented in Table 1.

Results

The mean age of the patients was 35.85 and 33.67 years in Group A and Group B, respectively. Group A comprised of 40% males and 60% females. Group B comprised of 45% males and 55% females.

Table 1: Comparison of Mean Scores Between Two Groups at Various Time Intervals.

	Groups	Group A	Group B				
Mean VAS scores		**Mean**	**Std.Dev.**	**Mean**	**Std.Dev.**	**T value**	**P value**	**Significance**
	Baseline	6.0000	1.0761	6.4000	0.9947	-1.2207	0.2297	NS
	1 week	4.0000	1.3377	3.9500	0.9987	0.1339	0.8942	NS
	4 weeks	4.8500	1.6631	3.5500	0.9987	2.9970	0.0048	S
	8 weeks	4.8500	1.6631	3.4000	0.9403	3.3942	0.0016	S
	12 weeks	5.0500	1.3169	3.3000	0.8013	5.0769	0.0000	S
Mean GPI scores								
	Baseline	1.9500	0.6048	2.1500	0.5871	-1.0611	0.2953	NS
	1 week	1.0000	0.5620	1.0000	0.6489	0.0000	1.0000	NS
	4 weeks	1.4000	0.5982	0.5500	0.5104	4.8338	0.0000	S
	8 weeks	1.4000	0.5982	0.7500	0.5501	3.5767	0.0010	S
	12 weeks	1.6000	0.5026	0.6000	0.5982	5.7235	0.0000	S
Mean of number of tender muscles								
	Baseline	1.9500	0.6048	2.1500	0.5871	-1.0611	0.2953	NS
	Baseline	2.4	0.0463	2.25	1.118	0.4381	0.6638	NS
	1 week	1.3	0.8013	0.9	0.553	1.8379	0.0739	NS
	4 weeks	1.5	0.8272	0.6	0.598	3.9428	0.0003	S
	8 weeks	1.55	0.7592	0.8	0.523	3.638	0.0008	S
	12 weeks	1.45	0.8256	0.55	0.605	3.9329	0.0003	S
	Baseline	2.4	0.0463	2.25	1.118	0.4381	0.6638	NS

Table 2a: F- Test and ANCOVA for comparison of mouth opening between two groups at various time intervals.

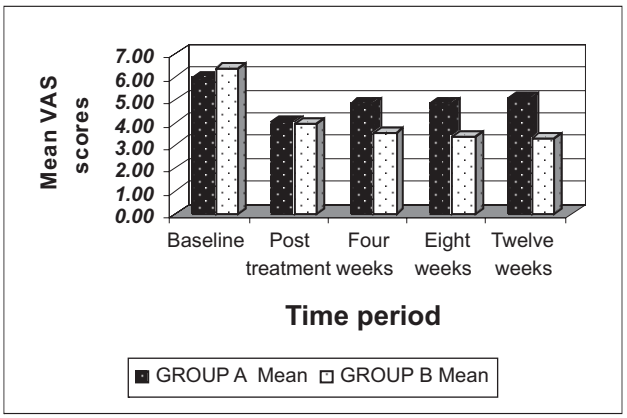
F-test between variances of Group A and Group B with respect to baseline value					
Group	Mean	Std. Dev.	F-value for variances	P value	Significance.
Group A	42.7500	6.6560	1.0024	0.9959	NS
Group B	44.2500	6.6481			

Table 2b: Analysis of covariance (ANCOVA) with baseline as a covariate.

1 week	Effect	20.9457	1	20.9457	7.4039	0.0099	S
	Error	104.6726	37	2.8290			
4 weeks	Effect	33.6901	1	33.6901	9.3650	0.0041	S
	Error	133.1061	37	3.5975			
8 weeks	Effect	34.0816	1	34.0816	9.5059	0.0039	S
	Error	132.6569	37	3.5853			
12 weeks	Effect	34.0816	1	34.0816	9.5059	0.0039	S
	Error	132.6569	37	3.5853			

The comparison of mean VAS and GPI scores between the two groups showed significant reduction in Group B during the follow-up period [Fig. 1 and 2, respectively]. The Group B patients showed significant reduction in number of tender muscles and significant improvement in mouth opening during post treatment follow-up period [Fig. 3, 4].

Fig. 1: Comparison of Mean Visual Analog Scale Scores of Group A and Group B.



Discussion

The various treatment modalities for TMDs mainly aim to relieve the symptoms of the patient as treatment aimed at correction of the exact cause is questionable. Selecting an appropriate treatment option for an individual patient poses great challenge to the clinician and depends on various factors like, economic feasibility, patient compliance and

Fig. 3: Comparison of Mean of Number of Tender Muscles Between Group A and Group B.

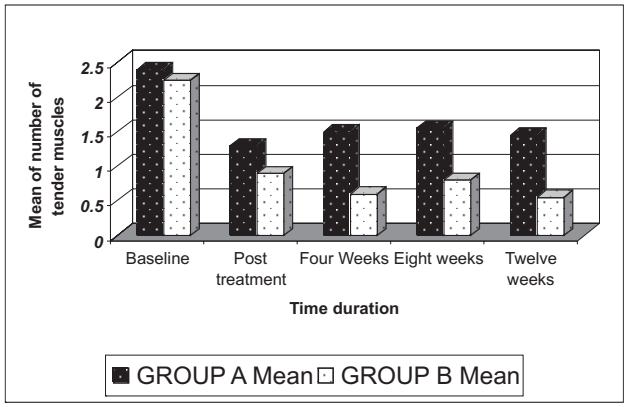


Fig. 2: Comparison of Mean Global Pain Impact Scores Group A and Group B.

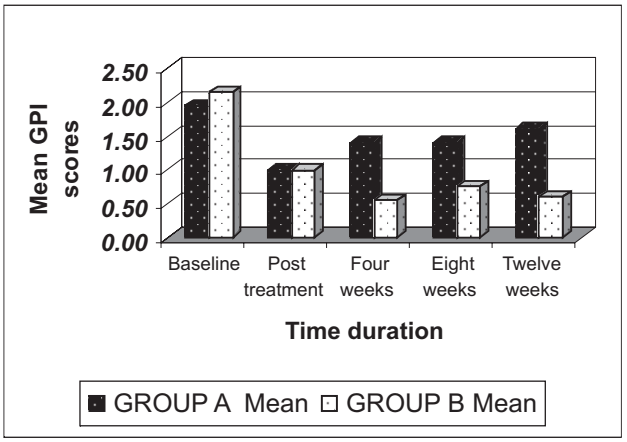
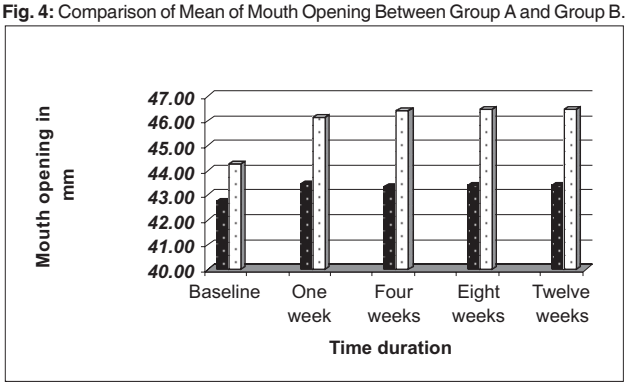


Fig. 4: Comparison of Mean of Mouth Opening Between Group A and Group B.



acceptance of treatment. The various conservative treatment modalities available for TMD include occlusal splints, analgesics, muscle relaxants, tranquilizers, exercises, joint and muscle injections, physical therapy, psychological counseling, and placebo[13]. Choosing a specific conservative treatment modality for myofascial pain patients depends on clinician's expertise, patient presentation, and elimination of possible etiologic factors. Physiotherapy modalities may be used as patient's sole treatment or as combination with other therapies like occlusal correction, splint therapy, etc.[14] The present study has used physiotherapy as one of the sole treatment modalities in one of the groups.

A meta-analysis of various physiotherapy modalities used for the treatment of myofascial pain has shown promising results with regards to benefit of patient and relief of pain[15]. The present study is an attempt to evaluate the efficacy of physiotherapy, compared with pharmacotherapy which is not only a conservative treatment modality, but also a commonly preferred treatment option by many clinicians.

Greider and co-workers[16] have first reported the applications of ultrasound for TMD. The guidelines on appropriate use and treatment with ultrasound are not clear from literature[17]. The therapeutic ranges of ultrasound include 0.75 to 3MHz. The present study employs ultrasound of 0.8W/cm^2 being used for four minutes for a period ranging from five to seven days. All the patients in our study showed significant reduction in VAS, GPI scores, increase in mouth opening, and reduction in number of tender muscles as compared to the pharmacotherapy group. Esenoyl et al.[18] have used an ultrasound of 1.5W/cm^2 for six minutes and their patients showed reduction in pain intensity and increase in range of motion and these effects improved even after three months after the treatment. Various authors (Gray et al.[19], Talaat et al.[20], and Majlesi et al[21] have supported the use of ultrasound for myofascial pain. The subjects of physiotherapy group of present study have shown improvement post treatment and during the follow-up period.

In the present study a total of four patients received TENS of 2Hz and pulse duration of 0.02ms. These patients have responded positively with decrease in VAS and GPI scores and increase in mouth opening and reduction in the number of tender muscles. One patient was treated with both TENS and ultrasound, owing to unsatisfactory response to initial TENS therapy for five days.

There are no reports of adverse effects due to use of ultrasound available in the literature. Hotta et al.[22] have reported that their patient initially treated with TENS, complained of head pain, hypertension, and nervousness and later it was substituted with ultrasound. None of the patients in the present study have reported any discomfort or adverse effects due to TENS therapy. The switching over from TENS to ultrasound in one of the patients in the present study was due to non responsiveness to treatment but not due to any adverse effect.

In the present study eleven patients received He-Ne LASER therapy in a pulsed mode of 30 to 40HZ over the TrPs continuously for five days with significant improvement in symptoms and there was no adverse effects caused by LASER therapy. Similar to our study Simunovic et al.[23] have reported pain relief, restored mobility, and decreased rigidity in myofascial pain patients with He-Ne laser treatment. None of the patients did require any repetition of treatment sessions.

Non steroidal anti-inflammatory analgesics are known to be effective in the management of mild-moderate inflammatory conditions, particularly of the musculoskeletal system[24]. Muscle relaxants are administered to reduce skeletal muscle tone and are often administered to patients with muscle tone with chronic orofacial pain to help prevent or alleviate the increased muscle activity[25]. They act by decreasing the muscle tone without impairment of motor function by depressing the central polysynaptic reflexes. Literature review shows that very few studies have used muscle relaxants solely or in combination with analgesics for the treatment of TMD. Greene and Laskin[26] have used meprobamate in the treatment of myofascial pain dysfunction syndrome and have concluded that drugs like meprobamate can reduce or eliminate the psychic tension and muscular spasm. Singer et al.[27] in their randomized double blind controlled clinical trial have evaluated Ibuprofen and Diazepam for chronic orofacial muscle pain and their study supports the efficacy of diazepam in the short–term management of chronic orofacial pain.

The previous studies available regarding pharmacotherapy for TMD is based on heterogenous population i.e. patients with myogenous pain, often not distinguished in clinical trials from those who have TMJ disorders such as degenerative arthritis or displacement of meniscus[25]. The present study is an attempt to evaluate the effectiveness of a combination analgesics and muscle relaxants as compared to physiotherapy in patients purely with myofascial pain. The duration of pharmacotherapy is also variable according to different authors and there is no single treatment duration that is suggested for these patients.

Dias de Andrade[28] has reported the pharmacological guidelines for treatment of TMD. Accordingly, for acute

spasm or myofascial pain, muscle relaxant can be administered three times daily for two days, whereas NSAIDs by oral route can be given for five to seven days for myositis and TMJ inflammatory disorders. A lack of therapeutic effect after a seven- to 10-day trial or the development of any gastrointestinal symptoms should prompt discontinuation of the drug[25].

Due to lack of standard recommended dosages of any form of pharmacotherapy, the present study employed a commercially available combination of muscle relaxant and analgesic consisting of ibuprofen 400mg, paracetamol 325mg, and chlorzoxazone 250mg administered orally as twice daily dosage for a period of five days initially. When the patients reported with recurrence of pain or symptoms during the post-treatment follow up, they were advised to repeat the same treatment regimen.

In the present study patients in pharmacotherapy group have reported with reduction in symptoms [VAS and GPI scores] initially following five days of treatment, but there was no significant improvement during the follow-up period. This is in accordance with Talaat et al.[20] report that the muscle relaxant group had only a mild reduction of pain and muscle spasm, but no effect on TMJ clicking as compared to ultrasound short wave diathermy groups. In contrast to absence of side effects in the physiotherapy group, five patients of the pharmacotherapy group reported with mild gastrointestinal symptoms during the follow-up, but these symptoms did not persist after discontinuation of drugs. The present study being a follow-up study enables the assessment of improvement in myofascial pain treated with physiotherapy and pharmacotherapy. Group A subjects had significant reduction in VAS and GPI scores and reduction in number of tender muscles only following a course of anti-inflammatory and muscle relaxant treatment. But the same results did not continue during the follow-up as compared to Group B. The practice of appropriate exercises with massaging of the muscles following the various physiotherapy modalities indicates the persistent improvement in symptoms of the GroupB during the follow-up period also.

To our knowledge there are very few studies comparing physiotherapy and pharmacotherapy in the management of TMD[20,29]. Earlier studies indicate that ultrasound, TENS, and LASERS exercises prove to be effective in the management of myofascial pain. In the current study the physiotherapist made the decision about the mode therapy for individual patient based on patient compliance and economic feasibility. Hence physiotherapy modalities were considered as a single group and its efficacy of treatment compared with pharmacotherapy.

The present study, infers that physiotherapy one of the conservative treatment modalities is useful in reduction of pain, tenderness in muscles, and improvement in mouth opening in patients with myofascial pain.

Commonly observed adverse effects with the use of NSAID group of drugs include nausea, dyspepsia, ulceration, enteropathy, strictures, bleeding, and perforations.[30] It has to be noted that if an NSAID is administered concomitantly with an anticoagulant, the potential for bleeding increases markedly. Furthermore this group of drugs may be contraindicated in patients on diuretics and in patients with severe renal disease. Therefore the clinician should not overlook benefit versus risk while administering these drugs, especially for a longer period of time. Appropriate motivation of patients to practice mouth opening exercises or simple methods like hot compresses might have great benefits to the patients. This can ensure frequent change of therapies and also saves the patient from suffering with the adverse effects of the drugs.

Conclusion

The treatment outcome with any from of therapy for TMD is not completely predictable. In view of the adverse effects caused by long term use of various NSAIDs, it is advisable to choose a safer form of therapy in the management of patients with chronic musculoskeletal pain. The advantages of physiotherapy observed in the present study were better long-term results, fewer side effects, cost effectiveness, and a better patient compliance. This does not totally preclude this modality from certain limitations such as, lack of total effectiveness in inaccessible muscles like lateral and medial pterygoid. Despite this limitation physiotherapy still remains as a better and safe treatment option in patients with chronic pain condition like myofascial pain. But furthermore randomized controlled trials are necessary to validate the effectiveness physiotherapy in a larger sample.

Acknowledgements

The authors would like to acknowledge Dr. C Bhasker Rao, Principal SDM College of Dental Sciences Dharwad for his encouragement, Ms Kiran Bhat Principal and Ms Sharmila Dudhani former post graduate SDM College of Physiotherapy Dharwad for the help rendered towards the study.

References

1. Okeson J P: Current terminology and diagnostic classification schemes. Oral Surgery Oral Medicine Oral Pathology Oral Radiology Endodontology 1997;83:61-4.
2. Michelotti A, De Wijer A, Steenks M, Farella M: Home exercise regimes for the management of non-specific temporomandibular disorders. Journal of Oral Rehabilitation 2005; 32: 779–785.
3. McNeill C: Management of Temporomandibular disorders: Concepts and controversies. Journal of Prosthetic Dentistry 1997; 77: 510-22.
4. Nicolakis P, Erdogmus B, Kopf A, Nicolakis, Piehslinger E: Effectiveness of exercise therapy in patients with myofascial pain dysfunction syndrome. Journal of Oral Rehabilitation 2002; 29: 362-368.
5. Dworkin SF, LeResche L, DeRouen T, Von Korff M: Research Diagnostic criteria for Temporomandibular disorders: review, criteria, examinations, and specifications and critique. The Journal of Craniomandibular Disorders 1992; 6:310-315.
6. Mulet M, Decker KL, Look J O, Lenton P A, Schiffman E L: A Randomized clinical trial assessing the efficacy of adding 6x6 exercises to self-care for the treatment of masticatory myofascial pain. Journal of Orofacial Pain 2007; 21:318-328.
7. Shankland W E: Temporomandibular disorders: Standard treatment options. General Dentistry 2004; 349- 355.
8. De laat A: Scientific basis of masticatory disorders.

Scientific Basis of Eating. Edited by Linden RWA. Front Oral Biol, Karger, 1998, pp 122-134.
9. Selby A: Physiotherapy in the management of temporomandibular disorders. Australian Dental Journal 1985; 30:273- 280.
10. Springer SP, Greenberg SM: Temporomandibular disorders. Burket's oral medicine diagnosis and treatment 9th edition. Edited by Greenberg MS, Glick M. BC Decker, Ontario, 2003, pp 310.
11. Stegenga B, de Bont LGM, Boering G: Temporomandibular joint pain assessment. Journal of Orofacial Pain 1993; 7: 23-37.
12. Okeson JP: Management of Temporomandibular disorders and occlusion 5th edition. Mosby, St. Louis 2003, pp 260-272.
13. Greene CS, Laskin DM: Long–term evaluation of conservative treatment for myofascial pain dysfunction syndrome. Journal of American Dental Association 1974; 89: 1365-1368.
14. Murphy JG: Physical medicine modalities and trigger point injections in the management of Temporomandibular disorders and assessing treatment outcome. Oral Med Oral Pathol Oral Radiol Endodontology 1997; 83: 118- 122.
15. Feine JS, Lund JP: An assessment of physical therapy and physical modalities for the control of chronic musculoskeletal pain. Pain 1997; 71:5-23.
16. Greider A, Vinton PV, Cinotti WR, Kanjur TT: An evaluation of ultrasonic therapy for tempormandibular joint dysfunction. Oral Surgery Oral Medicine Oral Pathology Oral Radiology Endodontology 1971; 31: 25-31.
17. Mohl DN, Ohrbach KR, Crow CH, Gross JA: Devices for the diagnosis and treatment of tempormandibular disorders. Part III: Thermography, ultrasound, electric stimulation, and electromyographic biofeed back. Journal of Prosthetic Dentistry 1990; 63: 472-7.
18. Esenyel M, Caglar N, Aldemir T: Treatment of Myofascial Pain. American Journal of Physical Medicine and Rehabilitation 2000; 79: 48-52.
19. Gray R.J.M, Quayle AA, Hall CA, Schofield MA: Temporomandibular Pain Dysfunction: Can Electrotherapy Help? Physiotherapy 1995; 81: 47-51.
20. Talaat AM, EL- Dibany MM, EL- GARF A: Physical therapy in the management of Myofascial pain dysfunction syndrome. Annals of Otology Rhinology Laryngology 1986 ; 95: 225-227.
21. Majlesi J, Unalan H: High-Power Pain Threshold Ultrasound Technique in the Treatment of Active Myofascial Trigger Points: A Randomized, Double-Blind, Case-Control Study. American Journal of Physical Medicine and Rehabilitation 2004; 85: 833-836.
22. Hotta TH, Vincente MFR, Candido dos Reis A, Bezzon OL, Bataglion C, Bataglion C: Combination therapies in the treatment of temporomandibular disorders: A clinical report. Journal of Prosthetic Dentistry 2003; 89:536-9.
23. Simunovic Z: Low level laser therapy with trigger points technique: a clinical study on 243 patients. Journal of Clinical Laser Medicine and Surgery 1996; 14: 163-167.
24. Dimitroulis G, Gremillion HA, Dolwick MF, Walter JH: Temporomandibular disorders.2. Non- surgical treatment. Australian Dental Journal 1995; 40: 372-6.
25. Dionne RA: Pharmacologic treatments for temporomandibular disorders: Oral Surgery Oral Medicine Oral Pathology Oral Radiology Endodontology 1997; 83: 134-42.
26. Greene CS and Laskin DM: Meprobamate therapy for the myofascial pain- dysfunction syndrome (MPD) syndrome: a double – blind evaluation. Journal of American Dental Association 1971; 82: 587-590.
27. Singer E, Dionne R: A controlled evaluation of Ibuprofen and Diazepam for chronic Orofacial Muscle Pain. Journal of Orofacial Pain 1997; 11: 139-146.
28. Andrade EDD, Barbosa CMR, Pinheiro MLP: Pharmacological guidelines for managing temporomandibular disorders. Brazilian Journal of Oral Sciences 2004; 3: 503-505.
29. Ismail F, Demling A, Hebling K, Fink M, Stiesch-scolz M: Short term efficacy of physical therapy compared to splint therapy in treatment of arthrogenous TMD. J of Oral Rehab 2007; 34: 807-813.
30. Barkin L R: Acetaminophen, Aspirin, or Ibuprofen in Combination Analgesic Products. American Journal of Therapeutics 2001; 8:433–442.

A proposed protocol for the physiotherapy management of osteoarthritis

Kavitha Vishal*, Narasimman S, Nagarajan M*****

*Lecturer in Musculoskeletal & Hand Rehabilitation, **Associate Professor & Head, Department of Physiotherapy, ***Assistant Professor in Musculoskeletal & Sports Physiotherapy, Department of Physiotherapy, Father Muller Medical College, Mangalore

Abstract

Osteoarthritis is one of the commonest problem leads to severe impairments and disability. Physiotherapy plays a major role in the rehabilitation of patients with Osteo arthritis. In this current era of Evidence based practice it is important to have preset protocol to improve the effectiveness of the treatment. This article is a proposed protocol for the management of Osteoarthritis knee.

Key Words

Osteo arthritis knee, Rehabilitation, Physiotherapy

Introduction

Osteoarthritis is one of the most common locomotor disabilities found in almost all parts of the world. It is one of the major disabling conditions and carries a lot of social and economic burden with it. It affects 33% of the individuals above the age of 65yrs[7,26,21]. This disease entity is seen in 70% of women and 60% of men.

The exact pathology in OA is presumed to be one of cartilage erosion progressively leading to exposure of the subchondral bone leading to pain. It mainly affects the weight bearing joints. Knee is the most common joint affected followed by the hip and the hand[23]. In normal day to day practice patients with osteoarthritis form a large percentage of clients visiting physiotherapy departments in our country. Rehabilitation of these individuals poses a lot of challenge to professionals working in this field.

Patients with OA present with pain, swelling, stiffness, limited motion and subsequent decline in function. Patient may also present with gait asymmetries which may ultimately lead to a tendency to adapt to sedentary lifestyles.

Physiotherapeutic measures should be directed towards the correction of these impairments and ultimately restore function. **An effective rehabilitation protocol** should target the strength, flexibility and kinetic chain deficits to minimize the progression of degeneration. It has been felt that there is a strong need in exploring the available evidence in the management of osteoarthritis and to propose a protocol.

Method

An expanded literature search through various electronic data base which includes Pubmed, Pedro, and CINHAL was performed. The key words used were osteoarthritis, knee, rehabilitation and physiotherapy. MeSH strategy was applied. Searches were restricted to English language. Boolean logic was used to combine, expand and restrict the search results. 84 articles which dealt the effects of various physiotherapy modalities were retrieved. (Full text only) Each article was analyzed by two different reviewers. Parts from these 4 evidence based guidelines were also included for the review.

Symptom characteristics in patients with osteoarthritis

Pain is one of the first symptoms to appear in knee OA. Patient will complain of pain in the anterior, anteromedial and anterolateral aspects of the knee joint. Pain is usually of a diffuse character associated with sustained posturing of the joint, gradually reduces with activity only to become worse at the end of the day. In addition to joint degeneration psycho social factors have to be considered in patients with OA. This entity stems from the wide discrepancy that we come across the radiological features and the pain experienced by these individuals[22].

Complains of morning stiffness are common in vast majority of the cases. The stiffness in OA is often experienced when the patient moves the joint after a period of rest. Majority of the patients will have tenderness along the medial joint line[26].

Pain is a complex phenomenon and as in any other condition the appearance of pain in OA alters the dynamic loading on the knee joint. Patient compensates by reducing the load on the knee which can lead to increase in loads on the hip and the ankle[22,12]. Reduction of pain and prevention of further biomechanical alterations is one of our major goals. Several physical measures have been studied to achieve the same.

Though osteoarthritis does not run an inflammatory course a low grade inflammatory response may be seen in the early stages, patients do present with swelling which also leads to paucity to move the joint further leading to decline in function. Reduction of swelling also forms a major aspect of therapy instituted for this individuals. Swelling is predominantly due to synovitis.

Joint Proprioception deficits have been reported in people with unilateral OA. Proprioception is a function of the joint mechanoreceptors by virtue of which we are able to perceive the position of body in space. Decrements in Proprioception in these people may be attributed to a decrease in the excitability of the quadriceps motor neuron pool. Pain can also be postulated to contribute to decreased mechanoreceptor activity. This along with reduced quadriceps recruitment leads to loss of Proprioception and joint position sense[23].

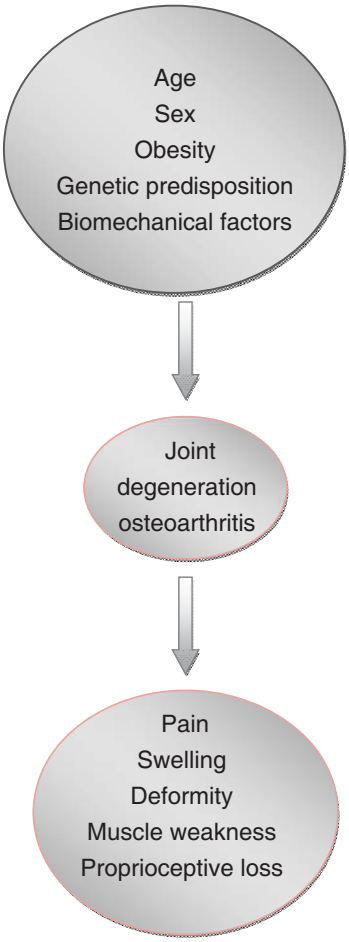
Patients with OA demonstrate significantly less extensor moments during walking. This may be adopted to reduce loads on the joint during walking.

Multimodal treatment regimens have gained popularity over the years which include patient education, weight loss,

physiotherapy, assistive devices and aerobic exercise programs. The scope of this paper is to provide a comprehensive rehabilitation option for the numerous osteoarthritis patients visiting our clinic.

No single modality has been successful in delaying the progression in OA[21].

Pathogenesis model of Osteoarthritis



Physiotherapy evaluation

Observation and Palpation for Swelling, Synovial thickening, deformities, and temperature & tenderness[16] should be included as part of the physical therapy assessment for osteoarthritis. Deformities[16] including Varus, Valgus[2], and Fixed flexion deformities in the knee should be observed. In addition to this an observation of deformities over other joints of the lower extremity as in any calcaneal valgus, inverted or everted foot and ankle should be observed.

Patellar Tap Test is recommended to assess the severity of knee joint effusion it was first described as a test by Magee in 1992. Pes anserinus, Medial joint line, Lateral joint line, Medial femoral Epicondyle, Infrapatellar, and Prepatellar should be palpated for Tenderness[16]. Crepitus and sudden locking movements should be palpated. Specific observation of muscle atrophy is a must as well.

Physical examination should commence with active movements followed by passive physiological movements along with interpretation of the end feel. In subjects with OA the pattern of restriction would be capsular which more in flexion than in extension is. In early stages of the disease the end feel may be empty or spasm because of involuntary muscle contractions. Toward the later stages of the disease Patients may also have empty or springy end feel depending upon the nature of the involved tissue[13]. Restrictions in range of motion of the knee joint including flexion, extension, internal and external rotation of the knee joint should be noted down along with their end feel and their influence on the behavior of symptoms.

Physical Examination should be focused on Pain on patellofemoral compression, Restriction on knee motions[10,14,17,29] including flexion, extension, internal and external rotation, Positive Ligamentous laxity[14], Anteroposterior drawer, Decreased muscle strength[1,24,25] in Quadriceps femoris, Hamstring, Single-leg standing may be positive for gluteus medius and hip rotator dysfunctions, Reduced ankle dorsiflexion, eversion strength[23]. Kinetic and Kinematic of the hip and the ankle of both the extremities are mandatory[12, 23].

Measurement of activity limitations can be a guide to effective rehabilitation. So in order to assess the impact of function in knee OA we recommend the use of a WOMAC QUESTIONNAIRE. The WOMAC Osteoarthritis Index consists of 24 questions, each corresponding to a visual analogue scale. This test has been shown to be a reliable, valid, and responsive multidimensional outcome measure for evaluation of patients with osteoarthritis of the hip or knee[3].

Short term goals may include Patient education, Reduction of pain, Reduction of Swelling, Improve Range of motion, Improve Flexibility, Increase Strength(static and dynamic), Improve joint stability, Address Kinetic chain deficits, Address gait variations, Improve General fitness, and prescription of assistive devices

Long term goals should target in improving Joint protection, Delay in progression of the disease, full functional restoration and to improve health related quality of life

Patient education

Patient education forms one of the highlights of the non pharmacological treatments rendered to these patients. Educating the patient regarding joint protection measures, to maintain the strength and flexibility, pacing, aerobic fitness and activity modification becomes an important aspect of the therapy program. Patients are advised to stick to the exercise regimen and maintain a healthy lifestyle[11,27].

Given the psychological factors associated with the disease people with OA may be taught self management tactics including coping, understanding skills and reducing anxiety and fostering positive health. Psychological counseling can be included as a part of overall therapy.

Physical therapy measures

Several modalities have been researched for pain alleviation in OA. Modalities which have been mentioned by authors include SWD, laser, TENS, ultrasound, cold and superficial heat therapies. Short wave diathermy has been reported to reduce the synovial thickening in these individuals[19]. Evidence regarding the use of one over the other is not conclusive. In the vast majority of the evidences existing for thermotherapy for OA we recommend the following for our patients. The selection of the appropriated

modality may be derived from the existing evidence or from clinical experience. Few studies have reported the effectiveness of TENS for pain relief in patients with OA. Pain inhibition through the segmental; spinal level may possibly provide the rationale for pain relief in OA. 2- 4 weeks of treatment has been recommended to produce an analgesic effect[30].

The selection of the modalities should be based on physical evaluation findings.

Reduction of pain: evidence of thermotherapy[4]

Ice massage -15 min (1 week)	Wax bath-20min (1 week)
Helps to increase the nociceptive threshold Conduction block Reduction of swelling	Reduces swelling Reduction of stiffness

Pain in OA produces dynamic joint range of motion restriction. This restriction of joint motion in turn increases the pain and a vicious cycle ensues. Thus improvement in range of motion will subsequently decrease the pain and improve function. Specific manual therapy along with exercise has found to have beneficial effects[9,11,27].

Impairment based manual therapy

Knee extension	Mobilization at end range Knee extension with valgus or varus	Grades iii-iv
Knee flexion	Mobilization at end range Mobilization with medial rotation	Grades iii-iv
Patellar glides	Superior, inferior, medial and lateral	Grades iii-iv
Soft tissue release	Peripatellar, surapatellar and popliteal fossa	Deep tissue massage

Patellar glides preferably given in knee slight amount of flexion

Flexibility

This is another aspect which needs to be addressed in these groups of patients. The pain along with decrements in range of motion can bring about changes in the soft tissue properties of the structures spanning the knee joint. Any tightness can cause muscle inhibition and again cause pain[27].

Quadriceps	Patient prone lying–prone knee bends
Hamstrings	Supine lying–hip flexion maintained to 90 degrees followed by knee extension
Tensor fascia lata	Patient side lying–modified ober's
Gastrocnemius	Patient standing–patient stands with the heel of the foot behind and leans forward until he feels the stretch on the posterior calf
Iliopsoas	Patient in Prone or Side lying, Hip Extension
Adductors	Patient in standing position feet apart toes pointing straight, leans sideways until he feels a stretch on the inner thigh

Stretching would ideally include 5 repetitions with 20 sec hold for each muscle group

Exercises to be graded and done respecting the pain factor. Patient re-assessed after the application of each technique.

Strengthening Exercises

Patients with OA have selective type II muscle atrophy. Strengthening exercises are carried out for the main muscle groups around the knee. inhibition of the quadriceps have been reported frequently in literature, the exact mechanism of muscle inhibition is not known. Muscle strength is significantly reduced in patients with OA[25]. There has been no consensus regarding the type of exercise that may be used for therapy[20]. Supervised exercises have been found to be superior to group exercises[5]. Exercises seem to decrease the knee adduction movement that takes place during gait[6]. There is a general notion among these patients that exercising may be harmful for the joints. It is very important that patents are educated regarding the benefits of exercise and a very individualized therapeutic program commenced so that long term benefits be expected.

Exercise protocol for osteoarthritis of the knee joint would include:

1. Static quadriceps—10 repetitions with 10 sec hold-performed initially when the patient complains of pain, isometric exercises are usually given in patients with joint pain when mobility of the joint is not warranted.
2. Supine lying straight leg raises-10 repetitions with 10 sec hold 3 sets. Contra lateral knee to be flexed to prevent loading on the lumbar spine
3. Supine lying terminal knee extension-10 repetitions with 10 sec hold 3 sets
4. Prone lying hamstring curls -10 repetitions with 10 sec hold 3 sets
5. Standing terminal knee extension.-10 repetitions

Closed chain activities

1. Partial squats with arm support – care to be taken not to take the knee joint beyond the ankle .Ideally perform 5 repetitions of the same
2. Step ups-performed with the affected knee. Push off is provided by the contra lateral knee as the patient weight bears on the affected side

Exercises to be graded and done respecting the pain factor. Patient re assessed after the application of each technique.

Kinetic chain deficits

Osteoarthritis in the knee can bring about ROM and strength deficits in the hip and the ankle. Range of motion exercises of these joints to be undertaken after assessment. Strengthening of the gluteus maximus and the medius to be performed.

Gait variations[15]

Patients with knee OA have altered temperospatial variables such as decreased walking speed, shorter stride length and a longer stance phase. There is a decrease in the plantar flexor force and an increase in the hip extensor force which needs to be addressed. Few patients may show decrements in doriflexor and evertor strength. The exercises prescribed would again depend on the initial physical examination findings

Aerobic exercise program

An exercise program should include adequate warm up

and cool down. 10 min of aerobic exercise may be performed. Stationary cycling is considered as one of that least strenuous exercise for the knee joint. Cool down of 5 to ten min is mandatory. Walking is another form of safe exercise for people with OA[7,11,27,28,30].

Both high intensity and low intensity aerobic exercise appear to be equally effective in improving pain, gait and function in patients with OA.

Prescription of assistive devices

Orthotics may include supportive footwear with lateral wedged insoles,[18] use of a cane on the contra lateral side in case of unilateral symptoms or a walker in case of bilateral symptoms to reduce load on the joints

Joint protection and disease progression

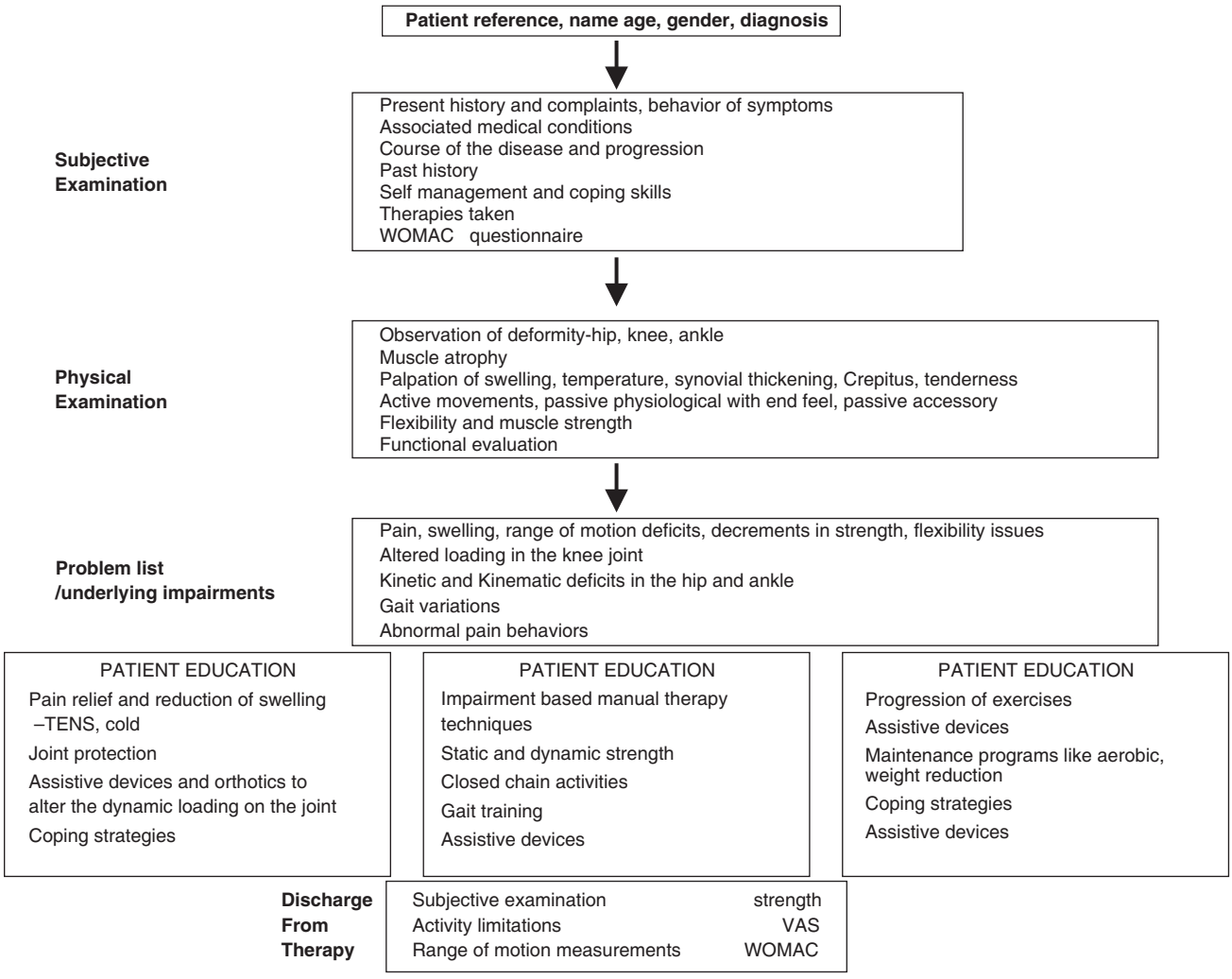
A person with OA should be explained about the following

All joints to be moved through their full ROM at least ten times, Maintain static and dynamic strength of the entire lower extremity, Avoid postures of loading as in squatting and fast walking, keep one self fit, Exercise regularly, and Judicious use of assistive devices.

Discussion

This protocol is proposed in keeping the developing countries need and facilities. We have started implementing this protocol in our clinical setup and have got positive responses. Though the guidelines were formulated on the basis of available evidence patients values should be considered in designing any protocol and it should be individually tailored. The frequent use of Short Wave Diathermy for pain reduction in OA is debatable. For pain reduction along with NSAID, TENS and other modalities prescribing ROM exercise proves to be effective. exercises prescribed in OA would address the underlying impairments that the patient presents within is important to keep in mind that the knee functions as part of a closed kinematic chain so deficits in the knee would be compensated at the distal and the proximal joints. so a thorough evaluation of the distal and proximal components and treatment of the underlying impairments are warranted. One should not forget about the weight reduction programme in the management of Osteo Arthritis Knee. Careful selection and application of manual techniques seems to have short term effect. Well designed research studies are needed in this regard

Proposed Algorithm



References

1. Aitkens S, Lord J, Bernauer E, Fowler WM, Lebeirman JS, Berck P. Relationship of manual muscle testing to objective strength measurement. Muscle Nerve, 1989; 12:173-177.
2. BD Jackson, AE Wluka 1, AJ Teichtahl, ME Morris & FM Cicuttini. Reviewing knee osteoarthritis - a biomechanical perspective, J Sci Med Sport 2004;7:3:347-357
3. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to anti rheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol,1988; 15:1833-40
4. Brosseau L, Yonge K A. Thermotherapy for the treatment of osteoarthritis. Cochrane database of systematic reviews,2003;(4)CD004522
5. Brosseau L, MacLeay L, Robinson VA, Tugwell P, Wells G. Intensity of exercise for the treatment of osteoarthritis (Review*).* Cochrane Database of Systematic Reviews 2003, Issue 2. Art. No: CD004259
6. C. A. Thorstensson Ph.D.yz, M. Henriksson Ph.D.x, A. von Porat M.Sc.k, C. Sjo¨ dahl Ph.D.K and E. M. Roos Ph.D. The effect of eight weeks of exercise on knee adduction moment in early knee osteoarthritis a pilot study. Osteoarthritis and Cartilage ,2007;15: 1163-1170
7. Frances M K Williams, Tim D Spector: Osteoarthritis. Osteoarthritis, 2006.
8. Fransen M, McConnell S, Bell M. Exercise for osteoarthritis of the hip or knee (Review) Cochrane Database of Systematic Reviews 2001, Issue 2. Art. No: CD004376
9. Gail D Deyle, Stephen C Allison, Robert L Matekel, Michael G Ryder, John M Stang. Physical Therapy Treatment Effectiveness for Osteoarthritis of the Knee. A Randomized Comparison of Supervised Clinical Exercise and Manual Therapy Procedures versus a Home Exercise Program. Phys Ther. 2005; 85:1301-1317.
10. Gajdosik RL, Bohannon RW. Clinical measurement of range of motion. Review of goniometry emphasizing reliability and validity. Phys Ther, 1987; 67(12):1867-1872
11. Gro Jamtvedt, Kristin Thuve Dahm, Anne Christie, Rikke H Moe, Espen Haavardsholm, Inger Holm, Kåre B Hagen. Physical Therapy Interventions for Patients with Osteoarthritis of the Knee: An Overview of Systematic Reviews**.** 2008 American Physical Therapy Association
12. Janie L. Astephena, Kevin J. Deluziob, Graham E. Caldwell, Michael J. Dunbard, and Cheryl L. Hubley-Kozeya. Gait and neuromuscular pattern changes are associated with differences in knee osteoarthritis severity levels. Journal of Biomechanics, 2008;41:868–87
13. Karen W Hayes, Cheryl Petersen, Judith Falconer. An examination of Cyriax's passive motion tests with patients having Osteoarthritis of the Knee. Physical Therapy, *1994; 74:*Number 8: *697*
14. Katherine S Rudolph, Laura C Schmitt, Michael D Lewek. Age-Related Changes in Strength, Joint Laxity and Walking Patterns: Are They Related to Knee Osteoarthritis? Physical Therapy, November 2007; 87: 11
15. Kenton R. Kaufmana, Christine Hughesa, Bernard F. Morreya, Michael Morreyb, and Kai-Nan Ana. Gait characteristics of patients with knee osteoarthritis. Journal of Biomechanics. 2001;34:907–915
16. Laurence Wood, George Peat, Elaine Thomas, Elaine M Hay, Julius Sim. Associations between Physical Examination and Self-Reported Physical Function in Older Community-Dwelling Adults with Knee Pain.
17. Martijn P M, Joost Dekker, Margriet E van Baar, Rob A B and Johannes W J. Muscle strength, Pain and disability in patients with osteoarthritis. Clin Rehabil 2001; 15: 331
18. Meika A Fang, Connie E Taylor MD, Aksone Nouvong. Effects of footwear on medial compartment knee osteoarthritis. JRRD ,43; 4 :427-434
19. Mei-Hwa Jan, Huei-Ming Chai, Chung-Li Wang, Yeong-Fwu Lin, Li-Ying Tsai. Effects of Repetitive Shortwave Diathermy for Reducing Synovitis in Patients with Knee Osteoarthritis: An Ultrasonographic Study. Phys Ther. 2006; 86:236 –244
20. Mei-Hwa Jan, Jiu-Jeng Lin, Jiann-Jong Liau, Yeong-Fwu Lin, Da-Hon Lin. Investigation of Clinical Effects of High- and Low-Resistance Training for Patients with Knee Osteoarthritis: A Randomized Controlled Trial. Physical Therapy, 2008;88(4):427-436
21. Michael C. Nevitt PhD. Osteoarthritis: Epidemiology. Best Practice & Research Clinical Rheumatology. 2006; 1: 3–25
22. Monica R Maly, Patrick A Costigan, Sandra J Olney. Contribution of Psychosocial and Mechanical Variables to Physical Performance Measures in Knee Osteoarthritis *Phys Ther*. 2005; 85:1318 –1328
23. Naija shakoor. A biomechanical approach to musculoskeletal disease. Best Practice & Research Clinical Rheumatology,2004;18(2):173–186
24. Nicholas JA, Strizak AM, Veras G. A Study of thigh muscle weakness in different in pathological states of lower extremity. Am journal of sports Med, 1976; 4:241.
25. Sheila C O'Reilly, Adrian Jones, Ken R Muir and Michael Doherty. Quadriceps weakness in knee osteoarthritis: the effect on pain and disability. Ann Rheum Dis 1998;57;588-594
26. Sisto SA, Malanga G. Osteoarthritis and therapeutic exercise. American journal of Physical Medicine Rehabilitation 2006 ;85:s69-s78
27. Stéphane Poitras1, Jérôme Avouac, Michel Rossigno, Bernard Avouac. A critical appraisal of guidelines for the management of knee osteoarthritis using Appraisal of Guidelines Research and Evaluation criteria. Arthritis Research & Therapy 2007, **9**:R126
28. Robin Christensen, Else Marie Bartels, Arne Astrup and Henning Bliddal. Effect of weight reduction in obese patients diagnosed with knee osteoarthritis: a systematic review and meta-analysis Ann Rheum Dis, 2007; 66: 433 -439
29. Watkins MA, Riddle DL, Lamb RL, Personius WJ. Reliabity of goniometric measurements and visual estimates of knee range of motion obtained in a clinical setting. Phys ther1991, 71:90-91.
30. W. Zhang Ph.D., R. W. Moskowitz M.D., G. Nuki M.B., and F.R.C.P., S. Abramson M.D. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. Osteoarthritis and Cartilage; 2008 16:137-162

Pediatric functional evaluation measure(PFEM): Development and standardisation

N. Padmapriya[1], J. Madhanagopal[2], M. Dhinesh Kumar[3], C. Elanchezhian[4], T.S. Kanaka[5]

[1]Principal, Meenakshi College of Physiotherapy, [2]Assistant Professor, Meenakshi College of Physiotherapy, [3]Assistant Professor, Meenakshi College of Physiotherapy, Chennai, [4]Assistant Professor, Meenakshi College of Physiotherapy, Chennai, [5]Research Guide, Meenakshi University

Abstract

The Pediatric Functional Evaluation Measure (PFEM) is a comprehensive tool to measure the functional capabilities and performance in children from the ages of 6 months to 6 years.

Background

Assessment of the functional limitations is important to determine the severity of disability in developmental delays and to evaluate the benefit of rehabilitation program. In India, one of the many challenges in assessing the effectiveness of therapies has been the paucity of validated measures of function.

Methods

The Pediatric Functional Evaluation Measure evaluates the functional abilities of children under three domains: Physical Function Domain, Mental Function Domain, and Social & Emotional Function Domain. Pooling of questions was done and content validity of the PFEM was examined using a panel of 35 experts. A pilot study was conducted on 110 normal children and 49 children with cerebral palsy.

Results

The content validity for the physical domain, mental domain and socio-emotional domain are 100%, 100% & 98.7% respectively. The mean score for inter-rater reliability is .869. The mean values of the normal children in all the three domains are 69.42 which are far higher than the mean value of the children with cerebral palsy (14.054).

Conclusion

These results indicate that the Pediatric Functional Evaluation Measure has a high degree of reliability and validity and also support the notion that the PFEM can be used to assess the functional abilities in children with cerebral palsy.

Key Words

Functional assessment, Evaluative measure, Cerebral palsy, Content validity, Inter-rater reliability.

Corresponding Author:

Dr. Padmapriya

Principal, Meenakshi College of Physiotherapy
mercury_priyaa@yahoo.co.in

Introduction

The roots of testing are lost in antiquity. There have been repeated accounts of the system of civil service examinations prevailing in the Chinese Empire for some 2000 years (Bowman, 1989). Among the ancient Greeks, testing was an established adjunct to the educational process. Tests were used to assess the mastery of physical as well as intellectual skills (Doyle, 1974)[1].

One of the earliest systematic attempts to understand the development of normal infants and preschoolers was made in a series of longitudinal studies by Arnorld Gesell and his associates at Yale (Ames 1989). These studies, which spanned a total of four decades, led to the preparation of the Gesell Developmental Schedules which, when first published (Gesell et al., 1940), represented a pioneering attempt to provide a systematic, empirically based method of assessing the behavior development of young children[1].

The decades of the 1960s to the 1990s witnessed an upsurge of interest in tests for infants and preschool children. One early contributing factor for this increased interest was the rapid expansion of educational programs for mentally retarded children. In order to meet the pressing practical needs, new tests and publications have appeared at a very fast pace, and considerable research has been conducted on innovative approaches to assessment.

Most children enjoy healthy childhoods with little need for specialized services in the health care system. However ~7.7% of children experience difficulties during their developing years and require access to and utilization of extensive health care resources over time. Cerebral palsy (CP) is one such developmental disorder that begins in early childhood as a set of functional limitations that stem from disorders of the developing central nervous system. The current estimated incidence of CP is 2.0 to 2.5 per 1000 live births in developed countries[2].

Although impaired motor function is the hallmark of the CP syndromes, many children also experience sensory, communicative, and intellectual impairments and may have complex limitations in self-care functions such as feeding, dressing, bathing, and mobility. These limitations can result in requirements for long-term care that far exceed the usual needs of children as they develop[2]. Assessment of the functional limitations is important to determine the severity of the disability in cerebral palsy and to evaluate the benefit of the rehabilitation program[3].

Several assessment instruments are available to quantify and monitor developmental skills and to assess the quality of life of patients and their caregivers. Readily available and useful assessment instruments include the Child Health Questionnaire and the Gross Motor Function Classification System for Cerebral Palsy. Functional scales such as the

Gross Motor Function Classification System for Cerebral Palsy standardize self-initiated movements and measure change in gross motor function over time and this particular scale is widely accepted and easy to administer in the primary care office. Other functional scales include: the Pediatric Evaluation of Disability Inventory, a judgment-based, standardized instrument using parent report through a structured interview measuring both fine- and gross-motor movements related to self-care and mobility; the Functional Independence Measure (FIM) for adults and the WeeFIM for children, which measure the amount of assistance a person would require to perform activities of daily living[4]. However the results of the measurements show variations according to different sociocultural characteristics.

In India, one of the many challenges in assessing the effectiveness of therapies has been the paucity of validated measures of function. Hence the purposes this study is to develop a standardized scale for the assessment of functional abilities in the pediatric population.

Description

The Pediatric Functional Evaluation Measure (PFEM) is a comprehensive tool to measure the functional capabilities and performance in children from the ages of 6 months to 6 years. The PFEM can be administered in the form of a structured interview and reports from parents.

Many scoring systems have been constructed to assess the development of cerebral palsy children and to evaluate the effectiveness of treatment. According to the purposes they fulfill, these instruments may be divided into three types: discriminative, evaluative and predictive[5].

The PFEM is an '*evaluative measure'* designed to measure the magnitude of change in function over time or after treatment. The questions are hierarchic in nature and the scoring is the cumulative scoring system. The tool will be very useful for physical therapists and occupational therapists and other members involved in the rehabilitation of children with developmental disabilities.

This tool measures the functional abilities of children under three domains:

Physical Function Domain, Mental Function Domain, and Social & Emotional Function Domain.

The physical function domain contains 78 questions, the mental function domain contains 30 questions, and social and emotional function domain contains 20 questions. These questions will directly measure the functional capability of the child. The questions have been designed to suit the Indian population.

Total possible score in PFEM is 128. The higher score in PFEM indicates better functional independence and the lowest score represents that the child needs assistance in activities of daily living.

Objectives of the PFEM

1. To identify areas of functional deficit in children who have delayed functional development.
2. To provide information to the parents and therapists regarding the child's functional deficits.
3. To evaluate improvement before and after rehabilitation programs.
4. As an outcome measure in pediatric rehabilitation.

Appropriate use of the PFEM

This tool can be used for evaluation of functional abilities over time in children with development delays.

Validation of the tool

Content validity

Content validity is usually the first step in developing a measure for further validation. Content validity is based on whether the items of an instrument adequately represent the domain they are supposed to measure (Kaplan et al.1976). This test domain is known as the underlying construct or latent trait of the measure. Classical test theory uses expert opinion to determine if the measure and the individual items measure the assumed construct[6].

The content validity of the PFEM was examined using a panel of 35 experts. The experts were asked to give their opinion on the: Clarity, Relevance and Appropriateness of Domain of the questions. A summary of the results are given in the following table:

Participants	P.T	O.T.	Clinical Psychologists	Med.Social Worker	Special Educator	Parents	Pedi atricians
Number	15	10	2	1	2	2	3

	Clarity	Relevance	Appropriateness of the Domain
Physical Function Domain	98.70	100.0	100.0
Mental Function Domain	98.00	100.0	100.0
Social & Emotional Function Domain	98.50	99.00	98.70

Pilot study

The Pediatric Functional Evaluation Measure was administered on 110 normal children and 49 children with cerebral palsy in the age group between 6 months to 6.5 years. Parents of the 159 children were interviewed. The children were selected randomly from regular schools, play schools, pediatric clinics and the neighborhood.

The following table gives the age distribution of children considered for the present study. Nearly 46 per cent of the children are below 30 months of age and nearly one fourth of the children are above 4 years of age.

Table 2 gives the gender distribution particulars. Nearly half the children are girls and the other half are boys

The mean values of the three domains and the overall mean scores are tested for equality between Cerebral palsy

Table 1: Age distribution of Children.

	Age Group	
	N	%
Upto 1 Year	21	13.2
13-18 Months	21	13.2
19-24 Months	16	10.1
25-30 Months	17	10.7
31-36 Months	14	8.8
37-42 Months	13	8.2
43-48 Months	16	10.1
49-54 Months	6	3.8
55-60 Months	8	5.0
61-66 Months	9	5.7
67-72 Months	13	8.2
73-78 Months	5	3.1
Total	159	100.0

Table 2: Sex distribution of children.

	Sex	
	N	%
Female	80	50.3
Male	79	49.7
Total	159	100.0

and Normal children. The summary details are given below.

It is hypothesized that the mean values of the three domains and overall mean scores are the same between Cerebral palsy and Normal Children. Lavene's test is used for testing the equality of the variances and the student's t test is used for testing the equality of the mean values. Since the significance values are all less than 0.05, the equality assumption fails and it is concluded that the mean values of the domains and the overall mean values are different for Cerebral palsy and Normal children. The values given in the above table indicate that the scores of Normal children are very high compared to the scores of Cerebral palsy children in all the three domains and in the overall score.

Table 5 shows the summary statistics of boys and girls in 3 domains and overall:

Table 6 shows testing the mean values of Normal and Cerebral palsy girls and boys separately for each one of the 3 domains and overall. Mean values are found to be significant between Cerebral palsy and Normal boys as well as Cerebral palsy and Normal girls in the three domains and in the overall score.

Table 7 gives details of mean values of three domains and overall mean score according to different age groups. The equality of mean values of Cerebral palsy and Normal children for each one of different age groups in the three domains and in the overall mean score is tested using One-Way Anova and the results are given in Table 8.

Mean values of Cerebral palsy and Normal children differ significantly in all age groups in the three domains and in the overall mean score.

In Table 9, correlations between the three domains for Cerebral palsy and Normal children are given. It is found that for both Cerebral palsy and Normal children the correlations are statistically significant between the three domains. Very high correlations are found for Normal children compared to Cerebral palsy children in the three domains.

Inter rater reliability

The reliability of an assessment refers to the consistency of scores across different occasions of measurement or different examiners, or of items within the instrument.

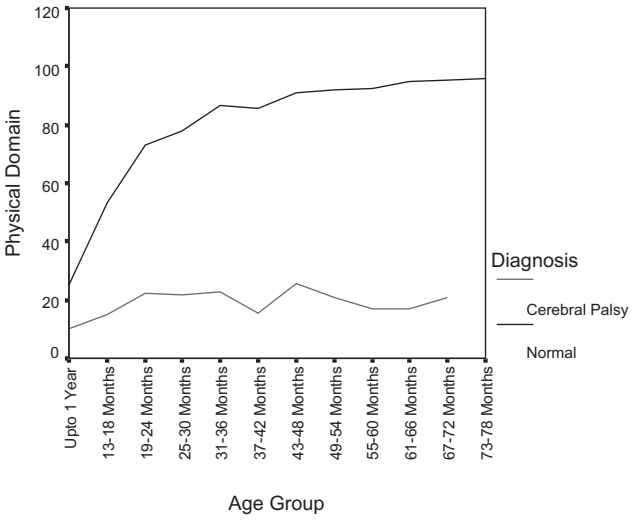
The inter rater reliability of the Pediatric Functional Evaluation Measure reported here.

Three raters (physiotherapists) independently scored the PFEM on 15 children with cerebral palsy. The parents of these children were interviewed and the summary is given below:

In table 10 the assessment of the three raters is given for the same set of cerebral palsy children in the three domains and in the overall mean scores.

The differences between the mean scores of the three rates are tested using One-way Anova and the results are presented in table 11. It is found that mean values are almost the same assessed by the three raters in the three domains in the overall score.

Fig. 1: Physical function domain – Cerebral palsy and Normal Children.



Results

The content validity of the PFEM was examined using an expert panel of 35 members. This expert panel provided ratings of the individual items and the results indicate strong content validity of the instrument.

The results of the pilot study conducted on 110 normal children and 49 children with cerebral palsy, indicate that the mean value of the normal children in all the three domains

Table 3: Summary Statistics.

Group Statistics					
	Diagnosis	N	Mean	Std. Deviation	Std. Error Mean
Physical Domain	Cerebral Palsy	49	19.18	7.960	1.137
	Normal	110	75.09	25.475	2.429
Mental Domain	Cerebral Palsy	49	6.82	4.662	.666
	Normal	110	63.46	30.687	2.926
Social-emotional Domain	Cerebral Palsy	49	16.16	5.724	.818
	Normal	110	69.71	28.047	2.674
Mean Score	Cerebral Palsy	49	14.0544	5.11776	.73111
	Normal	110	69.4212	27.36884	2.60952

Table 4: Student's t-test.

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Physical Domain	47.506	.000	-20.846	146.081	.000
Mental Domain	103.464	.000	-18.878	119.858	.000
Social-emotional Domain	84.662	.000	-19.148	127.799	.000
Mean Score	78.434	.000	-20.431	125.034	.000

Table 5: Summary statistics – Boys and Girls.

Sex		Diagnosis	N	Mean	Std. Deviation	Std. Error Mean
Female	Physical Domain	Cerebral Palsy	21	19.29	8.088	1.765
		Normal	59	74.61	26.647	3.469
	Mental Domain	Cerebral Palsy	21	7.33	5.877	1.282
		Normal	59	64.15	29.620	3.856
	Social-emotional Domain	Cerebral Palsy	21	16.05	6.674	1.456
		Normal	59	69.17	27.376	3.564
	Mean Score	Cerebral Palsy	21	14.2222	5.87777	1.28263
		Normal	59	69.3107	27.21004	3.54245
Male	Physical Domain	Cerebral Palsy	28	19.11	8.011	1.514
		Normal	51	75.65	24.300	3.403
	Mental Domain	Cerebral Palsy	28	6.43	3.563	.673
		Normal	51	62.67	32.154	4.503
	Social-emotional Domain	Cerebral Palsy	28	16.25	5.023	.949
		Normal	51	70.33	29.065	4.070
	Mean Score	Cerebral Palsy	28	13.9286	4.57526	.86464
		Normal	51	69.5490	27.82188	3.89584

Table 6: Independent Samples Test.

Sex		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Female	Physical Domain	21.387	.000	-14.214	76.958	.000
	Mental Domain	30.270	.000	-13.982	69.087	.000
	Social-emotional Domain	27.981	.000	-13.798	73.079	.000
	Mean Score	25.168	.000	-14.622	70.681	.000
Male	Physical Domain	24.792	.000	-15.181	66.899	.000
	Mental Domain	85.853	.000	-12.353	52.214	.000
	Social-emotional Domain	62.173	.000	-12.941	55.285	.000
	Mean Score	59.602	.000	-13.938	54.801	.000

Fig. 2: Mental function domain – Cerebral palsy and Normal Children.

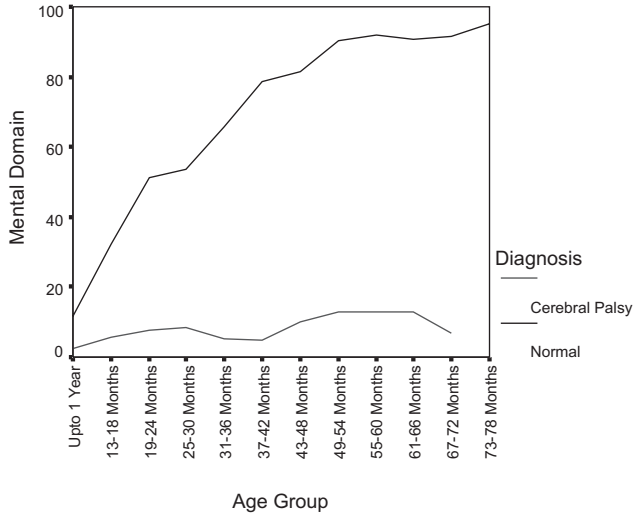
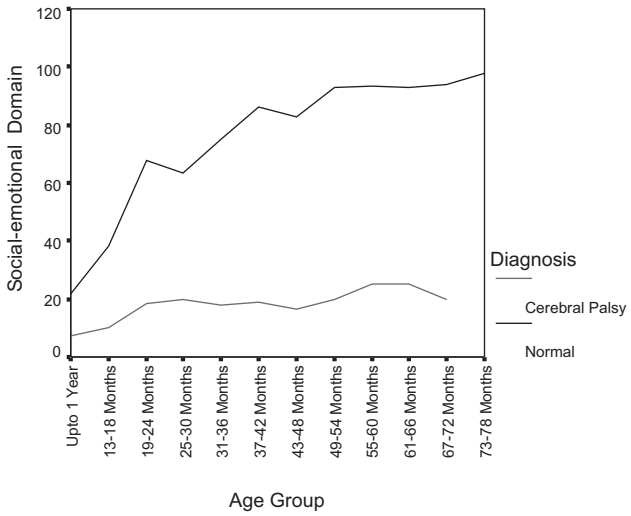


Fig. 3: Social and Emotional function domain – Cerebral palsy and Normal Children.



are far higher than the mean value of the children with cerebral palsy.

Overall conclusion, irrespective of age and gender differences is that the children with cerebral palsy are found to have very low scores in all the three domains and in the overall mean when compared to the normal children. It is also found that very high correlations are found for normal children when compared to children with cerebral palsy in all the three domains.

Analyses of inter rater assessments show that the mean values assessed by the 3 raters are almost the same in the three domains as well as in the overall score. These results indicate that the Pediatric Functional Evaluation Measure has a high degree of reliability and validity and also support the notion that the PFEM can be used to assess the functional abilities in children with cerebral palsy.

Discussion

Several assessment instruments have been developed in the Western countries to assess functional abilities in the pediatric population but due to the vast socio-cultural differences many of the tools cannot be applied for the Indian population. For eg., The Functional Independence Measure (WeeFIM) for children is a simple-to-administer scale for assessing independence across 3 domains in American children. WeeFIM is useful in assessing functional independence in children aged 6 months to 7 years. It can be used for children with developmental disabilities aged 6 months to 21 years. Normative WeeFIM data had been validated for American children[7]. Because of cultural and environmental differences among countries; this tool can be used only if the normative data for our population is established.

Table 7: Summary statistics – Age wise distribution.

	Diagnosis							
	Cerebral Palsy				Normal			
	Physical Domain	Mental Domain	Social-emotional Domain	Mean Score	Physical Domain	Mental Domain	Social-emotional Domain	Mean Score
Age Group	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Upto 1 Year	10	2	8	6.58	25	12	22	19.45
13-18 Months	15	6	10	10.17	53	32	38	41.27
19-24 Months	22	8	18	16.07	73	51	68	64.00
25-30 Months	22	8	20	16.81	78	54	63	65.07
31-36 Months	23	5	18	15.19	87	66	75	75.71
37-42 Months	16	5	19	13.00	86	78	86	83.37
43-48 Months	26	10	16	17.33	91	82	83	85.03
49-54 Months	21	13	20	18.00	92	90	93	91.67
55-60 Months	17	13	25	18.33	93	92	94	92.71
61-66 Months	17	13	25	18.33	95	91	93	92.87
67-72 Months	21	7	20	16.00	95	91	94	93.39
73-78 Months	.	.	.	.	96	95	98	96.27

Table 8: One way - Age Group Comparisons.

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
Physical Domain	Between Groups	81582.535	11	7416.594	11.107	.000
	Within Groups	98154.421	147	667.717		
	Total	179736.956	158			
Mental Domain	Between Groups	117634.580	11	10694.053	16.577	.000
	Within Groups	94830.414	147	645.105		
	Total	212464.994	158			
Social-emotional Domain	Between Groups	98046.209	11	8913.292	15.154	.000
	Within Groups	86463.942	147	588.190		
	Total	184510.151	158			
Mean Score	Between Groups	97826.052	11	8893.277	14.690	.000
	Within Groups	88995.847	147	605.414		
	Total	186821.899	158			

Table 9: Correlations.

Correlations					
Diagnosis			Physical Domain	Mental Domain	Social-cultural Domain
Cerebral Palsy	Physical Domain	Pearson Correlation	1	.574(**)	.542(**)
		Sig. (2-tailed)	.	.000	.000
		N	49	49	49
	Mental Domain	Pearson Correlation	.574(**)	1	.485(**)
		Sig. (2-tailed)	.000	.	.000
		N	49	49	49
	Social-emotional Domain	Pearson Correlation	.542(**)	.485(**)	1
		Sig. (2-tailed)	.000	.000	.
		N	49	49	49
Normal	Physical Domain	Pearson Correlation	1	.915(**)	.919(**)
		Sig. (2-tailed)	.	.000	.000
		N	110	110	110
	Mental Domain	Pearson Correlation	.915(**)	1	.941(**)
		Sig. (2-tailed)	.000	.	.000
		N	110	110	110
	Social-emotional Domain	Pearson Correlation	.919(**)	.941(**)	1
		Sig. (2-tailed)	.000	.000	.
		N	110	110	110

** Correlation is significant at the 0.01 level (2-tailed).

Pediatric Evaluation of Disability Inventory (PEDI) is an instrument for evaluating function in children with disabilities aged 6 months to 7.5 years. The PEDI measures both functional performance and capability in three domains: self-care, mobility, and social function[8]. The normative data has also been validated for the American population.

Some of the questions in the PEDI are not suitable for our population. For eg., tub transfers – majority of the our population does not use the bath tub. Similarly car transfers – not all children have the accessibility to cars[9].

Many attempts have been made by Indian authors in translating and modifying functional assessment scales designed in the western countries for the pediatric population, but the literature search reveals that none of the tools have been published. Paucity of standardized and published functional assessment scales for children in the Indian rehabilitation setup creates drawbacks in evaluating improvement before and after rehabilitation.

Table 10: Inter raters' Assessments.

	Raters					
	1		2		3	
	Mean	SD	Mean	SD	Mean	SD
Physical function	66	26	63	25	65	26
Mental function	60	27	53	29	59	28
Social emotional function	66	25	63	24	65	24
Mean score	63.96	23.13	59.64	23.08	62.84	22.97

The construct of the Pediatric Functional Disability Assessment Measure is a sincere attempt at developing a comprehensive evaluative measure in pediatric rehabilitation.

The measure covers three domains viz., physical function, mental function and social & emotional function of children from 6 months to 6 years. The scale was designed according to the normal developmental milestones and also according to the lifestyle of normal children from urban Chennai population.

Pooling of the questions was done initially and first round of content validity of the scale was examined using a panel of 35 experts. As per the experts' valuable suggestions, some questions were modified, some were added and some more were deleted. Then, once again the modified scale was given to the 35 experts and their opinion was obtained on the clarity, relevance and appropriateness of domain of all the questions. The results indicate that the content validity for all the three domains is high. Hence, the PFEM has high content validity.

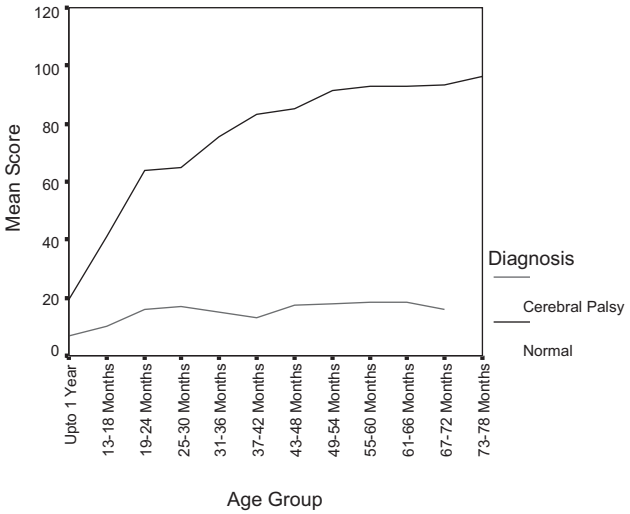
A pilot study was conducted on 110 normal children and 49 children with cerebral palsy. While interviewing the parents, it was observed that the parents inclined to discuss with parents of other children. So it was necessary to make sure to conduct the interview in a separate room and also we made sure that the parents who finished the interview did not discuss with the parents who were yet to be interviewed.

Statistical analyses indicate that the mean scores of the children with cerebral palsy were very low when compared with the scores of normal children. Very significant results were obtained which indicate that the scale has very high reliability and validity.

The inter-rater reliability has been established for PFEM on 15 children with cerebral palsy using three raters (physiotherapists). The statistical analyses apt for inter-rater reliability are ANOVA. The result reveals that the physical function domain (0.958) and socio-emotional domain (0.945) have high inter-rater agreement, moderate agreement for the mental domain (0.745).

Limitations: The pilot study has been done only on children with cerebral palsy. Children with other developmental disorders have not been assessed. Further this study has been done only on the urban children of Chennai.

Figure 4 : Overall mean scores – Cerebral palsy and Normal Children



Recommendations: It is recommended that further studies be done on children with other developmental delays. Further studies must be done to find out if differences exist between the different cultural groups across the country. The tool must also be translated in various regional languages of the country.

Conclusion: The Pediatric Functional Evaluation Measure is a standardized assessment measure which can be used to evaluate the functional disabilities in children with developmental delays. Further studies are in progress to evaluate the discriminant validity and also to evaluate functional improvement before and after rehabilitation programs, using the PFEM.

Note: The Pediatric Functional Disability Assessment Measure is a free tool and the sample scoring form is given in the appendix. Instructions for administration, Glossary, Scoring particulars will be provided by the author upon request.

Acknowledgements

Sincere thanks to all the children and parents who participated in the study and to all the experts who contributed towards the content validity.

Sincere thanks to the valuable contributions of Prof.A.G.Dhandapani, Principal, College of Physiotherapy, SRMC and Prof. S.Govindaraju, HOD, Department of Statistics, Madras Christian College.

Table 11: Oneway – Inter Raters' Differences.

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
Physical function	Between Groups	56.044	2	28.022	.043	.958
	Within Groups	27672.533	42	658.870		
	Total	27728.578	44			
Mental function	Between Groups	460.578	2	230.289	.296	.745
	Within Groups	32693.733	42	778.422		
	Total	33154.311	44			
Social emotional function	Between Groups	67.511	2	33.756	.057	.945
	Within Groups	25037.467	42	596.130		
	Total	25104.978	44			
Mean score	Between Groups	150.301	2	75.151	.141	.869
	Within Groups	22337.600	42	531.848		
	Total	22487.901	44			

APPENDIX

Pediatric functional evaluation measure physical function domain

A. Types of food

1. Takes liquid food:
2. Eats mashed / blended food:
3. Eats semi-solid food:
4. Eats all types of food:

B. Feeding habits

5. Needs full assistance in eating:
6. Picks up food with fingers and puts in mouth. (With spilling):
7. Eats by self with fingers when food is mixed and given (without spilling):
8. Able to mix food with own hands and eat:
9. Able to eat well using a spoon:

C. Drinking

10. Needs assistance for drinking:
11. Holds bottle / sipper with both hands:
12. Holds bottle / sipper with one hand:
13. Holds tumbler / cup with both hands and drinks liquids by self:
14. Holds tumbler / cup with one hand and drinks liquids by self:
15. Pours water from jug into a glass and drinks by self:

D. Dressing up

16. Co-operates while being dressed:
17. Removes unbuttoned shirt / T.shirt:
18. Puts on shirt / T-shirt independently, without buttoning:
19. Pulls down and puts on pants / knickers independently:
20. Puts buttons / zip in shirt or pant independently:
21. Puts belt in loops:

E. Foot wear

22. Needs full assistance in putting on chappals / sandals:
23. Can put chappals / sandals on the correct feet independently (without buckles):
24. Needs assistance in putting buckles / Velcro straps in chappals / sandals:
25. Can put on chappals / sandals correctly, independently.

F. Brushing teeth & bathing

26. Needs full assistance for brushing teeth:
27. Brushes teeth with minimal assistance / guidance:
28. Brushes teeth thoroughly, independently:
29. Co-operates while being bathed:
30. Pours water on self for bathing:
31. Washes face, legs and hands with soap:
32. Bathes and wipes well independently:

G. Combing hair

33. Co-operates while hair is being combed:
34. Tries to use comb and combs hair (not perfectly):
35. Combs hair independently:

H. Toileting

36. Indicates when wet:
37. Indicates the need to use toilet:
38. Sits on the toilet seat / squats to pass urine / stools:
39. Needs assistance in cleaning and managing clothes after toileting:
40. Needs assistance in cleaning but independent in managing clothes after toileting:
41. Independent in cleaning and managing clothes after toileting:

I. Bed transfers

42. Rolls about in the bed / mat:
43. Raises to sitting position from lying in the bed / mat:
44. Goes to lying position from sitting in the bed / mat:
45. Gets in and out of the bed, with assistance:
46. Gets up from sitting to standing in the mat, with assistance:
47. Gets in and out of the bed, without assistance:
48. Gets up from sitting to standing in the mat independently:

J. Chair transfers

49. Sits independently, when placed in chair with backrest:
50. Sits independently, when placed in chair without backrest:
51. Climbs down from chair / bench with assistance:
52. Climbs down from chair / bench without assistance:
53. Climbs up and sits in small size chair independently:
54. Climbs up and sits in adult size chair independently:

K. Indoor ambulation

55. Rolls, creeps and crawls on the floor:
56. Stands, independently:
57. Walks, with support:
58. Walks without support, with broad base and steps of unequal length:
59. Walks well, with feet only slightly apart:
60. Walks about inside the house with support:
61. Walks well inside the house, independently:

L. Outdoor ambulation

62. Walks outdoors on level surfaces, with hands held:
63. Walks outdoors on level surfaces, without support:
64. Walks outdoors on rough uneven surfaces, with support:
65. Walks outdoors on rough uneven surfaces, without support:
66. Walks upto 100 feet without difficulty:
67. Walks well, up and down on ramps:

M. Climbing upstairs / downstairs

68. Climbs stairs holding rails, two feet per step:
69. Climbs stairs holding rails, one feet per step:
70. Climbs stairs without support:
71. Climbs downstairs holding rails, two feet per step:
72. Climbs downstairs holding rails, one feet per step:
73. Jumps off the bottom step:
74. Climbs up and downstairs one foot per step, without support:

N. Other skills

75. Rides tricycle:
76. Catches ball with arms outstretched:
77. Throws and catches ball well:
78. Skips, hops and dances:

Mental function domain

A. Speech & communication

1. Vocalizes Amma, appa, mama:
2. Asks for objects by vocalizing / gesturing:
3. Repeats words overheard:
4. Puts words together in phrases:
5. Can retell a simple story:
6. Can narrate own experiences:

B. Comprehension

7. Responds to own name:
8. Understands people's names and familiar words:
9. Recognizes few objects by name / function:
10. Carries out simple instructions:
11. Understands concept of pictures / colours:
12. Listens to short story and can answer simple questions about it:

C. Time / place orientation

13. Is aware of mealtimes and other routines of the day:
14. Tells correctly if it is day / evening / night:
15. Follows yesterday, today and tomorrow:
16. Looks at clock and tells the hour and minute hand:
17. Aware of incidents and their relation to time:
18. Can differentiate between own "home" and other places:
19. Aware of places visited like 'Park', 'Beach' etc:

D. Reading & writing

20. Looks at objects / pictures and scribbles:
21. Matches objects and pictures correctly:
22. Identifies alphabets:
23. Colours pictures:
24. Reads and writes words / numbers:

E. Arithmetics

25. Keeps objects in specific pattern:
26. Puts beads one by one in container:
27. Can count numbers:
28. Identifies rupee notes and coins:
29. Does simple additions:

F. Memory

30. Able to recollect immediate past events:

Social & emotional domain

A. Social interactions

1. Smiles responsively when called:
2. Makes noise to get attention:
3. Greets others, either verbally or using gestures;
4. Says "Please, Sorry, & thank you":
5. Makes friends and has a preferred friend:
6. Has conversation and tells jokes:

B. Play

7. Reaches for and grasps toy:
8. Builds blocks, manipulates toys and solves simple puzzles:
9. Can play games with groups:
10. Plays indoors / outdoor games; but not understanding rules:
11. Plays indoor / outdoor games; understanding rules:

C. Domestic chores

12. Picks up and puts away toys with reminder from parents:
13. Does simple chores along with mother:
14. Answers telephone:
15. Does simple errands for parents:

D. Self protection

16. Cries, if uncomfortable:
17. Careful in handling sharp / hot / cold objects (at home):
18. Careful while climbing stairs / running around (indoor):
19. Careful while playing outdoors:
20. Knows not to accept anything from strangers:

References

1. Anne Anastasi. Susana Urbina. Psychological Testing. Dorling Kindersley (India) Pvt.Ltd., 2007
2. Parminder Raina, PhD., Maureen O'Donnell, MD., Peter Rosenbaum, MD., Jamie Brehaut, PhD., Stephen D. Walter, PhD., Dianne Russell, MSc., Marilyn Swinton, BSc., Bin Zhu, MSc., and Ellen Wood, MD. The Health and Well-Being of Caregivers of Children With Cerebral Palsy. PEDIATRICS Vol. 115 No. 6 June 2005, pp. e626-e636.
3. Erkin G, aybay C, Kurt M, Keles I, Cakci A, Ozel S. The assessment of functional status in Turkish children with cerebral palsy (a preliminary study). Child Care Health Dev.2005 Nov; 31(6): 719-25
4. Karen W. Krigger. Cerebral Palsy: an Overview. American Family Physician 2006; Jan 1;73(1):91-100No.1.
5. Pietrzak S, Jozwiak M., Subjective and objective scales to assess the development of children with cerebral palsy. Ortop Traumatol Rehabil. 2001 Dec 30:3(4):487-9
6. Diane J Russel, Peter L. Rosenbaum, Lisa M Avery. Gross Motor Function Measure User Manual. Cambridge University Press. 2002
7. Wong V, Wong S, Chan K, Wong W. Functional Independence Measure (WeeFIM) for Chinese children: Hong Kong Cohort. Pediatrics. 2002 Feb;109(2):E36
8. Berg M, Jahnsen R, Froslie KF, Hussain A. Reliability of the Pediatric Evaluation Of Disability Inventory (PEDI). Phys Occup Ther Pediatr. 2004;24(3):61-77.
9. Stephen M. Haley Ph.D., Wendy J. Coster, Ph.D., Larry H. Ludlow, Ph.D., Jane T. haltiwanger, Ph.D., Peter J. Andrellos, Ph.D. Pediatric Evaluation of Disability Inventory (PEDI). Development, Standardisation and Administration Manual. Boston 1992.

The effect of severity on the isokinetic strength in knee osteoarthritis (OA)

Madan Shilpa
Senior Physiotherapist, Max Super Speciality Hospital, Saket, New Delhi

Abstract

Purpose

To determine the relationship of torque measures of knee flexors to extensor muscles developed as a result of dysfunction and disease in knee Osteoarthritis (OA) and does the maximum peak torque measures change in patients with knee OA compared to healthy normal subjects.

Materials and Methods

30 patients with the symptomatic osteoarthritic knees (age 40 – 60 yrs) were divided into 3 groups.
Group1 – 10 Subjects exhibiting symptomatology and radiologic findings of knee OA.
Group2 – 10 Subjects having knee joint pain without any radiologic evidence of knee OA.
Group3 – 10 Healthy subjects.

Subjects in all the 3 groups performed concentric contractions of knee flexors and extensors that include 4 repetitions at 60 deg/sec, 10 reps at 120 deg/sec and 20 reps at 180 deg/sec. Values of maximum peak torque of flexors and extensors and maximum peak torque hamstring to quadriceps ratio were recorded after each session.

Results

Significant difference was found in maximum peak torque of flexors and extensors among 3 groups of subjects but no significant difference for ratio was observed among 3 groups. Values of maximum peak torque measures decreased with increasing speed of shortening and the hamstring to quadriceps values increased with increasing speed of shortening.

Conclusion

There is equal strength loss of both the muscles in patients with knee osteoarthritis, so hamstring strengthening exercises should be incorporated along with quadriceps strengthening exercise in rehabilitation plan of knee OA.

Keywords

Isokinetic strength, concentric contraction, maximum peak torque, isokinetic dynamometer

Introduction

Knee osteoarthritis is the leading cause of chronic disability in older persons[1]. Osteoarthritis commonly affects hands, feet, spine and large weight bearing joints such as hip and knees. Osteoarthritis is the second most common rheumatic problem and is most frequent joint disease with prevalence of 22% to 39% in India[4]. Prevalence of osteoarthritis in all joints is strikingly correlated with age. For subjects over the age of 45 years most population surveys showed that presence of radiographically determined OA of the knee varies between 14 and 30% and increases steadily with age[6]. Osteoarthritis of knee joint is characterized by localized tenderness over the joint and pain on passive or active motion Pain is frequently the first symptom and is often associated with swelling. Crepitus can often be detected and muscle atrophy is seen secondary to disuse[7]. Knee flexor muscle gaps are subject to hypotrophy and loss of strength, as well as the knee extensors in osteoarthritis of the knee joint. It has been documented that dynamic stability of the Knee joint depends on the appropriate strength ratio of quadriceps and hamstrings[9]. Purpose of this study is to determine the relationship of torque and torque ratio of knee flexors to extensors muscles developed as a result of dysfunction and disuse in osteoarthritis.

Statement of the Question

1. Does the maximum peak torque measures and maximum peak torque hamstring/quadriceps ratio change in patients with knee osteoarthritis compared with normal control subjects
2. Are there any differences between 2 patient groups when maximum peak torque and maximum peak torque hamstring/quadriceps ratios were compared with each other.

Hypothesis

There is equal strength loss of knee flexors and extensors in patients with knee osteoarthritis

Methodology

Sample: A sample of convenience of 30 subjects with an age range from 40-60 years were recruited from Department of Orthopedics (Physiotherapy), All India Institute of Medical Sciences. Subjects were referred by the Orthopedician. The eligibility criteria were checked and a written consent was taken from the subjects.

Inclusion criteria

1. Age group : 40-60 years
2. Symptomatic Osteoarthritic knees
3. Minimum available range of 0-90 degrees knee flexion

Exclusion criteria

1. Symptoms or signs of synovitis
2. Acute or chronic ligamentous insufficiency
3. Any history of knee surgery
4. Any history of recent injury to knee joint
5. Low back or hip joint disorders
6. Any systemic illness
7. Any history of doing prescribed exercises for knee osteoarthriti

Design

A Comparative design was used in this study. Subjects were randomly assigned into three groups and were named as Group 1, Group 2 and Group 3. Demographic data was collected from the subjects who met the inclusion and exclusion criteria of the study. This included age, height weight, etc. Data was collected in one 45 minutes test session.

Instrumentation

1. Biodex System3 Pro Isokinetic Dynamometer
2. Weighing Scale
3. Stadiometer

Protocol

1. Subjects were diagnosed by the Orthopedician with the diagnosis of knee Osteoarthritis.Diagnosis was based on the Clinical criteria by Altman et al. Severity of osteoarthritis was measured by Kellgren and Lawrence criteria for radiological assessment.
2. The subjects diagnosed with knee osteoarthritis were invited to participate in the study. Those who fulfilled the inclusion criteria were asked to sign an informed consent form.
3. A Subjects were assigned into three groups as :

Group 1: 10 subjects exhibiting symptomatology and radiologic findings of knee osteoarthritis.
Group 2: 10 subjects having knee joint pain without any radiologic evidence of knee osteoarthritis.
Group 3: 10 healthy subjects.

Procedure

All the testing was completed on Biodex System 3 Pro computer controlled isokinetic dynamometer, which was caliberated every 2 weekly by caliberation verification procedure as described in the operation manual of Biodex.

1. All the subjects were explained about the purpose, procedure and nature of the result.
2. Subjects were seated on the biodex chair and secured using upper crossing torso, pelvic, distal thigh stabilization straps.
3. An adjustable lever arm was attached to subject's leg by a resistance pad was put 1 inch proximal to the medial malleolus.
4. Subjects gripped the sides of chair and leaned back against the backrest, which was inclined posteriorly to an angle of 90 degrees above the horizontal.
5. The axis of rotation of dynamometer arm was positioned lateral to lateral femoral condyle
6. Subject's anatomical position was caliberated by placing the joint in anatomical reference angle(0 degrees extension position was used as reference position in all subjects)
7. A range of motion of o degrees extension to 90 degrees flexion was targeted in all subjects.
8. With the limb positioned at 45 degrees of knee flexion, caliberation of limb weight was done to negate the gravity effect by the biodex software.
9. Subjects completed the warm up phase prior to actual testing. Warm up consisted of 3 consecutive trials for each speed of testing, one of which ws a maximal contraction.
10. Subjects performed concentric contraction of knee flexors and extensors at 3 preset speeds with 20 sec rest period between the sets.
11. Subjects performed 3 sets that included 4 repetitions at 60 degrees per second, 10 repetitions at 120 degrees per second and 20 repetitions at 180 degrees per second. The order of testing was from slower to faster speeds
12. Subjects were verbally encouraged to exert maximal efforts.
13. Data were collected for the maximum peak torque of flexors and extensors relative to body weight.

Data Analysis

Statistically the characteristics of the groups and the results were compared using One way ANOVA and Paired t tests.

Data were managed on an excel spreadsheet. SPSS (Statistical package for social science) software was used for data analysis.

One way ANOVA (Duncan's Mean Test) was used to analyze the difference in maximum peak torque of flexors and extensors and maximum peak torque hamstring to quadriceps ratio among 3 groups of respondents.

Paired t test was used to analyze the difference in maximum peak torque of flexors, extensors and maximum peak torque hamstring to quadriceps ratio among 3 speeds within the groups of respondents

Result

In the present study, there was significant difference in Maximum peak torque of Flexors and Extensors among 3 Groups of respondents. No significant difference for Maximum peak torque (Hamstring / Quadriceps) Ratio was found among 3 Groups.When within group analysis was performed it was found that the value of maximum peak torque measures decreased with increasing speed of shortening and the Hamstring to Quadriceps sratio values increased with increasing speed of shortening.

Intergroup Analysis

Maximum peak torque / body weight of Extensors and Flexors and maximum peak torque hamstring to quadriceps ratio were compared among 3 groups of respondents using One way anova test.

Comparison of Maximum peak torque / body weight of Extensors among 3 Groups of respondents

At 60 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 56.99,

P<0.01) Significant difference was found between groups 1 & 2, 2 & 3 and 1 & 3.

At 120 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 41.04, P < 0.01) Significant difference was found between groups 1 & 2, 2 & 3 and 1 & 3.

At 180 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 23.45, P < 0.01) Significant difference was found between groups 1 & 2, 2 & 3 and 1 & 3.

Comparison of Maximum peak torque / body weight of Flexors among 3 Groups of respondents

At 60 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 27.57, P<0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

At 120 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 16.14, P < 0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

At 180 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 6.86, P < 0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

Comparison of Maximum peak Torque (Hamstring / Quadriceps) Ratio among 3 Groups of respondents.

At 60 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.45, P = 0.10)

At 120 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.10, P = 0.14)

At 180 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.22, P = 0.12)

Within Group Analysis

Maximum Peak Torque / Body weight of extensors and flexors were compared among 3 speeds of testing within each group using paired-t test

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 2.87, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 5.66, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 120 deg/sec and 180 deg/sec (t value = 4.39, P < 0.01)

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 2.32, P < 0.05)

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 3.64, P < 0.01)

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 2.93, P < 0.01)

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 0.75, P = 0.47)

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 2.17, P < 0.05)

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 2.17, P < 0.05)

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 3.87, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 6.78, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 120 deg/sec and 180 deg/sec (t value = 8.97, P < 0.01)

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

No significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 0.98, P = 0.35)

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 2.97, P < 0.01)

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 2.60, P < 0.05)

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 1.96, P < 0.05)

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 1.63, P = 0.13)

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 0.54, P = 0.60)

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 5.30, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 8.27, P < 0.01)

Significant difference in maximum peak torque of extensors was found between 120 deg/sec and 180 deg/sec (t value = 5.82, P < 0.01)

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 4.68, P < 0.01)

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 7.28, P < 0.01)

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 5.16, P < 0.05)

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 1.64, P = 0.13)

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 1.96, P < 0.05)

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 0.97, P = 0.91)

For the Maximum peak torque measures, as the velocity of shortening increased, the value of concentric peak torque reduced. With the increase in the velocity of shortening an increase in value of maximum peak torque (Hamstring / Quadriceps) Ratio was observed.

Discussion

Knee stability is accomplished through three components osseous structures, ligamentous structures and the neuromuscular dynamic control system. The dynamic stabilizers of the knee are the muscles surrounding the joint. Muscle functions to provide movement dynamic joint stability and to control and absorb joint stress.

The quadriceps muscle is an important stabilizer of the knee joint and often exercise is designed to strengthen the quadriceps muscle[7].

However, pain and swelling of the knee joint leads to restriction of range of motion and contractures of joint capsule and hamstrings[54]. Therefore, knee flexor muscle groups are subject to hypotrophy as well as knee extensors in knee osteoarthritis.

In this study investigation was done to determine the relationship of torque developed by knee flexors and extensors in the presence and absence of radiologic evidence of knee osteoarthritis. Measures of patients were also compared with healthy subjects to investigate muscle wasting in knee osteoarthritis.

To see the effect of severity on the Isokinetic strength in knee osteoarthritis. 3 groups of subjects were included in the study. Group 1 comprised of subjects with symptomatology and radiologic findings of knee osteoarthritis., more advanced cases of knee osteoarthritis. were included. Group 2 included subjects having knee joint pain without the radiologic evidence of knee osteoarthritis.. Group 3 comprised of healthy subjects of the same age group (40 – 60 years).

Lack of association between symptomatology and radiologic eveidence of OA was previously described by Cobbs et al in a study of Jaletan and Balci et al[55].

The radiologic appearance may be normal if pathologic changes leading to clinical symptoms are sufficiently mild[56] and radiographic findings may lag behind patient's symptoms.

Stauff et al[49] cited in the study of Messier et al reported differences in Isometric strength of 55% to 70% in osteoarthritis. subjects compared to group of healthy adults.

Messier et al[49], in their studies confirmed that adults with osteoarthritis of knee have significantly less strength in both the dominant and non-dominant legs compared to age and gender matched adults without arthritis.

Chang, Pai et al[58], reported reduction in knee extension torques in knee osteoarthritis. Lankhorst et al [50] reported that dynamic torque measurements had very little advantage over static tests.

Isokinetic exercise is an effective, safe and reliable alternative for knee osteoarthritis rehabilitation in elderly.

Concentric strength measures of knee flexors and extensors were used in accordance with the study by David et al[58], they reported test retest reliability of concentric mode of biodex.

Hamstring/quadriceps strength ratio was used based on the finding by Campbell et al (1982) who found that this ratio is better measure of knee function than peak torque[36].

Klopffer et al[60] (1998) suggested the use of peak torque relative to body weight in establishing goals for rehabilitation of individuals with knee pathology.

Sitting position[48,61] was chosen to measure maximum peak torque as supported by studies.

Slow to fast speed testing order was used in accordance with the study of Wilhite[48] et al (1992)

Tredinnick and Duncan[62] (1988) reported excellent reliability of concentric peak torque at 60 degrees/sec, 120 degrees/sec and 180 degrees/sec.

Trunk stabilization was used in accordance with a study by Hart et al[35]

(1984) who found that adequate trunk stabilization leads to higher production of torque.

Michael et al[45] reported the importance of gravity correction of isokinetic peak torque during calculating knee flexor to extensor ratios.

Three submaximal including one maximal trials were selected in warm up on the basis of supporting literature[63,46].

Hard cushion end stop was used as suggested by Taylor et al[47] (1991).

Visual feed back of torque values was provided to subjects as supported by Broadie[63] et al (1991).

In this study significant difference was found in the maximum peak torque measures (Maximum peak torque/ body weight of flexors and extensors) of Group 1, 2 and 3. At all the speeds the extensor and flexor strength was reduced in subjects with advanced osteoarthritis as compared with healthy controls. In Group 1 subjects reduction of strength measures was more remarkable than subjects of Group 2.

There is significant isokinetic strength loss of both flexor and extensor muscle group progressing from Group 3 to Group 1, indicating that isokinetic strength loss progresses with disease progression, These findings are consistent with study by Jale tan et al (1995) they reported that there is isokinetic strength loss in patients with knee osteoarthritis.

Slemenda et al[59] (1998) reported reduced quadriceps strength relative to body weight in patients with knee osteoarthritis and contributed this to reflex inhibition of muscle contraction.

Dekkar et al cited in study of Giir et al[46] (2003) stated that muscle weakness is a mediating factor between negative

affect and disability. They stated that negative affect enhances patient's tendency to avoid pain related activities, a low activity level induces muscle weakness and instability of joints.

Within group analysis in this study showed that as the speed of shortening increases the values of concentric torque decreases. Isokinetic muscle strength of knee flexors and extensors at 60 deg/sec was higher than the strength measures performed at 120 deg/sec and 180 deg/sec. These findings[55,64,66,67,69] are consistent with the findings reported in the literature.

Klofter and Grey[70] demonstrated increasing torque output by the hamstrings as the test velocities increased. They concluded that increasing velocity of knee extension may cause increased reaction of the stretch receptors in the hamstrings and facilitated torque production.

Thorstenson et al[71] (1977) stated that composition of fast twitch fibres and slow twitch fibres may effect torque output. If hamstring or quadriceps muscles contain a higher ratio of fast twitch fibres, increased torque production with increasing velocities may be expected.

The present study showed increased peak torque at decreasing velocity. Subjects (inactive, middle aged) in the study probably had a higher proportion of slow twitch fibres.

Kannus(1994)[72,35] reported that for concentric contractions there is parallel decrease in maximal moment developed by muscles as speed increases. This is because of neuromuscular recruitment patterns that is both type I and type II fibres are activated together at lower speeds but as speed increases less number of type I fibres are recruited and eventually become inactive. At very high velocities smaller and smaller fiber populations are recruited.

The hamstring to quadriceps ratio is a measure of the relationship between strength of these two muscle groups.

In the present study, Within Group analysis showed that as the speed of shortening increases the value of torque increases.

These findings are in accordance with findings by Kannus et al[72], Nunne et al, indicating a possible decline in quadriceps activity.

Maximum peak torque hamstring to quadriceps ratio values were not significant between 3 groups of subjects at 60 deg/sec, 120 deg/sec and 180 deg/sec. The results indicate that there is hamstring as well as quadriceps weakness in subjects with knee osteoarthritis. These findings are consistent with findings by Brandt et al and Tan et al[55] (1995).

The findings of the present study are that i) as the disease progresses there is an increase in isokinetic strength loss of both flexors and extensors of the knee.ii) No significant difference in maximum peak torque hamstring to quadriceps ratio indicates strength loss of both muscle groups.

Clinical relevance

The results of this study showed that there is considerable loss of strength of flexors and extensors in patients with osteoarthritis as the severity of disease increases. There is no significant difference in maximum peak torque ratio indicating equal strength loss of both muscle groups.

So, hamstring muscle strengthening exercises are as important as quadriceps strengthening exercises and should be incorporated in the treatment plan of knee osteoarthritis.Isokinetic maximum peak torque loss of knee extensors and flexors was found in both patient groups, when measures were compared with healthy individuals. However, isokinetic strength ratios of hamstring to quadriceps muscles did not show a statistically significant difference between the groups. This may be related to equal strength loss of knee extensors and flexors sin patients with knee osteoarthritis rather than an ipsilateral muscle imbalance, which significantly proves the present hypothesis.

References

1. Sharma Leena, September Cahue, Jing Song, Karen Hayes(2003), Physical functioning over three years in knee osteoarthritis, Arthritis & Rheumatism, 48;3359-3370
2. Bullough G. Peter (1984), Osteoarthritis: Pathogenesis and Aetiogy, British Journal of Rheumatology, 23;166-169
3. Lawrence J.S., J.M. Bremner, F. Bier (1966), Prevalence in population and relationship between symptoms and X-ray changes, Ann Rheum Dis, 25;1-24
4. Mahajan A., Verma S, V. Tandon(2005), Osteoarthritis, Journal of Association of Physicians in India, 53;634-41
5. Malaviya AN, Singh RR, Kapoor SK, Sharmati(1994), Prevalence of rheumatic diseases in India; results of a population survey, Journal of Indian Rheumatism Association, 2; 7-13
6. Spector T.D., Hart DJ, J Byrene, PA Harris(1993), Definition of Osteoarthritis of the knee for epidemiological studies, Ann RheumDis, 52;790 – 94
7. Moskowitz RW (1992): Osteoarthritis – symptoms and signs, Osteoarthritis Diagnosis and
8. Medical/Surgical Management. 2nd Ed., Philadelphia, WB Saunders, 255 – 61
9. Howell DS, Felletier JP:Etiopathogenesis of Osteoarthritis, McCarthy & Koopman, Arthritis & Allied Conditions, (13th Ed.), Philadelphia, Lea & FebigerVol. 2;1723 – 34
10. Campbell DE, Glenn W (1982), Rehabilitation of Knee Flexor and knee extensor muscle strength in patients with menisectomies, ligamentous repairs and chondromalacia, Physical Therapy, 62;10-15
11. Leader(1989), Osteoarthritis: definitions and criteria, Annals of rheumatic diseases, 48;531 – 32
12. Carolyn Kisner, Lynn Allen Colby(2003), Therapeutic Exercise Foundations and Technique, 4th Edition, 86., Jaypee Publications
13. Todd S. Ellenbecker (2000), Isokinetics in Rehabilitation, Knee Ligament Rehabilitation, 1st Edition, Churchill Livingstone, 52 – 65.
14. Lawrence H. Bannister, Martin M. Berry, Mary Dyson (2000), (Lower LimbSkeletal System), Gray's Anatomy, 38th Edition ,Churchill Livingstone, 697 - 704
15. Chaurasia B.D.(1999), Human Anatomy : Lower Limb and abdomen, 3rd Edition, Vol. 2: 50; 74
16. Norkin Cynthia, Pamela K. Levangie(1998), The knee Complex structure & function,Joint structure and function , 2nd Ed, Jaypee 337- 39
17. Donald B. KettleKamp, Robert A. Colyer(1984); OA of knee, Osteoarthritis diagnosis and management, Ist Edition, , Philadelphia, 403 – 424
18. Felson David T., Yuquing Zhang (1995). The incidence and natural history of OA in Elderly:Framingham Osteoarthritis study, Arthritis & Rheumatism, 38;1500

– 1505
19. Koopman, Altman(1991), Osteoarthritis, Clinical Primer on Rheumatic Diseases, 1st Edition, 245 – 61
20. Peyron Jacques G. (1982), The epidemiology of Osteoarthritis. Osteoarthritis diagnosis & Management, Ist Edition, Philadelphia 9 – 27
21. Maradee A. Davis, walter HI Ettinger, John M. Neuhaus (1989), The association of knee injury and obesity with unilateral and bilateral osteoarthritis of the knee, American journal of Epidemiology, 130;278 – 288
22. Cooper cyrus, Paul A. Dieppe (2000), Risk factors for the incidence and progression of radiographic knee osteoarthritis, Arthritis & Rheumatism, 43;995- 1000
23. Marc. C. Hochberg, Jordan D. Tobin (1995), The association of body weight, body fatness and body fat distribution with osteoarthritis of the knee, J Rheumatol, 22;488 – 93
24. Felson David, Jennifer J. Anderson, Allan Naimark (1988), Obesity and knee osteoarthritis, Annals of Internal Medicine, 1, 18 – 24
25. Felson David Barbara Weissmann (1997), Risk factors for incident radiographis knee Osteoarthritis in the elderly, Arthritis & Rheumatism, 40; 728 – 33
26. Sharma leena, September Cahue, Dorothy D. Dunlop (2000), The mechanism of the effect of obesity in knee OA, Arthritis & Rheumatism, 43;568 – 75
27. Marco A. Cimmino, Massimiliano Parodi (2000), Risk factors for Osteoarthritis, Seminars in Arthritis and Rheumatism, 49;29 – 34
28. Cooper Cyprus, David Coggon, Peter Egger (1994), Occupational activity and osteoarthritis of the knee, Ann of Rheumatic Diseases, 53;90 – 93
29. Sharma leena, David T. Felson, Dorothy D. Dunlop (1999), Laxity in healthy and osteoarthritic knees, Arthritis and Rheum, 42; 861 – 70
30. David T. Felson (1988), Epidemiology of Osteoarthritis, Osteoarthritis Management, 2nd Edition, W.B. Saunders 9 – 16.
31. Howell DS, Felletier JP: Etiopathogenesis of osteoarthritis, McCarthy & Koopman, Arthritis & Allied Conditions, 13th Edition, Philadelphia, Vol. 2; 1723 – 34
32. Sheila O' Reilly and Michael Doherty, Signs, symptoms and laboratory tests, McCarthy & Koopman, Arthritis & allied Conditions, 13th Edition, Philadelphia Vol. 2;197 – 209
33. Feliciantonio Di Domenica, Fabiola Atzeni Laura Volonte, Gerardo Mele (2004), Physical and rehabilitative approaches in osteoarthritis,seminars in Arthritis and Rheumatism, 62 – 69
34. i) Gail D. Deyle, Nancy E. Henderson (2000), Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee, Annals of Internal Medicine, 132; 173 – 181
    ii) R. Altman, E. Asch, D. Bloch (1986), Development of criteria for the classification and reporting of osteoarthritis, Arthritis and Rheumatism, 29; 1039 – 49.
    iii) Kellgren JH, Lawrence JS(1957),Radiological assessment Osteoarthrosis, Annals of Rheum. Dis16;494-501.
35. Helen J. Hislop, james J Perrine (1967), The isokinetic concept of Ex., Physical Therapy, 47; 114 – 117
36. Todd S. Ellenbecker (2002), Isokinetics in Rehabilitation, Knee Ligament Rehabilitation, 277 – 290
37. V. Baltzopoulous, D.A. Broadie (1989), Isokinetic dynamometry; Applications and limitations, Sports Medicine, 8;101 – 116
38. Mary Moffroid, Robert Whipple, Jack Hofkosh(1969), A study of Isokinetic Exercise, Physical Therapy, 49; 435 – 746
39. Howard G. Thistle, Helen J. Hislop, Mary Moffroid(1967), Isokinetic Contraction: A new concept of resistive exercise, Arch Phys Med & Rehabil, 43; 279 – 282
40. Zeevi D Vir(1994),Isokinetic testing in knee Isokinetics: Muscle Testing, Interpretation and clinical applications, Ist Edition, 2 – 20.
41. i) R. A. Gaard, E. B. Simonsen, M. Trolle, J. Bangsbo(1995), Isokinetic hamstring/Quadriceps. Strength ratio: Influence from joint angular velocity, gravity correction and contraction mode, Acta Physial Scand, 154; 421 – 427
    ii) Rosalind Coombs, Gerard Garbutt(2002) Development in the use of the hamstring/Quadriceps ratio for the assessment of muscle balance, Journal of sports science and Medicine 1; 56 – 62
42. Jules M. Rothstein, Robert L . Lamd, Thomas P. Mayhew (1987), Clinical uses of Isokinetic measurements, Physical Therapy, 67;1840 – 44
43. Davie G.,Kevin E. Wilk (1988), Isokinetic Testing and Exercise for the knee, Physical Therapy of the knee, 2nd Edition, Churchill Livingstone 262 – 288
44. Joseph J. Knapik, Roberta H. Mawdsley (1982), Comparison of Isokinetic measurements with test repetitions, Physical Therapy, 62; 169 – 172.
45. Johnson R, Wilk K (1988), Leverarm length relative to peak torque production of knee musculature, Physical Therapy, 68;779
46. Michael Fillyaw, Thomas Bevins, Lisa Fernandez (1986), Importance of correcting Isokinetic peak torque for the effect of gravity when calculating knee flexor to extensor muscle ratios, Physical Therapy, 66; 23 – 31
47. Hakan Giir, Nilgiin Cakin (2003), Muscle Mass, Isokinetic torque and functional capacity in women with Osteoarthritis of the knee, Arch Phys Med Rehabil, 84; 1534 – 41
48. Negil A. S. Taylor, Ross H Sanders, E. Ian Howick, Stephen N. Stanley (1990), Static and dynamic assessment of the Biodex dynamometer, Eur J Appl Physiol, 62; 180 – 88
49. Marjorie R. Wilhite, Ellen R. Cohen, Stephen C. Wilhite (1992), Reliability of concentric and eccentric measurements of quadriceps performance using the kincom dynamometer: The effect of testing order for 3 different speeds, J Orthop sports Phys Ther 15; 175 – 82
50. Stephen P. Messier, Richard F. Loeser, Jacqueline L. Hoover, Christopher M. Wise (1992), Osteoarthritis of the knee: Effects Gait, Strength and flexibility, Arch Phys Med Rehabil, 73; 29 – 36
51. Gustaf J. Lankherst, Rob J. Vandestadt (1985), the relationships of functional capacity, pain and Isometric and Isokinetic torque in osteoarthritis of the knee, Scand J Rehad Med, 17;167 – 72
52. Mark F Reinking, Teddy Worrell, Jack Farr (1996), Assessment of quadriceps muscle performance by Hand held, Isometric and Isokinetic dynamometry in patients with knee dysfunction, J Orthop Sports Phys Therapy, 24,;154 – 159
53. Kenneth D. Brandt, Charles Slemenda, Steven Mazzuca

(2000). A comparison of lower extremity muscle strength, obesity and depression scores in elderly subjects with knee pain with and without radiographic evidence of knee osteoarthritis, The Journal of Rheumatology, 27;1937 – 46
54. Charles Slemenda, Douglas K. Heilman, Barry P. Katz (1997), Quadriceps weakness and osteaoarthritis of the knee, Annals of Internal Medicina, 127;97 – 104
55. Lars Olof Nordesjo, Bengt Nordgren (1983), Isometric Strength and endurance in patients with severe rheumatic arthritis or osteoarthritis in knee joints, Scand j Rheumatology, 12; 132 – 136
56. Jale Tan, Nilufer Balci, Vesile Sepici (1995), Isokinetic and Isometric strength in osteoarthritis of the knee, Am J. Phys. Med. Rehabil, 74;364 – 369
57. Moskowitz RW (1993) Clinical and laboratory findings is osteoarthritis, in: Mc Carthy DJ, Koopman WJ, Arthritis & allied conditions, Philadelphia, 1st Edition, 1735 – 59
58. Pai Y – C, Chang HJ, Sinacore JM (1994), Alterations in multi joint dynamics in patients with bilateral knee osteoarthritis, J. Orthop Sports Phys Ther, 19;60 – 61
59. David C. Feiring, Todd S. Ellenbecker (190), Test restest reliability of the Biodex Isokinetic Dynamometer J Orthop sports Phys Therapy, II, 298 -300
60. Charles Slemenda, Douglas K. Heilman, Barry P. Katz, Donna Byrd (1998), Reduced Quadriceps strength relative to body weight, Arthritis & Rheumatism 41; 1951 –59.
61. David A. Klopffer, Steven D. Greij (1988), Examining Quadriceps / Hamstring performance at high velocity Isokinetics in untrained subjects, J Orthop Sports Phys Ther, 10;18 –21
62. Richard W. Bohannon, Richard L. Gajdosik, barney F. Leveau (1986), Isokinetic knee flexion and extension torque in the upright sitting and semireclined sitting positions, Physical Therapy, 66; 1083 – 86
63. I) Todd John Tredinnick, Pamela W. Duncan (1988), Reliability of measurements of concentric and eccentric isokinetic leading, Physical Therapy, 68;656 – 659
II) Magnusson P, Geisman R, Nicholas J (1992). The effect of Trunk Stabilization on knee extension / flexion Torque Production, J Orthop Sports Phys Therapy, 15;51 – 52.
64. Vasilios Baltzopoulos, John G. Williams, David A Broadie (1991), Sources of error in Isokinetic dynamometry: Effects of visual feedback on maximum torque measurements, J Orthop sports Phys Ther, 13; 138 – 142
65. Janet P. Lord, Susan G. Aitkens (1992), Isometris and Isokinetic measurement of Hamstring and Quadriceps Strength, Arch Phys Med Rehabil, 73; 324 – 330
66. Thorsten Ingemann, hansen and Jens Halkjaer (1979), Force velocity relationships in the human quadriceps muscles, Scand J Rehab med 11; 85 – 89
67. David R. Ghena, Amy L. Kurth, Martha Thomas (1991), Torque characteristics of the quadriceps and hamstring muscles during concentric and eccentric loading; J Orthop Sports Phys Therapy, 14;149 – 167
68. Teddy W. Worrell, David H. Perrin (1989), The influence of hip position on quads & names peak torque and reciprocal muscle group ratio values, J Orthop sports phys Therapy, 11; 104 – 107
69. Joseph J. Knapik, James E Wright. Joanne Braun (1983), Isometric, Isotonic and Isokinetic torque variations in 4 muscle groups through a range of joint motion, Physical Therapy, 63; 938 – 47
70. Alf Thorstensson, Gunnar Grimby (1976), Force Velocity Relations & fiber composition in human knee extensor muscles, J Applied Physiology, 40 (1);12 – 16
71. Hill LD, Gillaspie DM (1988), Examining Quadriceps / Hamstrings performance at high velocity Isokinetics in untrained subjects; J Orthop sports Phys Therapy, 10; 18 –22
72. Thorstenson A, Larsson L, Tesch P (1977), Muscle strength and fiber composition in athletes and sedentary men, Med Sci Sports Exerc, 9;26 – 30
73. Kannus P (1988), Ratio of hamstring to quadriceps femoris muscles strength in the anterior cruciate ligament insufficient knee Phys Therapy, 68; 961 – 965
74. D.A.Winter, R.P.Wells,G.W.Orr (1981), Errors in use of Isokinetic Dynamometers,Eur J Appl Phsiol, 46; 397-408
75. T.Brock Symons, Anthony A.Vandervoort(2005), Reliability of single session isokinetic and Isometric Strength measurement protocol in older men, Journal of Gerontology, 60A; 114-119.
76. Altman RD, Meenan RF, Hochberg MG (1983), An approach to developing criteria for the clinical diagnosis and classification of Osteoarthritis, Journal of Rheumatology, 10;180-83

Comparative study of ultra sound & laser therapy in the treatment of temporomandibular joint disorders

S.D. Ganvir
Professor, Ravi Nair Physiotherapy College, Sawangi (M) Wardha, Maharashtra

Objective

To Investigate the effectiveness of Ultra Sound & Laser therapy in the treatment of patients with Temporomandibular joint Disorders.

Methods & Measures

42 Patients with the diagnosed condition of Temporomandibular joint disorders were taken up for the study. They were divided equally randomly into two groups. Patients in control group were treated with Ultrasound n=21& experimental group with laser therapy n=21. Both the groups were put on common exercise programme, consisting of range of motion exercises , stretching exercises and postural training. Treatment consisted of ten sessions, in a period of 30 days. Active range of motion (AROM), visual analogue scale (VAS) of pain and muscle (masseter and anterior temporalis) palpation were used for follow-up analysis.

Results

Pre& post assessment was done by another therapist who was blinded to the groups. Assessment tools were VAS for the relief of pain & measuring tape for recording the changes in range of motion of TM joint. Data were analyzed by Friedman test and ANOVA for repeated measurements. Results showed decrease in pain and increase in AROM for both groups ($p<0.05$), and improvement in muscle tenderness for the LASER group. Authors concluded that both therapies are effective as part of TMD management.

Introduction

The TMJ is the joint formed by the temporal bone of the skull (Temporo) with the lower jaw or mandible(mandibular) There are two different movements associated with jaw, opening and closing. For about the first third of the opening range the movement is hinge-like, and in the last two thirds of the opening range the condylar head, slides forward and down. Closing movement occur in reverse order[1]

We use this joint more frequently than most of the other joints in our bodies. Every time we talk, chew, bite down or swallow, we put the TMJ to work. This condition produces pain in the muscles and joints of the jaw that can radiate to the face, neck, and head and even the shoulders[2]. There also may be difficulty opening the mouth all the way, or clicking and popping noises when chewing, yawning, kissing or moving the joint. The most common causes of TMJ are a poor bite, and stress, combined with grinding of the teeth, especially at night. Gum chewing can make this problem even worse. The causes of temporomandibular joint disorder are a combination of muscle tension and anatomic problems within the joints. TMD comprise a number of signs and symptoms affecting the masticatory muscles, temporomandibular joint (TMJ) or both. In this context, physical therapy aims to:

1. Increase the awareness of the Patients about the cause of the symptoms
2. Allow for recovering of normal function.
3. Relieve pain
4. Re-establish muscle& joint movement[3].

There are many papers reporting the use of LLLT (low level laser therapy) for improvement of symptomatology of TMD patients. In 1988, Bezuur Habets, Hansson observed total pain relief in 80% of arthrogenic patients (TMJ) after delivery of LLLT for a mean period of 6 days. Hansson, in 1989, reported a fast decrease in intra-articular inflammation in TMJ of five patients after application of infrared laser[4]. In 1989, Hatano observed positive effects of laser radiation for reduction of the patient's responses to palpation with an 830nm device, but this study did not include a control group[5]. On the other hand, Hanssen, Thoroe (1990), carried out a double-blind study to evaluate the effectiveness of an invisible infrared laser diode (904nm) for therapy of orofacial pain and no significant differences were found for the VAS between the control and experimental groups[6]. Gam, Thorsen, Lonnberg, in 1993, observed the effect of low level laser therapy in a meta-analysis and concluded that such treatments not effective for Musculoskeletal disorders[7] . ''conti et al' in 1997,evaluated the efficacy of low level laser therapy in patients with TMD by means of a double-blind design and the outcomes did not demonstrate significant differences between the real and placebo groups.

The literature demonstrates the importance of physical therapy in the treatment of temporomandibular disorders. Therefore the aim of this study was to compare the effectiveness of ultrasound and low-level laser therapy for the treatment of patients with TMD[8].

Examiners

The research coordinator applied the laser therapy, while Therapeutic ultrasound was applied by a general practitioner. Another researcher carried out the selection of patients and co-ordination of the project in order to establish a double blind design. Moreover, a specialized dentist along with physiotherapist conducted the physical evaluation of the patients before and after treatment sessions.

Devices

A low level laser device with wavelength of 830 to 904nm was used at an output of 4J/cm^2 and power of 100mW (INFRARED-27) Hintek Delhi Phyaction 740, Laser unit

producing semi-conductive (diodic) gallium arsenide (Ga As)laser (wave length 904 nanometer, mean output power :17mW)was utilized in my study. The two most tender points were selected during examination (masseter and the anterior portion of the temporalis muscle). Therapeutic ultrasound selected device was the Electro care system Limited continuous mode with frequency of 1MHz, an intensity of 0.8W/CM Square over area of selected tender point.

Material and methods

Subjects

Although a total of 45 subjects were initially included, three abandoned the study for different reasons. Final sample was composed of 42 individuals with a mean age of 25.6 years attending TMD in the department of Prosthodontics of sharad pawar dental college Datta Meghe University of health sciences sawangi, Wardha. The entire sample was informed about the objectives of the study and after all procedures had been explained, including palliative home care, counseling or muscle exercises, an informed consent form, was signed. TMJ sounds, limited mouth opening, or TMJ locking, were included in my study. Cases with congenital abnormality, concomitant inflammatory or neoplastic conditions, and those with a recent history of acute trauma or any form of treatment within the last month were excluded. Patients were randomly selected & proportionally divided into two groups, namely LASER group and ULTRASOUND group. Before three days and during course of this study, patients were asked not to take analgesic drugs, or other form of therapy.

Treatment modalities

The application techniques followed the manufacturers' instructions. The LASER group was submitted to the low level laser therapy with "scanning" movements instead of touching the skin directly over the painful area. This technique was suggested by the manufacturer and allows for treating not only a limited painful spot, but the entire painful area by means of this "scanning" motion. The period of application for this group was 9 minutes for each side of the face. The Ultrasound group received the same number of sessions as the LASER group, comprising 10 sessions, 3 times a week, during 4 weeks. The total time of application of this therapy was 40 minutes, excluding the first 5 minutes.

Evaluation was performed immediately before and 5 minutes after each therapeutic session by means of the visual analogue scale (VAS), mandibular active range of motion (AROM) and palpation of the masticatory muscles[9,12,13,14,15].

Statistical analysis

After informed consent was obtained, all patients were evaluated by the investigator. Pain intensity, number of tender points and joint sounds, maximal active and passive mouth opening, right and left lateral jaw motion were assessed immediately before and 5 minutes after each therapeutic session. Pain intensity was recorded in mm on 100mm Visual Analogue Scale(VAS). Number of tender points(minimum:0,maximum :36)were assessed by palpation of the following 18 points in both sides: joint capsule(lateral-posterior-superior) masseter (anterior-inferior-deep), temporal (anterior-deep-middle-origin), medial lateral pterygoid, sternocliedomastoid (upper-middle-lower) trapezius (origin-upper), splenius capitis muscles. On examination the two most tender points in each were selected for therapy. (masseter and the anterior portion of the temporalis muscle). Number of joint sounds were assessed by oscultation of TMJ during mouth opening &closing, listening for the presence of opening &closing clicks a well as fine &coarse crepetation (30)The total number of sounds on both sides were recorded. The patients were asked to open his/her mouth as much as possible for the measurement of maximal active mouth opening. Maximal passive mouth opening was measured after application of downward pressure on the mandible by the second &third fingers of the patient. The vertical distance between upper &lower teeth was measured by a ruler scale &recorded in mm for these parameters(23,30-31). Lateral jaw motion was assessed by measurement of the horizontal distance between the midpoints of upper& lower incisors in mm(23,30,31)[9]. All patients of group A (laser) were treated with ten sessions of LLLT. INFRARED-27 Hintek Delhi Phyaction 740, Laser unit producing semi-conductive (diodic) gallium arsenide (Ga As)laser (wave length 904 nanometer, mean output power:17mW)was utilized in my study. The two most tender points selected during examination (masseter and the anterior portion of the temporalis muscle). All patients were evaluated by the first investigator who was blinded to treatment group. The VAS is carried out through horizontal line measuring hundred mm, containing the text no pain at the left end and the worst possible pain at the right end, on which the patients mark with vertical line the position that better indicate the degree of perceived pain at that moment. such measurement constitute a parameter for subjective follow-up of the evolution of symptom. Muscle palpation was performed bilaterally, with firm yet gentle &constant pressure approximately 1500 gram as describe by "conti et al' Thus, on the basis of the reactions demonstrated by individuals, the degree of pain under palpation was rated as 0 – no pain; 1 – mild pain; 2 – moderate pain; 3 – severe pain. The evaluated muscles were the masseter and the anterior portion of the temporalis muscle[10].

Table 1: Demographic data for each evaluated group.

GROUP	LASER (group A)	ULTRASOUND (group B)
Gender	20 female and 01 male	20 female and 01 male
Age(mim—max)	25.8 years(25-40)	25.6 years(25-40)
Pain duration (mim—max)	8 months(6-24)	9 months (6-24)

Results

Evaluation of the Visual Analogue Scale (VAS)

Initial VAS for the LASER group was 66.1mm and final VAS of 7.8mm ($p<0.001$). For the ultrasound group, initial VAS was 57.2mm and final VAS was 4.4mm ($p<0.019$). Treatment evolution can be seen in Fig. 1, where a general improvement before and after each session can be observed. Besides, it is noticed that the posterior session begins with a milder pain the anterior session. The outcomes of the VAS highlighted that there was no statistically significant difference between groups ($p=0.527$)and the immediate effect was also not significant ($p=0.266$).On the other hand, the effect between sessions (within group analysis) was statistically significant ($p=0.048$).

Fig. 1: Visual analogue scale in millimeters for each evaluated group, before (B) and after (A) each therapeutic session.

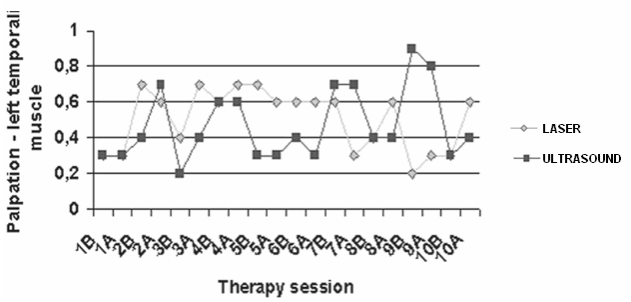
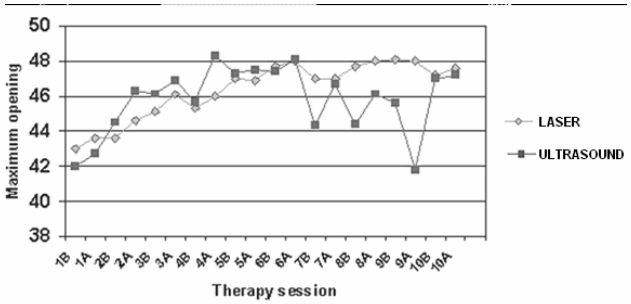


Fig. 2: Mean maximum opening in millimeters for each evaluated group, before (B) and after (A) each therapeutic session.



Active range of motion (AROM)

Fig. 2 shows the significant improvement in maximum opening (initial mean of 42.5mm, being 43mm for the LASER group and 42mm for the ultrasound group, and final mean of 47.4mm, being 47.6mm and 47.2mm for the LASER and ultrasound groups, respectively. The ANOVA demonstrated that there was no statistically significant difference between groups, including the immediate effect (p=0.860 and p=0.091, respectively). However, a significance difference between sessions was found (p<0.001).

Muscle palpation

Statistical analysis (Friedman test) revealed no statistically significant difference regarding pain relief for the anterior temporalis muscle between groups (laser and ultrasound) or between right or left sides (Table 2). Fig. 3 and 4 demonstrate alternation between pain

Improvement and worsening for the temporalis muscles at the right and left sides, with no evident evolution. There was no statistically significant difference regarding pain decrease of the masseter muscle for both right and left sides (p=0.312 and p=0.097, respectively) for the ultrasound group. However, for the LASER group there was a statistically significant difference for both sides (right and left), yielding p<0.001, respectively. Data can be observed in Table 3. Fig. 5 and 6 demonstrate variation of the pain condition for the masseter muscles at the right and left sides.

Conclusions

Within the limitations of this study, the following conclusions were drawn:

Table 2: Demographic data for each evaluated group.

Group	Laser	Ultrasound
Gender	20 females and male	20 females and 1 male
Age(min- max)	25.8 years(25-40)	25.4(25-40)
Pain duration (min- max)	8 month(6-24)	10month(8-24)

Table 3: Statistical outcomes for muscle palpation of the left and right temporalis muscles for each evaluated group

Group	Right side	Left side
Laser	P=0.237	P=0.607
Ultrasound	P=0.187	P=0.094

Table 4: Statistical outcomes for muscle palpation of the left and right masseter muscle for each evaluated group.

Group	Right side	Left side
Laser	P=0.017	P=0.003
Ultrasound	P=0.311	P=0.097

Fig. 3: Mean palpation of the right temporalis muscle for each evaluated group, before (B) and after (A) each therapeutic session.

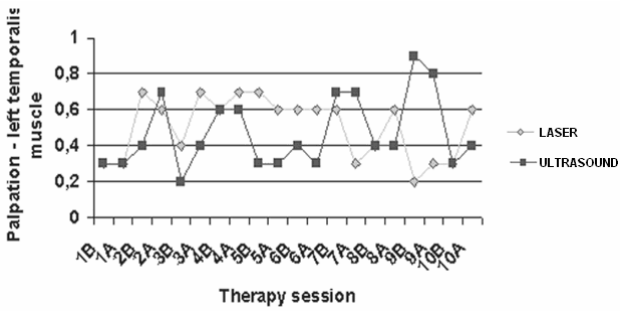


Fig. 4: Mean palpation of the left temporalis muscle for each evaluated group, before (B) and after (A) each therapeutic session.

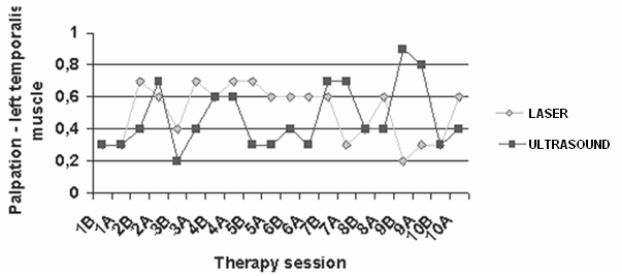


Fig. 5: Mean palpation of the right masseter muscle for each evaluated group, before (B) and after (A) each therapeutic session.

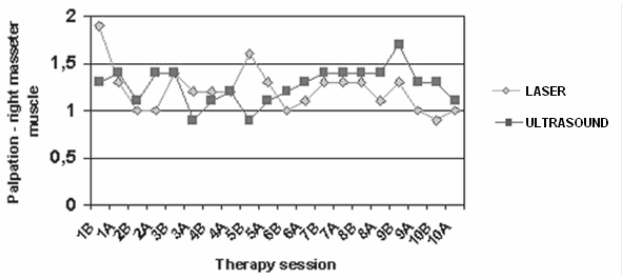
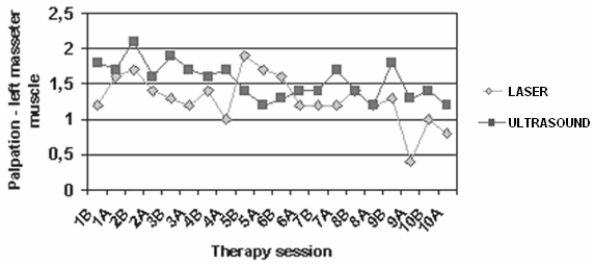


Fig. 6: Mean palpation of the left masseter muscle for each evaluated group, before (B) and after (A) each therapeutic session.



1. Both therapies were effective for decreasing the symptoms of TMD patients, regardless of the type of device used.

2. Caution is suggested when analyzing these results, because of the self-limiting aspect of musculoskeletal conditions like TMD. Further clinical studies must be performed to evaluate the efficacy of other physical therapy modalities.

References

1. Friedman MH. The hypo mobile temporomandibular joint. Gen Dent 1997 May; 45(3): 282- 5.
2. Friedman MH, Valhalla NY. Closed lock: a survey of 400 cases. Oral Surg Oral Med Oral Pathol 1993 April; 75(4): 422- 7.
3. Friedman MH, Weisberg J. Joint play movements of the temporomandibular joint: clinical considerations. Arch Phys Med Rehab 1984 July; 65: 413 -7
4. Bezuur NJ, Habets LLMH, Hansson TL. The effect of therapeutic laser Treatment on patients with craniomandi-bular disorders. J Craniomandibular Disorder. 1988;2:83-6.
5. Hanssen HJ, Thoroe U. Low power laser biostimulation of Chronic orofacial pain. A double-blind placebo controlled cross-over study in 40 patients. Pain. 1990; 43:169-79.
6. Hatano, Y. Laser in diagnosis of the TMJ problems. Laser in Dentistry. 1989;1:169-72
7. Gam AN, Thorsen J, Lonnberg F. The effect of low-level laser therapy on musculoskeletal pain: a metal-analysis. pain.1993;52:634.
8. Conti PCR. Low level laser therapy in the treatment of temporomandibular disorders (TMD): a double-blind pilot study. J Craniomandibular Pract. 1997;15 (2):144-9.
9. Hansson TL. Infrared laser in the treatment of craniomandibular disorders, arthrogenous pain. J Prosthet Dent1989;61: 614 – 77-
10. Conti PCR, Ferreira PM, Pegoraro LF, Conti JV, Salvador MC. A Cross-sectional study of prevalence and etiology of signs and symptoms of temporomandi-bular disorders in High School and University Students. J Orofac Pain. 1996;10(3):254-62
11. Gray RJ, Quayle AA, Hall CA, Schofield MA. Physio-therapy in the treatment of temporomandibular joint disorders: a comparative study of four treatment methods. Brit Dent J. 1994; 17 6(7):257-61.
12. Wood W, Loomis AL. The physical and biological effects of high-frequency sound waves of great intensity. Phil Mag S 1927;4:417- 436.
13. Harvey E, Loomis A L. High frequency sound waves of small intensity and their biological effects. Nature 1928;121:622-624.
14. Harvey E, Loomis A L. High frequency sound waves of small intensity and their biologicaleffects. Nature 1928;121:622-624.
15. Wood W, Loomis AL. The physical and biological effects of high-frequency sound wave's ofgreat intensity. Phil Mag S 1927;4:417- 436.

A differential electromyographic analysis of rectus abdominis muscle segments during performance of different test movements: A randomized within participants experimental study

Swati C. Meshram
Assistant Professor, Ravi Nair Physiotherapy College, Wardha, Maharashtra

Objective

To compare surface EMG activity of upper & lower portion of Rectus Abdominis activity during 4 test movements viz, trunk curl up(TCU), Leg Lowering, Abdominal Muscle Lift (AML), Leg Raise. To provide the biomechanical basis for rationalized clinical testing & training of abdominals. To find out an activity producing optimal & maximal activation of abdominals.

Methods

Study design & setting: Randomized, repeated measure within subject, experimental study. All measurements were performed in hospital EMG laboratory.
Study population: 20 normal healthy female chosen randomly who were capable to perform all test movements comfortably.
Procedure: EMG data was collected from Upper &Lower portion of Rectus Abdominis muscle during performance of 4 tests movements by the subjects.
Outcome measures: Peak EMG amplitude during maximum recruitment of muscle.
Results: Study showed differences in the activation of rectus abdominis during 4 tasks. Amongst all the exercises Abdominal muscle lift (95% CI=82.5-93.8, 89.7-98.2) showed greater activation followed by Trunk curl up (95% CI=80.4-97.3, 74.8-93.3), Leg raise (95% CI=57.2-74.09, 63.3-79.4) & leg lowering (95% CI=53.8-70.4, 52.9-71.7).
Conclusion: No significant differences in the activation of two portions. Rectus Abdominis activity is maximum during abdominal muscle lift.

Key words

Rectus Abdominis, EMG activity, Abdominal Muscle testing, abdominal muscle lift.
Abbreviation: Rectus abdominis (RA), Upper portion of RA(URA), Lower portion of RA(LRA), Trunk curl up (TCU), Leg lowering(LL), Abdominal muscle lift (AML), Leg raise(LR).

Introduction

Rectus abdominis is broad & long muscular strap descending throughout the abdominal wall. It acts to support the viscera, helps in respiration[1]. It is most active in crook lying curl up[2].

Apart from its action as the flexor of torso[1] it has recently been defined as movement synergist & global stabilizer of the spine[3,4]. Muscle also bears great share of load of pregnant uterus & undergoes great amount stretching & widening[5].

Strengthening of this muscle has been given prime importance not only in the rehabilitation of low back pain population but also in fitness testing & training in sportsperson. Its testing & training involves curling of trunk & leg exercises for upper & lower portion of muscle resp[6,7].

Various studies have been conducted to quantify the activation level of upper & lower portion of RA during various exercises. One such study Showed that curl type exercises activates upper rectus while pelvic tilting type of exercises activates lower rectus to the greater extent[8]. Another study examined upper, medium, lower rectus abdominis during seven abdominal exercise tasks[9]. Significant differences in activation of the different portion were observed. While other evidences suggest no such differences between its portions, significant difference was present amongst the exercises with regard to activation of RA muscle as a whole[10]. In another study, little differences (20%) were found which were attributed to geometric & postural changes rather than preferential activation of upper & lower portion[11].

Present study, attempts to examine the extent of activation of upper & lower portion of rectus abdominis during performance of 4 different task. These include basic exercises used to test the muscle in its upper & lower portion differently. Such a trial have neither been attempted before nor does any subtle evidences exist to support the view that this exercise preferential activate portions of RA differently.

Present study was an attempt to analyze normalized Electromyographic activity of upper & lower segments of rectus abdominis muscle. Spinal curvature & torso geometry was maintained constant. This was done to obtained constant force output making data comparable.

Methods

Study design: Structured, randomized, Prospective, Comparative, study[12].
Sampling techniques: Simple random sampling.
Study population: 20 healthy female resident volunteer, undergraduate students of physiotherapy. (Age=19.45$\pm$ 0.4, BMI=16.75$\pm$1.3)
Study set up: EMG lab, Shree Swaminarayan College of physiotherapy, Kadodara, Surat. Local ethical committee of college approved the study.
Inclusion criteria: Healthy females with their informed consent to participate in study. Only female subjects were studied because the variation in the amount and distribution of subcutaneous tissue between the sexes could have confounded the results.

Exclusion criteria

Subjects having BMI > 24.9.Subjects giving H/O recent injury, any kind of musculoskeletal impairment (structural &

functional), recurrent backaches, abdominal colic of any origin etc. Subject who did not give informed consent to participate in study.

Subject selection: 20 subjects satisfying above criteria.

Procedure

Assessment

Participants were subjected to strength testing of the RA.

For this purpose basic test movement (TM) were used[7].

TM 1: Trunks curl up test as follows:

Subjects were positioned in crook lying position with knees flexed to 90 degree. They were asked to perform following movements.

Grade 1: Lifting of head in an attempt to look towards the toes hold it for 6 sec.

Grade2: Lifting of head & curling of shoulders off the plinth & hold it for 6 sec.

Grade3: Hands towards knees lifting of head &curling of shoulders with rib cage off the plinth until lower angle of scapulae clears plinth & hold it for 6 sec.

Grade4: Hand across the chest lifting of head & curling of shoulders with rib cage off the plinth until lower angle of scapulae clears plinth & hold it for 6 sec.

Grade5: Hands behind head curling of shoulders with rib cage off the plinth till lower angle of scapulae clears plinth & hold it for 6 sec.

Maximum possible grade that subjects were able to perform was noted.

TM 2: Bilateral leg lowering test.

Position of subjects: Crook lying position with hip flexed to 70-degree position. BP cuff placed below lumber spine. Subjects were asked to perform posterior pelvic tilting action. Mercury level was noted. Subjects were asked to maintain pelvic tilt so that mercury level at any time does not fall below the noted reading + 10 mm of Hg while lowering the legs[15].

Maximum grade was noted as follows:

Grade1: hip flexed to 90 degree.

Grade 2: hip flexed to 60 degree.

Grade 3: hip flexed to 45 degree.

Grade 4: hip flexed to 20 degree.

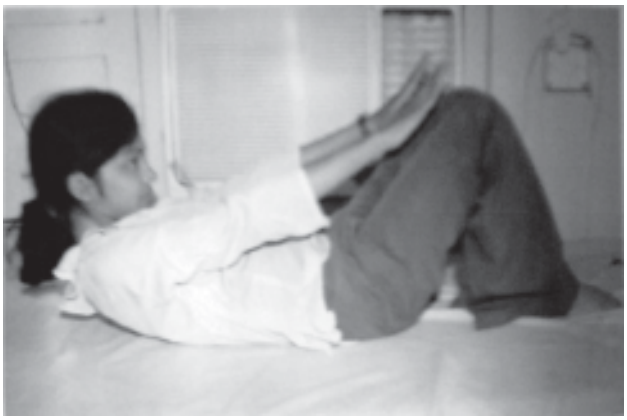
Break of 4 min was given between each grade[7].

Subjects were kept in their predetermined test position (max grade possible on TCU & leg lowering test).Skin was prepared for the application electodes. Cathod was placed appx. 3 cm lateral & 5 cm superior & inferior to umbilicus for upper & lower portion of rectus abdominis resp on rt. side[8,13].

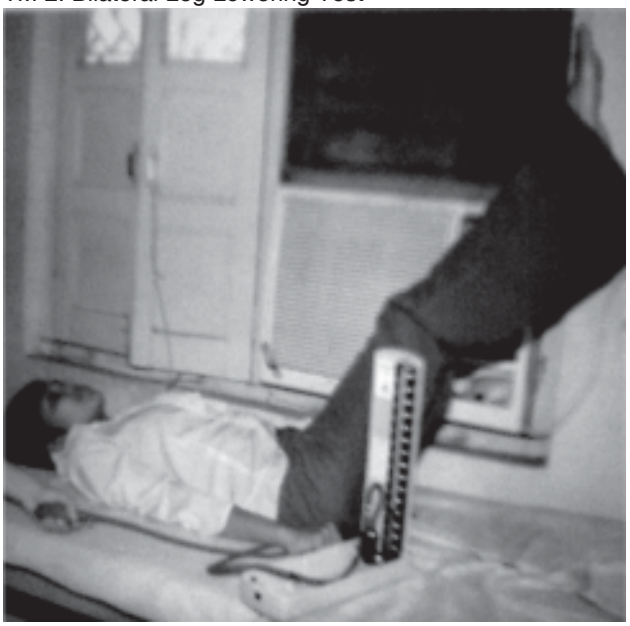
Instrumentation: Surface EMG (double channel , Neuroperfect Medicaid System) was used to record the muscle activity of upper & lower portion of rectus abdominis at simultaneously while execution of task. Filter settings were adjusted to 20 Hz to 2Kz with sensitivity at 500 UV. Electrode movement was avoided by keeping posture constant & collecting data during isometric hold.

Data collection: Subjects were passively kept in their predetermined test position for TCU & Leg Lowering Activity. Raw EMG data was collected from URA & LRA when subjects exerting actively to hold the position in predetermined grades. Similarly, Data was also collected for abdominal muscle lift & leg raise activity. During leg raise Pelvic tilting was monitored same as in leg lowering activity. Subjects were trained for both the activities just prior to data collection.

TM 1: Trunk curl up test (TCU)



TM 2: Bilateral Leg Lowering Test



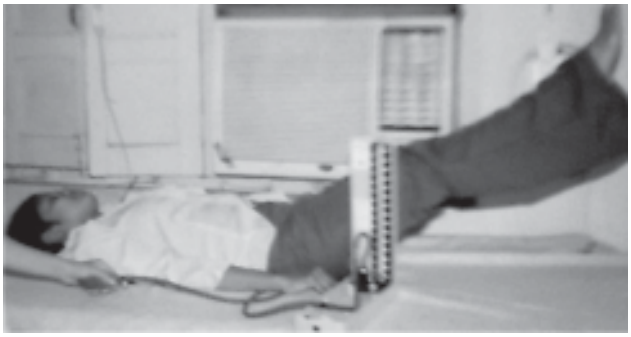
Abdominal muscle lift is the activity similar to trunk curl up. Only difference is that the neck lies in line with trunk. Subject attempts to lift the trunk off the plinth. Starting position remains similar to the TCU activity[13].

TM 3**:** Abdominal Muscle Lift test.

Leg raise is activity where subject has to bilaterally raise the legs without curling of the back, which was monitored through the pressure cuff[7].

Outcome parameters: Raw EMG data was collected over 2 sec for each of 4-test activities. Data of each subject for URA & LRA separately was then normalized to max EMG activity noted during any of four tasks. Same procedure was

TM 4: Leg Raise



followed for all 20 subjects. Thus, actual data used for comparison was the % of max EMG activity of upper & lower portion. This enabled us to rectify the individual differences of strength as well as making the data comparable[8,11,13].

Data analysis: Normalized EMG data was analyzed to compare the activity of upper & lower portion of RA during an exercise task. Also all 4 activities were compared for the extent of activation of rectus abdominis.

Comparison of URA amongst all 4 activity through ANOVA: F=13.30, P=0.000.CI =73.36-82.56.Comparison of LRA amongst all 4 activity through ANOVA: F=14.7, P=0.000.CI =71.64-80.80.Bonferroni Post hoc test suggest that TCU activates muscle to the similar extent as abdominal muscle lift task for LRA (P=1.000, CI=-13.58-14.9) & URA (P=0.4, CI=-24.5-4.7). Leg lowering activates muscle to the similar extent as leg raise task for LRA (P=1.000,CI=-17.7-10.78) & URA (P=0.58, CI=-5.57-23.67).

Discussion

Descriptive analysis suggests no significant differences between upper & lower portion of rectus abdominis activity (table 4) (chart 2), although the differences exist in the level of its recruitment amongst the tested exercise task. (Table 2, 3). One of the study showed similar findings in which Rectus Abdominis did not show any differences concerning its upper & lower portion recruitment during curl up exercise. However, extent of its recruitment amongst 4-exercise task showed differences. On the other hand, same study showed reduced EMG activity during reverse curl up, leg lowering, & rolls out task[10].

In present study, attempt is made to compare basic test movements i.e. TCU & leg lowering with abdominal muscle lift, which haven't been tried before. Amongst the 4 tested exercise task; abdominal muscle lift showed overall greater activation of upper &lower part of rectus abdominis followed by trunk curl up as compared to leg lowering & leg raise

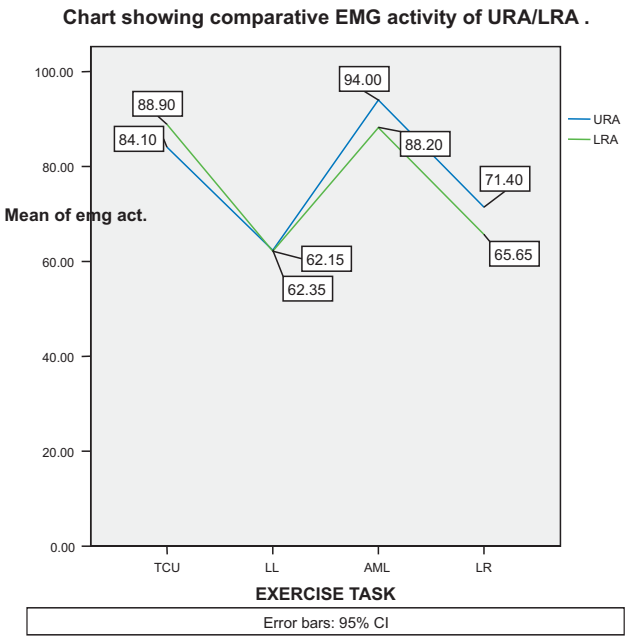
Table 1: Showing demographic data of subjects included in study.

	weight	height	TCU	LL	BMI
Mean	43.45	161.25	4.15	1.7	16.72
Lower95% CI	42.16	158.95	3.8	1.35	16.09
Upper 95% CI	44.73	163.54	4.49	2.04	17.4
S.D	2.74	4.89	0.74	0.73	1.39
S. E	0.61	1.09	0.16	0.16	0.31

Table 2: Descriptive analysis of URA for all test movements.

	N	Mean	S.D	S.E.	95% C.I.
TCU	20	84.1	19.76	4.42	74.84-93.35
LL	20	62.35	20	4.47	52.98-71.71
AML	20	94	8.98	2	89.79-98.2
LR	20	71.4	17.15	3.83	63.37-79.42
Total	80	77.9	20.68	2.31	73.36-82.56

Chart 1:



activities. (Table 3, 4). Differences are statistically significant. The exercise tasks selected for the present study are the activities used to test the upper & lower portion of Rectus Abdominis muscle differently[7,14].

However, findings of present study suggest that the lifting of upper torso type of activity activates the rectus abdominis in the better way as compared to leg lowering & leg raising task. One of the study supports this finding in which significant differences were observed between upper & lower portion of rectus abdominis muscle during performance of certain exercise task[13].

Results also suggest that abdominal muscle lift was the activity has a tendency to recruit rectus abdominis to maximum extent consistently followed by trunk curl up. (Table 3, 4)

Findings presented by sarti et al, showed the preferential recruitment of lower rectus abdominis during posterior pelvic tilting exercises in highly trained individuals. While upper portion of rectus recruited more during trunk curl, type of exercises[8]. In his study, author had assigned the subject to a group of highly trained correct performers, so it is highly doubtful that to which extent the above findings can be made generalized to the population where fitness characteristics are varied & non uniformity exist amongst the demographic characteristics of the subjects. In our study, we selected the

Table 3: Descriptive analysis of LRA for all test movements.

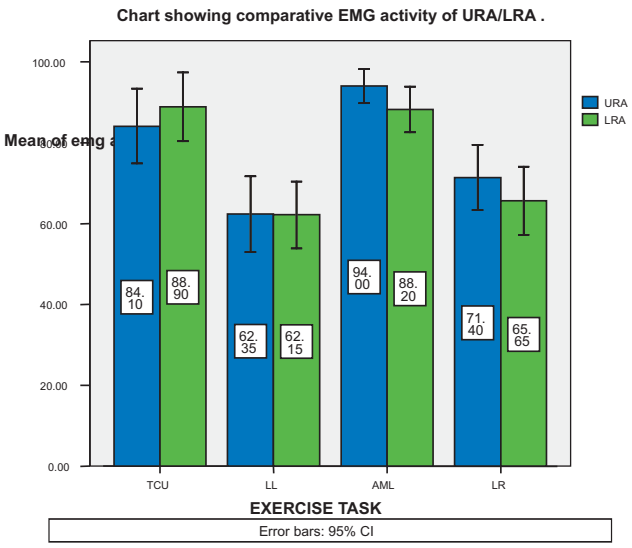
	N	Mean	S.D	S.E.	95% C I
TCU	20	88.90	18.13	4.05	80.41-97.38
LL	20	62.15	17.66	3.94	53.88-70.41
AML	20	88.20	12.06	2.69	82.55-93.84
LR	20	65.65	18.03	4.03	57.20-74.09
Total	80	76.22	20.56	2.29	71.64-80.80

Table 4: Comparison of activation between upper & lower portion of RA during performance 4 exercise task.

Paired Samples Test

Test Mov.	Mean diff	S.D	95% C I	t	Sig. (2-tailed)
TCU	-4.80	22.04	-15.11-5.51	-0.97	0.34
LL	.20	17.90	-8.17-8.57	0.04	0.96
ABM	5.80	12.71	-0.15-11.75	2.04	0.05
LR	5.75	23.02	-5.02-16.52	1.11	0.27

Chart 2:



physiotherapy female students of average built, who were not under any training programme. (Table1)

Our main concern was to study the activity of lower portion of rectus abdominis recruitment during trunk curl up & abdominal muscle lift.

It was noted that lower portion was activated to similar extent as the upper portion of rectus in fact its recruitment was greater during this two activities as compared to leg raise &leg lowering activity, which was significant statistically (table3). The result does not support the belief that leg raise & lowering are necessary conditions to activate the lower portion of rectus abdominis. That the strength & endurance adaptation occurring at one section should occur in other section too[13]. During leg raise & leg lowering activity overall Rectus Abdominis activation was although the lesser than as compared to other two task; both the upper & lower portion were activated the similar extent. (Table 4) Thus, even the upper part of rectus can be stimulated through the leg raise & leg lowering exercises. Thus, we can say that as lower portion gets activated to the similar extent as upper portion through AML & TCU, upper portion gets activated to the similar extent as lower one in leg raise & leg lowering. Further selection then depends on whether eccentric muscle work or concentric muscle work is required & determine by the effects of specificity of training. Thus, lower portion of rectus testing & training can be achieved satisfactorily through trunk curl up & abdominal muscle lift exercise.

It was shown that curl up activity at least activates 20-50% of MVC of rectus abdominis, which is sufficient to stimulate force production (strength) & endurance. In same study 20% differences in differential recruitment of upper & lower portion of rectus abdominis were observed. This was attributed to geometric & postural changes[11].

Thus, to bring about an activity whether it is to curl up the torso or lift & lower the leg, both the portions of rectus are recruited to almost similar extent in general population of average strength (Table 4). The scope for its clinical application in certain situation should be searched out .e.g. diastasis of recti where rectus testing & training cannot be undertaken thought trunk curl up exercise .In this situation leg lowering or its lowest sub grades can be used to test & train the muscle. If any portion becomes preferentially weak as occurs in the diastasis of lower portion of recti 2 possibility exists. First, not only leg raise but trunk curl will also be weak. Second, strong portion must be compensated for the weak part to bring an activity creating undue overloading of the respective part of thoracolumber spine. Amongst 4 exercises, all the activities tested muscle concentrically except leg lowering task where muscle works eccentrically. Trunk curl up & abdominal muscles' lift checks muscle ability to raise the torso while leg raise & leg lowering checks its ability to stabilize the pelvis ability to against the moving limb.(static action). Hence, each of the exercise bears unique biomechanical characteristics. This should be a deciding factor while undertaking the testing & training procedure for the rectus abdominis. This possibilities advocates further research & needs to be tested clinically.

Conclusion

Traditional exercises employed for the differential testing of rectus abdominis recruits both portions to similar extent. In such situation, purpose of testing, training, & biomechanical characteristics of an exercise should be a consideration. Given priority to theses aspects, one should use realistic testing procedures in certain special situations.

References

1. Grays' anatomy; chapter 5 myology.pg.no.602, 37 the edition; 1989.
2. Sodenberg, G.L. (1986).Kinesiology: application to pathological motion. Baltimore: Williams & Wilkins.
3. Richardson C, Jull G, Hodges P, Hides J. Therapeutic Exercises for Spinal Segmental Stabilization in Low Back Pain. Toronto; Churchill, Livingstone.1999.
4. Christopher M Norris, Spinal Stabilization. An exercise progression to enhance lumber stabilization .Theory & Practice .Physiotherapy; March 1995, Vol 81 No: 3
5. Boissonnauilt JS, Blaschak MJ. incidences of diastasis of recti abdominis during childbearing year.phys Ther.1988; 68:1082-1086
6. Christopher M Norris Spinal Stabilisation.4. Muscle Imbalances & low Back Pain. Theory &Practice .Pg.no. 132-133
7. Kendall F; McCreary L.Muscle testing & function,3rd ed; Baltimore: Williams & Wilkins 1983: 147-176
8. Sarti MA, Monfort M, fuster M, Villaplna I.A .muscle activity in upper & lower rectus abdominis during abdominal exercises. Archives of phys med rehab.1996; 77; 1293-1297.
9. Negrao Filho Rdef, BerzinF, Souza Gda C.Dept of P.T., faculty of science & technology. University state paulista Julio de Mesqui
10. Clark km, Sinyard J. EMG comparison of upper & lower rectus abdominis during abdominal exercises. The school of health & human performance, Dalhousie University, Halifax, Nova Scotia, Canada, B3H, 3Js.
11. Francisco J Vera –gracia, Sylvain G Grimier, Stuart M McGill. Abdominal muscle responses during curl up on both stable & labile surfaces. Physical therapy.vol 80, no.6, June 2000.
12. Sally French R, JS. Practical Research: A Guide for Therapists. 2nd edn. BUTERWOTH /HEINEMANN.
13. Gregory J Lehman, Stuart M McGill quantification of the differences in electormyogrphic activity magnitude between the upper & lower portions of rectus abdominis

muscle selected trunk exercises.
14. Wendy L.Gilleard, MSc (Hons), J.Mark.Brown, Phd.An Electromyographic Validation of an abdominal Muscle Test.Arch phys med rehab Vol 75 September 1994.
15. Mulhearn, S & George, K (1999).Abdominal Muscle Endurance & Its Associations with Posture & Low Back Pain. An initial investigation in male & female elite gymnast. Physiotherapy April 1999/vol 85/no.4

Hospital based study to assess knowledge, awareness and perception regarding physiotherapy among the patients in the physiotherapy OPD

Agarwal Vaibhav*, Meena Raj Kumar, Khan Amir Maroof***, Bansal Rahul******

*Asst. Professor, **Principal, Subharti Physiotherapy College, Meerut, ***Asst. Professor, ****Professor and Head, Subharti Medical College, Department of Community Medicine, Meerut

Abstract

Introduction

Physiotherapy is concerned with identifying and maximizing movement potential, within the spheres of promotion, prevention, treatment and rehabilitation. The practice of physiotherapy should not be defined by the use of modalities but rather the integration of examination, history and analysis of movement dysfunction. Physiotherapy is used in wide variety of disease conditions like musculoskeletal problems, neurological disorders, sport injuries, geriatric injuries, burn injuries and rehabilitation of patients in intensive care unit. But unlike various specializations dealing with health and disease like medicine, surgery, orthopedics, ophthalmology etc, this important specialty has not gained much popularity. Not much research has been conducted in our country on this important topic.

This study has therefore been conducted to gain insights regarding patient's awareness and perceptions regarding physiotherapy and to build future roadmaps to increase the same.

Objectives

1. To find out awareness and perception regarding physiotherapy.
2. To compare income level of patients of various categories with the duration of treatment.
3. To find out myths and misconception regarding physiotherapy.
4. To suggest measures for educating the patients regarding physiotherapy.

Material and method

Cross-sectional hospital study of 200 patients attending the physiotherapy OPD done in a period 6 months (July 2007-dec2007). All eligible subjects were interviewed personally by physiotherapist using a performed and pre-tested schedule. Questions regarding the respondent's biosocial characteristics, awareness and perception regarding physiotherapy were included in the schedule.

Quantitative analysis was done using chi-square test.

Results

Results show that 54.43 % urban and 34.71% rural subjects were aware of physiotherapy. These results were according to their level of education and occupation. Similarly only 90 patients out of 200 had the knowledge of physiotherapy treatment.

Key words

Knowledge, awareness, perception, physiotherapy OPD

Introduction

Patients and staff satisfaction is an important component of the health care industry in this modern competitive era. It was felt that there is a need to the awareness and perception level of the patients. Patients attending each hospital are responsible for spreading the information of physiotherapy and therefore awareness and good perception of patients attending the hospitals is equally important for physiotherapy[1]. The promotion of health and active life for people is embedded in local council planning, awareness and perception with specific programmes on disease prevention. We wanted to get away from the stereotypical view of the type of exercises that older people enjoyed, such as keep fit classes and change older peoples exception of what activities they are capable of doing. The programme aims to improve capabilities of everyday life and build their confidence so that they feel like living like again. Awareness and perception puts the services success down to many factors; the facility itself, staff dedication, training home care staff in rehabilitation and the backing of senior executives who allow operational managers to get with delivering the service.

Purpose

In the hospitals, the outpatient department is often called "shop window"[2]. Patient's awareness leads to drift in both new and old patients, which hinders the sustainability of any hospital in long run. This study was conducted to know the awareness and perception level of patients. Various studies[3] about out patient services, perception and awareness elicited problems like overcrowding, delay in consultation, proper behavior of staff are vital in improvement of awareness and perception. Purpose of this is to investigate the extent of public awareness of physiotherapy service and identify the sources of public information.

Materials and method

200 subjects were randomly selected for the questionnaire based study. A questionnaire was made in English and Hindi comprising of questions regarding the personal details of the patients, their level of education, family details, physiotherapy awareness, source of information regarding physiotherapy, effectiveness of physiotherapy, and duration of treatment. The questionnaire consists of two page document involving 18 questions which were either given by ticking the appropriate answer or by writing the answer in short.

Statistical test was done using chi-square test.

Inclusion criteria

Patients should be cooperative. In case of patients in pediatric age group (less than 12 years), their accompanying parents/guardian will be interviewed.

Exclusion criteria

Patients in critical condition meaning there are in need of admission in hospital/bedridden or who will not be in need of physiotherapy or not able to respond or not wiling to participate will not be included in study. Patients interviewed once were not included again.

Results

The following table shows correlation between the different categories of patients among rural, urban, level of education and level of occupation. (Table No.1)

Level of significance was found using p value $\leq .05$ between following categories:

Knowledge and perception level

90 patients out of 200 knew about physiotherapy and then there knowledge about physiotherapy was assessed using simple questions. The results are as follows:

Discussion

Results have shown that more awareness was found among patients in the urban sector but that too only those who were highly qualified and were professionals. It is calculated that 115 patients out of 200 were unaware of physiotherapy out of which 79 were from rural sector and 36 from urban (Table No 1). This unawareness towards the upcoming branch of paramedical sciences that is physiotherapy, occupational therapy etc. is due to misconceptions towards yoga which is just a way for keeping fit physically and mentally as compare to physiotherapy which prevents the diseases and improves quality of life by sort of exercise, manipulations and mobilizations without any side effects, without consuming handful of drugs.

This owes its root to lack of education. Results also show that only 18.18% illiterate, 35.90%high school, 86.67% professional are aware of physiotherapy (Table No. 1). Another reason being that physiotherapy is considered similar to allopathy treatment like visiting the doctor only once or twice will serve the purpose. This misconception should be removed from patients mind and they should be exposed to physiotherapy treatment for at least one week to ten days.

It is evident from table no. 4 and subsequent graphs when duration and income was correlated, it was seen that patients falling under low income group or are unemployed / illiterate opted for short duration or did not know about the duration. A proper complete physiotherapy treatment needs more time and money, people runaway from it finding a less expensive and easy short cut for their treatment. They are unaware and fall a prey in the hands of massage corners etc. Physiotherapy treatment should be made available to rural sector and low income group at affordable prices within their reach.

Similarly when the knowledge of physiotherapy was compared among different group of people according to education and occupation as per table no 5 it was seen only 90 patients had knowledge of physiotherapy, only around 60-70% knew that physiotherapy had no side effects and that highly qualified wanted to continue their treatment. Skilled, semiskilled and unskilled had no knowledge whether to continue the treatment or not.

Table 1:

Rural/ Urban

S.No.	Category	Total	Patients Aware N (%)	Patients not aware
1	Rural	121	42 (34.71)	79
2	Urban	79	43 (54.43)	36
Education				
3	Illiterate	44	08 (18.18)	36
4	Primary school	21	07 (33.33)	14
5	Middle school	28	06 (21.43)	22
6	High school	39	14 (35.90)	25
7	Intermediate	24	11 (45.83)	13
8	Graduate	29	23 (79.31)	06
9	Professional degree	15	13 (86.67)	02
Occupation				
10	Unemployed	23	13 (56.52)	10
11	Unskilled	25	04 (16.00)	21
12	Semiskilled	26	05 (19.23)	21
13	Skilled	09	05 (55.56)	04
14	Clerical	58	25 (43.10)	33
15	Semi professional	37	20 (54.04)	17
16	Professional	22	11 (50.00)	11

Table 2:

S. No	Categories
1	Rural and urban *
2	Illiterate and high school ns
3	Graduate and professional ns
4	Unskilled and skilled *
5	Semiskilled and skilled *

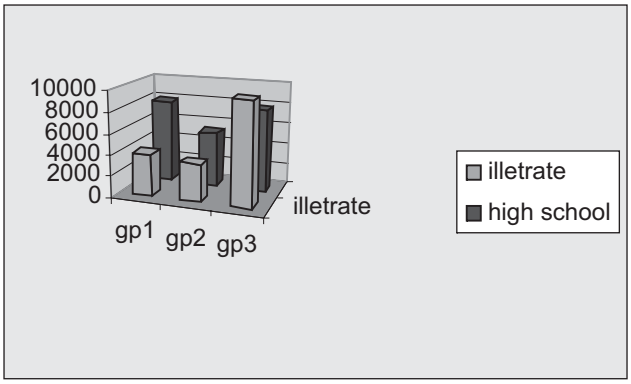
* -Significant

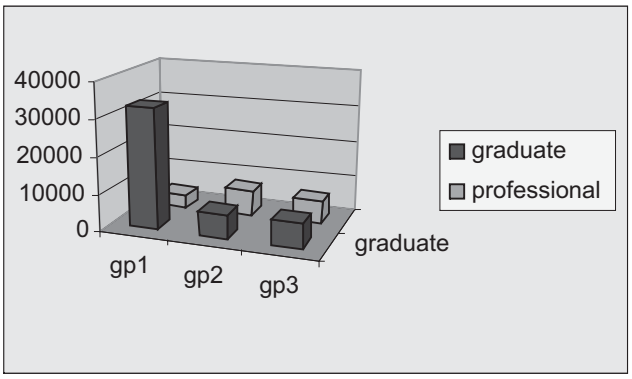
ns- not significant

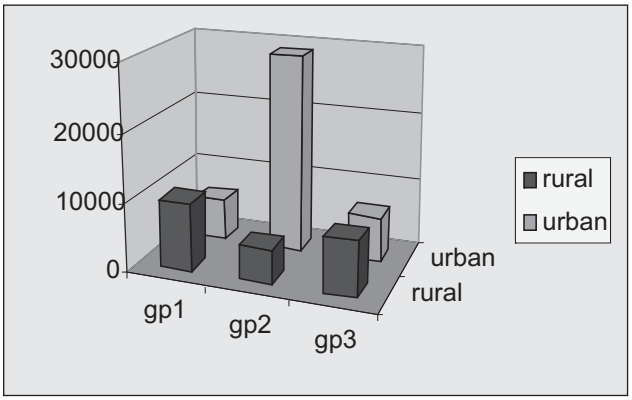
Table 3:

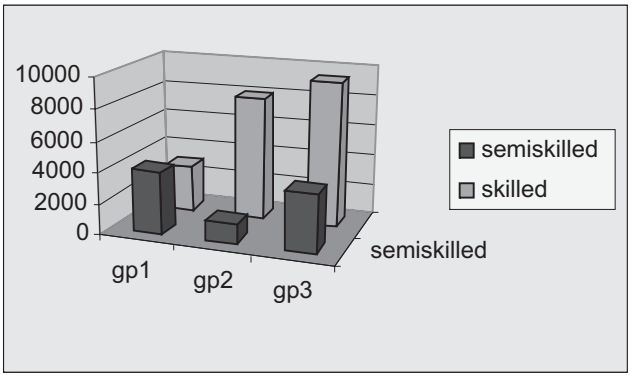
S. No	Categories	Total	% of patients who had Knowledge of different treatment techniques	% of patients who knew that physiotherapy has no side effects	% of patients who wanted to continue the treatment	Number of patients who knew about physiotherapyTreatment
1	Rural	45	88.88	60	84.44	40
2	Urban	45	73.33	73.33	91.11	37
3	Illiterate	10	60	60	70	06
4	High school	18	66.66	61.11	88.88	12
5	Graduate	21	80.95	71.42	95.23	17
6	Professional	13	61.53	69.23	100	08
7	Unskilled	04	75	75	-	03
8	Semiskilled	08	62.5	62.5	-	05
9	Skilled	06	83.33	50	-	05

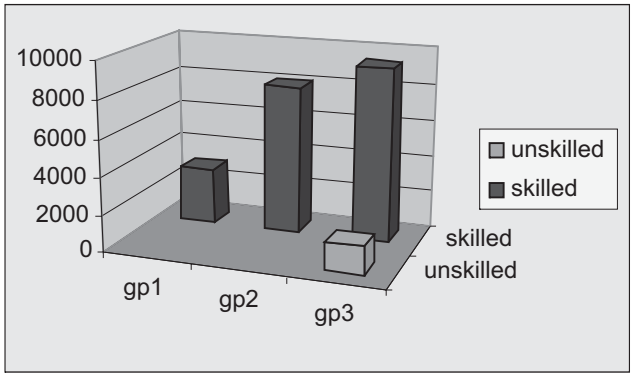
Graphs showing correlation between duration and income of different categories











This profession now a day is highly exploited by its own professionals who are do short term courses. In the thirst of earning at an early stage youngsters/elementary educated people do short term courses. They apply their knowledge which is like a drop in the ocean of physiotherapy which may harm the patients many a times and defame our profession.

Table 4:

Categories	Gp1	Gp2	Gp3
Illiterate	4000	3625	9750
High school	8000	5222	7900
Graduate	33333	6575	6944
Professional	3750	6916	6250
Rural	9928	4971	8052
Urban	6071	29000	6613
Unskilled	-	-	1483
Skilled	3000	8000	9350
Semiskilled	4000	1250	3750

Gp1= short term duration

Gp2= long term duration

Gp3= no knowledge of duration of physiotherapy

Conclusion

It is concluded that mostly urban, highly educated and skilled people were aware of physiotherapy and had its knowledge. Therefore it is apparent that there is a room in the rural area to spread awareness and knowledge about physiotherapy to a larger section of the society who are illiterate or unskilled by organizing physiotherapy camps and surveys[4] to promote fitness in the healthy individual across the age spectrum.

A concern to provide an authentic alternative to the massage parlors forces me to request you all to help and come forward to change the outlook of our profession by giving best quality of treatment to patients and highest level of education to the upcoming students of this profession.

It is my vision to bring about a revolution in physiotherapy and I do believe that this research will channelize the efforts to achieve the goals of ameliorating the problems faced by physiotherapy community.

Let us all strive and help the profession of physiotherapy

to blossom to become the largest allied health profession.

References

1. De Brun C, Howell F Bedford D, Et.al. Outpatient services in acute hospitals. Ir J Med sci.2002 Apr-june;171(2):89-93
2. March S, Swart E, Robra B. Patient satisfaction with outpatient/short stay operations in a practice clinic.Gesundheitswesen 2006 Jan;68(6):376-82.
3. Renzi C, Abeni D, Picardi a Et.al. Factors associated with patient satisfaction with care among dermatological out patients. Br. J Dermatol 2001 Oct, 145 (4): 617-23.
4. Abstracts, 46th Annual IAP conference, 2008 page no 191.

Effectiveness of physiotherapy management in cervicogenic headache: A systematic review

Wincent Anthony, Kate Grafton, Chandrasekhar Dekka
Faculty of Health and Well Being, Sheffield Hallam University, UK

Abstract

Objectives

To review the recent research on effectiveness of Physiotherapy Management for Cervicogenic headache patients.

Design

The computerised search of CINAHL (1982 to may 2006), EMBASE (1988 to may 2006), MEDLINE (1988 to may 2006), Cochrane Central Register of Controlled Trails (issue 3, 2006), AMED (1988 to may 2006) and Physiotherapy Evidence Database (1980 to may 2006) was conducted.

Participants

Studies which include patients with Cervicogenic Headache of all age group, both gender, of all duration are considered.

Interventions

Any one of intervention or combinations of Physiotherapy was included. These are manipulation, exercise, manual therapy, posture modifications, soft tissue techniques etc.

Main outcome measures

Atleast one or more of the following outcome measures had to be considered for inclusion in this review i.e., Headache frequency, Intensity and Duration, Northwick Park Neck Pain Questionnaire, Medication usage, Neck Pain Disability Index, Visual Analogue Scale.

Results

Quality scores of 11 studies which met inclusion are 5 RCT's and 6 case studies (qualitative studies) which ranged from 2 to 9 with average of 6.6 and 5 to 9 with average of 5.6 respectively.

Conclusions

The review and best evidence synthesis of all the 11 studies from 1990 to 2005 revealed that physiotherapy which includes manipulation and exercise as combination for treatment of cervicogenic headache might be effective. However, further large, well-controlled, randomised trials are required in order attain definitive results.

Key words

Physiotherapy, cervicogenic headache, manipulation, exercise.

Corresponding Author:

Wincent Anthony

104 Sharrow Lane, Sheffield, S11 8AL, UK
Ph no: +447912361410
vincentpt1@gmail.com.

Introduction

Headache is a symptom commonly treated by physiotherapists and other health care professionals who might include osteopaths, chiropractors and manual medicine practitioners[1]. Cervicogenic headache (CH) as a diagnosis was first introduced by Sjaasted et al 1983[2]. He argued that Cervicogenic headache was a secondary headache arising from a disorder or lesion within the cervical spine or soft tissues of the neck. The World Cervicogenic Headache Society in 1998[3] has defined Cervicogenic headache as ''a referred pain perceived in any part of the head and caused by primary nociceptive source in musculoskeletal tissues that are innervated by cervical nerves''.

It is generally accepted that the sources of pain originates form various structures innervated by upper three cervical nerves. Therefore, the diagnosis of Cervicogenic headache relies on identification of these structures[5].

Much literature has been published exploring Cervicogenic headache's epidemiology, however it remains unclear. Its estimated prevalence ranges from 0.4 to 2.5% of general population[2] and appears to be common among females[7].

There are several published studies that evaluate the effectiveness of various physical therapies for Cervicogenic headache which include manipulation, exercise, manual therapy soft tissue manoeuvres and various others. Several systematic reviews have assessed the effectiveness of physical treatments for chronic or recurrent headache[8-10]. These reviews address the different types of treatment for headache and these reviews only considered randomised control trails. There has been no systematic review specifically addressing the effectiveness of physiotherapy in Cervicogenic headache. Therefore, the aim of this review is to systematically review current available literature to evaluate the effectiveness of physiotherapy for Cervicogenic headache.

Literature search

A comprehensive literature search was carried out to identify the pertinent research on Physiotherapy

Management of Cervicogenic headache. One reviewer searched computerised databases independently. The following databases were searched **CINAHL** (1982 to may 2006), **EMBASE** (1988 to may 2006), **MEDLINE** (1988 to may 2006), **Cochrane central register of controlled trails** (issue 3, 2006), **AMED** (1988 to may 2006) and **Physiotherapy evidence database** (1980 to may 2006) were searched. Subject headings and key words were initially derived from the research question and included headache, cervicogenic and manipulation. Subsequently, keywords were then identified from the initial articles including exercise, mobilization, pain and further headache specific language including trigeminocervical and cervical headache i.e., headache of cervical origin. These terms also assisted in identifying the research regarding pathophysiology, theory and classification.However, these are not discussed in detail as this review perhaps focused towards physiotherapy management aspect.

Subject specific search was based on combinations of

- 'Randomised controlled trial'.
- 'Randomised controlled trials'.
- 'Case study'.
- 'Case report'.
- 'headache' and 'physical therapy'.
- 'headache' and 'physiotherapy'.
- 'cervicogenic' and 'headache'.
- 'cervicogenic headache' and 'treatment'.
- 'Physiotherapy' and 'cervicogenic headache'.
- 'Physical therapy' and 'cervicogenic headache'.
- 'manipulation and Cervicogenic headache'.
- 'exercise' and 'cervicogenic headache'.
- 'Interferential therapy'.
- 'transcutaneous electrical nerve stimulation'.
- 'manipulation' and 'exercise' and 'cervicogenic headache'.
- 'chiropractic'.
- 'osteopathic medicine'

Finally references from retrieved articles were screened and if noted to be pertinent they were considered.

Types of studies included (Fig. 1)

This review includes randomised controlled trials, case studies, case reports and case series. Full text articles until May 2006 published in English were considered for this study. To determine whether the study should be included, the abstracts of all identified articles were assessed by two reviewers. If there was any speculation, the full text article was retrieved and read independently by the reviewer. Any disagreement among reviewers was resolved by consensus.

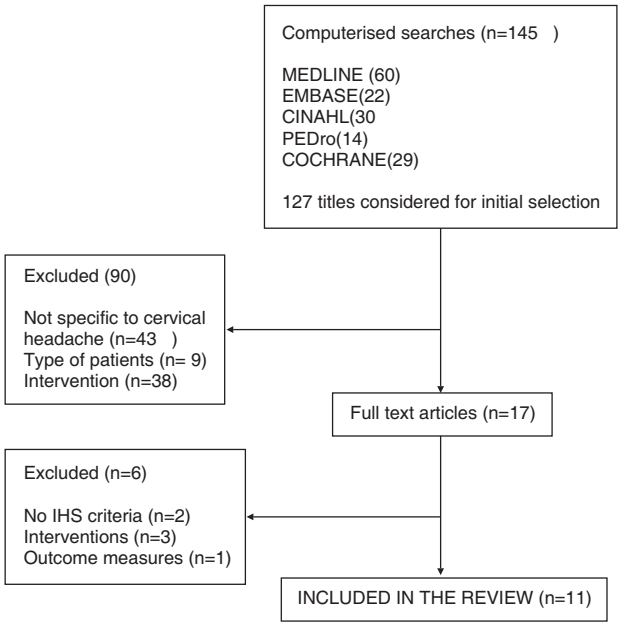
Types of participants

Studies which include patients with Cervicogenic headache of all age group, all gender, of all duration are considered.

Type of intervention

Any one of intervention or combinations of Physiotherapy was included. These are Manipulation, Exercise, Manual therapy, Posture modifications, Soft tissue techniques such as Trigger point massage, Muscle energy techniques.

Fig. 1:



Outcome measures

At least one following outcome measures had to be considered for inclusion in this review i.e., Headache frequency, Intensity and Duration, Northwick Park Neck Pain Questionnaire, Medication usage, Neck Pain Disability Index, Visual Analogue Scale. These outcomes considered were based primarily on the specific goals for patient with Cervicogenic headache.However, outcome measure such as Range of Motion (ROM) was not considered as it was a secondary requirement for patients with Cervicogenic headache.

Assessment of methodological quality

The methodological assessment was performed by two reviewers independently for all included studies (full text articles). The methodological quality of randomised controlled trials was performed using **PEDro** rating scale (Table 1) (Appendix B)[24] and case study was assessed separately using **CASP** (Critical Appraisal Tools, 2006) (Table 2) (Appendix C)[25]. This scale was chosen for two reasons. First, unavailability of other standardized rating scale for case studies. Second, it is relatively easy to access

Table 1:

Criteria for assessing methodological quality of qualitative studies	
1.	Aims clearly stated.
2.	Use of appropriate methodology.
3.	Appropriate Research design.
4.	Sampling.
5.	Data collection.
6.	Reflectivity (research partnership relations/ recognition of researcher bias.
7.	Ethical issues.
8.	Data analysis.
9.	Clear statement of findings.
10.	Value of research.

Based on CASP (critical appraisal skills programme) (2006). {**If Yes= +, If No= -, No Information = -**}

Table 2:

CBO QUALITY

Hierarchy of quality of individual studies and strength of the evidence
Hierarchy of evidence
A1 systematic reviews, which include trials at quality level A2, and have consistent results.
A2 randomised controlled trials of good quality and sufficient power and consistency.
B randomised controlled trial of moderate quality or insufficient power, or other non-randomised controlled studies.
C non-controlled studies
D Expert opinion, such as working group members
Strength of the evidence
Level 1 1 systematic review or studies at level A2
Level 2 2 studies of level B
Level 3 1 study of level A2 or B or C
Level 4 Expert opinion, such as working Group members.
Formulation of recommendations
Level 1 it has been shown that.....
Level 2 it is likely that.....
Level 3 there are indications that.....
Level 4 the opinion of working group is.....
Source: CBO 2005

and simple to assess.

The reviewer scored each item of the included studies with '**Yes**'(If sufficient information is available and bias is considered to be unlikely), '**No**'(If bias is considered to be likely) or '**No information**'(If insufficient information is given or the criterion is rated inconclusive).Positive (**+**) scores for '**Yes**' and negative (**-**) score for '**No**' and '**No information**' were added. The study was considered to be good if it had a minimum score of 4.Any disagreement among reviewers was followed by discussion, if necessary scrutiny by another reviewer was considered.

Data collection (Appendix A)

Detailed information about the patient demographics, type of headache, clinical characteristics, interventions, outcome measures were collected using standardised abstracting form modified from Cochrane Database for Systematic Reviews (appendix A). One reviewer independently extracted and recorded relevant data from each article.

Results

The selection of the studies are shown in the Fig. 1. The search could not be narrowed only to randomised controlled trails due to insufficient number of this type of evidence. Therefore the search strategy resulted in 127 articles in total. Based on abstracts 90 were excluded. These were excluded (n=43) as they did not specify the headache of cervical origin and others (n=9) did not base on the IHS criteria (International Headache Society), however, it was difficult to assess this criteria with case studies. Further in order to determine the effectiveness of physiotherapy the studies that used modalities extensively were excluded (n=38). Overall, 17 full articles were retrieved, resulting in exclusion of another 6 articles. This exclusion of studies (n=2) was based on the same criteria as previously discussed. In addition studies which included the surgical treatment such as radiofrequency denervation (n=3) was excluded. Finally, a study was excluded based on the outcome measure (n=1). Overall, 11 articles were included for this systematic review. Out of these 11 articles, four (n=4) were randomised

Table 3:

PEDRO CRITERIA (TABLE 1)

STUDY	1	2	3	4	5	6	7	8	9	10	11	PEDRO Score TOTAL	CBO Qlt (TABLE 3)
RCT'S:													
Ammer (1990)	+	-	-	-	-	-	-	+	-	-	-	**2**	**B**
Nilsson (1997)	+	+	+	-	-	-	+	+	-	+	+	**8**	**A2**
Jull (2002)	+	+	-	+	-	+	+	+	+	+	+	**9**	**A2**
Whi ttingham (1997)	+	+	-	+	-	-	+	+	-	-	+	**6**	**B**

[CRITERIA FOR RCT'S =1-11= Pedro criteria (table 1), Qlt= quality, += yes, -= no,-= no information]

Table 4:

CASP CRITERIA (TABLE 2)

STUDY	1	2	3	4	5	6	7	8	9	10	CASP Score TOTAL		CBO Qlt (TABLE 3)
CASE STUDIES:													
McDonnell (2005)	+	+	+	-	-	-	+	-	+	+	6		C
El dridge (2005)	+	+	+	+	+	-	+	+	+	+	9		C
Hanten (2005)	+	+	+	+	+	-	+	-	+	+	8		C
Peterson (2003)	+	+	+	+	-	-	-	-	+	+	6		C
Whorton (2000)	+	+	+	+	+	-	-	-	+	+	7		C
Sizer (2002)	+	+	+	-	-	-	-	-	+	+	5		C
Schoenese (1995)	+	+	-	-	-	+	+	+	-	-	6		C

[CRITERIA OF CASE STUDIES =1-10 = CASP criteria (table 2), Qlt= quality, + = yes, - = no, - = no information]

controlled trial[11-14], one (n=1) was prospective case series [20], two (n=2) case reports i.e., one retrospective[21] and other prospective[19]. The others (n=4) were case report and case studies[15-18].

The methodological quality of the studies which are RCT's was assessed by PEDro (table 3) and other qualitative studies such as case studies or reports was assessed using CASP (table 4). Due to small number controlled trails, study heterogeneity (particularly in terms of comparisons), lack of adequate data for calculating effect size and time constraint and reviewer could not carry out meta-analysis.

Quality of studies

The average score for RCT's (n=5) was 6.1 at the maximum of 9 out of 11 which suggests studies were of fairly good quality. Two studies were considered high quality based on their scoring[13,12] and at the level of A2.However, the most common problem was allocation was not concealed and blinding of subjects in the studies[13,14,11]. It is evident that effective blinding of subjects or therapists is difficult or impossible in these trials and therefore such trials would not receive maximum score on PEDro rating scale. Most of the studies the interventions were involving manipulation and exercise aspect.

On the other hand, the average score for Qualitative studies was 6.7 at the maximum score of 9 out of 10.However; it had been difficult to assess these studies using the rating scale i.e., CASP due to complexity of scale and type of questions. An overview of studies which describes the patient demographics, type of headache, clinical characteristics, interventions, and outcome measures were presented **(Appendix A)**.Two studies involved manual

therapy and exercise[18,20], one study involved a specific exercise program and modification of postural alignment[16] and other two studies involved manipulation and exercise[17,21]. one study included muscle re-education in addition to manual therapy.

Interventions

In eleven studies, seven studies i.e., four RCT's and three case reports evaluated the effect manipulation with or without exercise[11-15,17,21]. Two studies studied the effect of manual therapy and exercise[18,20]. One study studied the effect of specific exercise program and modification of postural alignment[16]. One study studied manual therapy in combination with muscle re-education[19].

Spinal manipulative therapy

Jull 2002[13] (n = 200) with the quality score of 9 (table 3) compared 6 weeks of SMT (Spinal Manipulation Therapy) (high- and low-velocity), exercise (endurance, isometric, and stretching), a combination of the two, and a no-treatment control. At 1 week and 12 months post-treatment, the SMT group showed significantly more reduction in pain intensity at 1 week and at 12 months and headache frequency than the no-treatment control group. SMT performed little better than no treatment in terms of headache duration. Compared to exercise, SMT showed similar reductions in pain at 1 week and at 12 months, headache frequency at 1 week at 12 months, and headache duration at 1 week and at 12 months, these results were not statistically significant. However, blinding was possible only for outcome assessment but success of blinding was not reported. A course of 8-12 treatment over 6 weeks was given to active treatment group but not to control group.

Nilsson 1997[12] (n = 54) with the quality score of 8 (table 3) compared SMT to massage plus placebo laser. There were six sessions of care in 3 weeks. SMT consisted of standard 'diversified' manipulation in the lower cervical region and 'toggle recoil' in the upper region. The massage group received deep friction massage and trigger point therapy. There was a significantly greater decrease in pain intensity and headache hours in the SMT group at 1 week post-treatment. The advantage for SMT in number of pain killers (pills per day) was not significant.

Whittingham 1997[14] (n = 105) with the quality score of 7 (table 3) compared SMT with placebo SMT. 'Toggle recoil' manipulation was administered to the upper cervical region three times per week for 3 weeks. Placebo manipulation consisted of treatment to the same region with a deactivated mechanical instrument. There were significant differences in favor of SMT after 3 weeks of treatment for pain intensity, disability, and number of headache locations.However, this difference was noted only for first phase (3wks).

Ammer 1990[11] (n=45) with the poor quality score 2 (table 3) compared manipulation and pulsed galvanic current vs direct galvanic current, ultrasound and ultraviolet rays for neck region vs moist pack and massage for shoulder and neck for 2weeks.At the end of 2 weeks treatment the effect was similar for all groups.

Eldridge and Russell 2005[17] with the quality score of 9 (table 4) evaluated the effectiveness of osteopathic manipulation and a specific exercise of cervical deep flexors muscle in reducing cervicogenic headache pain and frequency in 26yr old female. Outcome measures included the quadruple visual analogue scale, a headache diary, and data recorded from a pressure biofeedback device. Osteopathic manipulation treatment involved high velocity low amplitude (HVLA) thrust techniques and a low load exercise programme targeting the deep cervical flexor musculature. There was significant reduction both intensity of headache pain and frequency. However, there was no attempt in this study to determine the effects of manipulation or exercise on the palpatory characteristics of cervical joint or soft tissues, or impaired cervical range of motion associated with Cervicogenic headache.

Schoensee et al 1995[15] with the quality score of 6 (table 4) evaluated the effectiveness of mobilization for 10 subjects of cervicogenic headache. A headache log was used to document headache frequency, duration, and intensity throughout all three phases (A-B-A).At the end of 4weeks, Visual analysis of data plots revealed a decrease in headache frequency, duration, and intensity from the baseline phase to the treatment phase suggesting improvement. However, the follow period in this study was very short.

Sizer et al 2002[21] with the quality score 5 (table 4) evaluated the effectiveness of manipulation in 45yr old female with 20 history of cervicogenic headache suggesting that manipulation is efficacious in treating this cervicogenic headache patient.However, results cannot be generalised as it is a single case report.

Summary of evidence

- There is a moderate to high quality evidence **(Nilsson 1997, Jull 2002, Eldridge and Russell 2005, Schoensee et al 1995)**[12,13,15,17] to suggest that spinal manipulation is superior to no treatment in reducing headache pain and frequency.
- There is high quality evidence **(Jull 2002, Eldridge and Russell 2005)**[13,17] to suggest that manipulation combined exercise is superior to no treatment.
- There is moderate quality evidence to suggest that spinal manipulation is superior to placebo for reducing pain, disability and headache frequency **(Whittingham 1997)**[14].
- There is very low quality evidence to suggest that manipulation combined with pulsed galvanic current is no better than direct galvanic current, ultrasound and ultraviolet rays for neck region and moist pack and massage for shoulder and neck for 2weeks **(Ammer 1990)**[11].
- There is C level evidence (table 2) to support that manipulation is effective cervicogenic patients **(Sizer et al 2002)**[21].

Manual therapy and exercise

Two studies with the quality score of 8 and 7 respectively studied the effect of manual therapy and exercise[18,20]. **Whorton and kegerries (2000)**[20] a case series involving six patients with chronic Cervicogenic headache evaluated the effectiveness manual therapy consisting of soft tissue mobilization including sub occipital release, scapular bordering, laminae release and joint non-thrust manipulation including 1st rib, upper thoracic and cervical regions and exercises for strengthening, stabilization, and aerobic

conditioning suggesting the significant improvement in five out of six subjects and decrease in PDI scores.

In another study by **Hanten et al 2005**[18] with the quality score 8 (table 4) also evaluated the effectiveness of manual therapy consisting of muscle energy technique and exercise in 2 patients (45yr and 26yr) with cervicogenic headache. Both subjects demonstrated an increase in functional activities, a decrease in average or worst pain and overall improvement in perception of change in headache.

Summary of evidence

- There is C level evidence (table 2) to support that combined manual therapy and exercise is effective **(Whorton and kegerries 2000, Hanten et al 2005)**[20,18].

Manual therapy and muscle re-education

One study by **Peterson (2003)**[19] with the quality score of 6 (table 4) studied the effect of manual therapy and muscle re-education in a 27yr old female patient. The significant improvement was noted in cervical mobility, headache intensity and frequency.However, the follow up period was very less.

Summary of evidence

- There is C level evidence (Table 2) to support manual therapy and muscle education is effective for treatment of cervicogenic headache **(Peterson 2003)**[19].

Exercise and posture modification

One study by **McDonnell et al 2005**[16] with the quality score of 6 (table 4) evaluated the effect of specific exercise and functional activity modification in a 46yr old patient with cervicogenic headache. At the end of 3months the patient demonstrated significant decrease in pain intensity and frequency. Upper cervical joint mobility, cervical range of motion, scapular alignment and scapulothoracic muscle strength was also improved. However, this patient was associated with decreased scapulothoracic muscle strength and scapular mal-alignment and as it is single case the results cannot be generalised.

Summary of evidence

- There is C level evidence (Table 2) to suggest exercise and posture modification is effective in treatment of patients with cervicogenic headache **(McDonnell et al 2005)**[16].

Discussion

The relatively small number of randomised controlled trials (n=5) and small number of Non-controlled studies (n=6) it is perhaps difficult to come definitive conclusion. Moreover as lack of control group is evident for these non-controlled trials it is perhaps difficult to compare the effects of these treatments.

This review provides some evidence for different forms of physiotherapy techniques which include manipulation, exercise, manual therapy and activity modification. However, only two studies that suggest the efficacy of manual therapy techniques and exercise[18,20] and one study[16] which suggests the effectiveness of specific exercise program and modification of the postural alignment. Most of the studies in this review[11,13-15,17] suggested manipulation combined with other physiotherapy methods such as exercise might be effective in management of patients with Cervicogenic headache. The patients (n=416) in these studies found improvement in almost all outcome parameters i.e., Headache frequency, Headache intensity, Headache duration etc. However, the proportion of people who had complete relief were not reported and corresponding figures in reduction of pain were not reported in one study[13]. Second, only two RCT's were of high quality[12,13] and one single case experimental study[17]. However, this study[17] had a short term follow up period and as with all case studies, this is limited in its generalisibilty to the wider population.

This review demonstrated that physiotherapy which involves manipulation combined with exercise targeting articular, muscular, postural and neural dysfunction may be helpful in treating patients with cervicogenic headache. Some of the randomised controlled trails in the review, include small and heterogeneous samples[11,12]. Out of four RCT's only two studies tried to assess findings against statistical tests[12,13]. However, one was perhaps successful[13], therefore resulted in attaining the maximum score (table 3). None of the studies reviewed, included the supporting data for cost effectiveness of these interventions for cervicogenic headache. Ultimately the intervention that demonstrates effectiveness and cost efficiency will be adopted as standard clinical practice[22]. Due to small number controlled trails, study heterogeneity (particularly in terms of comparisons), lack of adequate data for calculating effect size and time constraint the author could not carry out meta-analysis/statistical pooling of results. Overall, In view of such weaknesses, further study is recommended to rectify these limitations, employing large, well-controlled, randomised trials in order attain definitive results.

The aim of this systematic review was to present with summary of research finding by synthesizing the best evidence using the rating system based on quality of the individual studies.However, this had certain limitations. First, rating to some extent is subjective and since systematic review were not considered in this study, A1 quality level evidence was not possible to score. Second, for the first time, case studies were rated which perhaps may limit the review results, as reliability of this rating scale is not yet determined.Third, during rating each study if certain information of the study was not clearly identifiable or not known these were considered to be 'No Information'. These were scored negative (**-**) which might have had affected the results of this review. Scoring was based on the understanding of the reviewer which may certainly affect the results. Fourth,the review considered case studies, which had no control group therefore the improvement in outcome might have had occurred due to natural course of disease, placebo etc .Consequently, the cause and effect relationship cannot be determined. This could affect the results of this review. Although, the reviewer had tried to hand search the specialist journals, the majority of the literature search undertaken using computerised databases which could have potentially missed pertinent papers[26] and no efforts were made to search unpublished or grey literature.

Recommendation for future research

From the review the author/reviewer would recommend that further trials are required to determine the effectiveness of manual therapy, exercise and posture modification in management of cervicogenic headache. In addition, the diagnosis should be based on firm and up to date criteria such as IHS (International headache society) 2004[4]. The role of deep cervical flexor strengthening in management of cervicogenic headache could be important consideration for future research. Incorporating universally accepted outcome measure in trials would certainly enhance the reliability and validity for the trials.

Conclusion

The review and best evidence synthesis of all the 11 studies from 1990 to 2005 revealed that physiotherapy which includes manipulation and exercise as combination for treatment of cervicogenic headache might be effective. However, further large, well-controlled, randomised trials are required in order attain definitive results. In addition, other Physiotherapy such as manual therapy and posture modification is also noted to effective but further randomised controlled trails are warranted to suggest its effectiveness and therefore its implementation in clinical practice. In conclusion, the reviewer suggests that physiotherapy may be effective in treating patients with cervicogenic headache.

ETHICAL APPROVAL: Not required.
FUNDING: Self.
CONFLICT OF INTEREST: None.

References

1. Jull G.Characterization of cervicogenic headache. *Phys. Ther.Rev* 1998; 3:95-105.
2. Sjaasted O, Saunte C, Hovdahl et al. Cervicogenic headache. A hypothesis. *Cephalalgia* 1983; 3:249-56.
3. World Cervicogenic Headache Society. Cervicogenic headache definition. Available at: http:// www.cervicogenic.com/ definit2.html. 1998.
4. International Headache Society. International classification of headache disorder 2nd edition. *Cephalalgia* 2004; 24:115-116.
5. Silverman B Steven. Cervicogenic Headache: Interventional, Anesthetic, and Ablative treatment. *Current Pain and Headache Reports* 2002; 6:308-314.
6. Sjaasted O, Fredriksen TA.Cervicogenic Headache: Criteria, Classification and Epidemiology. *Clinical Exp Rheumatology* 2000; 18(19):S3-6.
7. Pollman W, Keidel M, Pfaffenrath V.Headache and Cervical Spine: a critical review.*Cephalalgia* 1997; 17:501-516.
8. Bronfort G, Assendelft WJ, Evans R, Haas M, Bouter LM. Efficacy of spinal manipulation for chronic headache: a systematic review. *Journal of Manipulative & Physiological Therapeutics* 2001; 24(7):457-66.
9. Melchart D, Linde K, Fischer P, Berman B, White A, Vickers A, et al. Acupuncture for idiopathic headache (Cochrane Review). In: *The Cochrane Library*, 2, 2004. Chichester, UK: John Wiley &Sons, Ltd.
10. Bronfort G, Nilsson N, Haas M, Evans R, Goldsmith CH, Assendelft WJJ, Bouter LM. Non-invasive physical treatments for chronic/recurrent headache. *Cochrane Database of Systematic Reviews* 2004; 3: CD001878.
11. Ammer K, Rathkolb O. Physical therapy in occipital headaches. [Physikalische Therapie bei Hinterhaupt-tkopfschmerzen]. *Manuelle Medizin* 1990; 28:65-68.
12. Nilsson N, Christensen HW, Hartvigsen J.The Effect of Spinal Manipulation in Treatment of Cervicogenic Headache. *Jour Manipulative Physiol Ther* 1997; 20:326-330.
13. Jull G, Trott P, Potter H, Zito G, Niere K, Shirley D, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. *Spine* 2002; 27(17):1835-43.
14. Whittingham W. The efficacy of cervical adjustments (toggle recoil) for chronic cervicogenic headaches [PhD dissertation]. Melbourne (Australia): Royal Melbourne Institute of Technology, 1997.
15. Schoensee SK, Jensen G, Nicholson G, Gossman M, Katholi C. The effect of mobilization on cervical headaches. *J Orthop Sports Phys Ther.* 1995; 21(4):184 –196
16. McDonnell K Mary, Sahrmann A Shirley, Dillen V Linda. A Specific Exercise program and Modification of Postural Alignment for Treatment of Cervicogenic Headache: A Case Report. *J Orthop Sports Phys Ther* 2005; 35:3-15.
17. Eldridge Luke and Russell Jarrod. Effectiveness of cervical spine manipulation and prescribed exercise in reduction of cervicogenic headache pain and frequency: A single case study experimental design. *International Journal of Osteopathic Medicine* 2005; 8:106-113.
18. Hanten P William, Olson L Sharon, Lindsa A Weston, Lounsberry A Kristina, Stetuart K Jeanine. The Effect of Manual Therapy and a Home Exercise Program on Cervicogenic Headaches: A Case Report. *The Journal of Manual & Manipulative Therapy* 2005; 13(1):35-43.
19. Petersen SM. Articular and muscular impairments in cervicogenic headache: A case report. *J Orthop Sports Phys Ther* 2003; 33:21-30.
20. Whorton R, Kegerreis S. The use of manual therapy and exercise in the treatment of chronic cervicogenic headaches: a series of case studies. *J Man Manipulative Ther* 2000; 8:193–203.
21. Sizer S Philip, Phelps Valerie, Brisme Michael Jean. Diagnosis and Management of Cervicogenic headache and Local cervical syndrome with Multiple Pain Generators. *The Journal of Man and Manipulative ther* 2002; 10(3):136-152.
22. Cleland J and Durall J C. Physical Therapy for Adhesive Capsulitis: A Systematic Review, *Physio-therapy* 2002; 88(8):450-457.
23. CBO (2005). Evidence-based guideline development: Manual for guideline development groups (Evidence-based richtlijnontwikkeling: handleiding voor werkgroepleden). *Dutch Institute for Health Care Improvement CBO,* Utrecht.
24. Physiotherapy Evidence Database. The PEDro Rating scale. [Online] Available at: http://www.pedro.fhs.usyd.edu.au. Last updated at 4 September 2006.
25. Critical appraisal tools. Learning and Development National Health Service. [Online] Available at: http:// www.phru.nhs.uk/casp/critical_appraisal_tools.htm. Last updated at 22 April 2006.
26. Colville-Stewart S. How to do a literature search. In: Tarling M, Croft L, editors. The essential researcher's handbook. For nurses and healthcare professionals. 2nd ed. London: Bailliere Tindall 2002:35–53.

APPENDIX A:

Data Extraction

Study	Ammer 1990
Methods	Design: parallel, 3 groups. Baseline: before treatment. Treatment: 2 weeks. Randomization method: not clearly stated.
Participants	Cervicogenic like occipital headache. Sample size: 45. Age range: 23-78. Mean age: 52yrs. Onset: 3months.
Interventions	GROUP 1 :(n=15) Manipulation and pulsed galvanic current for neck (2weeks) for 10 (sessions). GROUP 2 :(n=15) Direct galvanic current and ultrasound and Ultraviolet over neck region (2 weeks) for 10 (sessions). GROUP 3 :(n=15) Moist herbal pack and massage for shoulder and neck (10sessions) (2weeks).
Outcome Measures	Pain rated headache improvement Pain scores
Results	Headache improvement: at the end of two weeks of treatment scores were similar for all groups.
Loss of follow up	7 out of 45.G1 and G2 5 patients discontinued treatment after 5 weeks as they were symptom free.
Quality Score	3

Study	Nilsson 1997
Methods	Design: Prospective, parallel, 2groups. Baseline: 1-2 weeks. Treatment: 3 weeks. Randomization: Labeled tickets prepared in advance.
Participants	Cervicogenic headache. Sample size: 54. Age range: 20-60. Mean age: 37 yrs. Onset: Not mentioned.
Interventions	GROUP1: High velocity, low velocity spinal manipulation (6 sessions). GROUP2: Deep frictions massage including trigger point therapy to posterior muscles of shoulder and upper girdle, upper thoracic and lower cervical region and low level laser (6 sessions).
Outcome Measures	Headache pain intensity Medication use Headache duration
Results	At the end of 4 weeks Grp 1 was superior to Grp2 in headache pain intensity. Grp 1 was more favourable than Grp 2 at medication usage. Grp 1 was superior to Grp 2 in headache duration.
Loss of follow-up	Only 1 out of 54.
Quality Score	9

Study	Whittingham 1997
Methods	Design: 2 groups, blinded-controlled, crossover. Baseline: 3weeks. Treatment: 3weeks. Randomization: Drawing allocated numbers out of the hat.
Participants	Cervicogenic headache. Sample size: 105. Age range: 17-80. Onset: 64% had 10 yr history.
Interventions	GROUP1: Spinal manipulation therapy (toggle recoil) to upper cervical spine 3 sessions for 3 weeks. GROUP2: Placebo 3 sessions for 3weeks.
Outcome Measures	Pain drawing of head and neck pain with pain intensity and number of headache location. Neck disability index. Sickness impact profile. Headache pain intensity. Headache disability. Number of headache locations.
Results	At the end of 3 weeks Grp1 was superior to Grp2 at headache intensity. Grp1 was superior to grp2 at headache disability. Grp1 was superior to Grp2 at headache locations.
Loss of follow up	3 out of 105.
Qulaity Score	7

Study	Jull G 2002
Methods	Design: Multicentre, 2x2 factorial. Baseline: 2weeks. Treatment: 6weeks. Randomization: Permuted block with strata for length of headache history and city of residence.
Participants	Cervicogenic headache Sample size: 200. Age range: 18-60. Onset: 2-10 yrs duration.
Interventions	GROUP1: Manipulation as described by Maitland, including low velocity joint mobilization and high velocity, low amplitude manipulation of cervical spine (8-12 sessions). GROUP2: Therapeutic exercise including low load endurance exercises to train

	muscle control of cervical scapular region, postural correction exercises as needed (8-12 sessions). GROUP3: Grp1+Grp2 (8-12 sessions). GROUP4: Control group.
Outcome Measures	Headache intensity. Headache frequency. Headache duration.
Results	Grp1, Grp2, Grp3 were superior to Grp4 at 1week of treatment at headache intensity measurement and also 12 months. Grp1, Grp2, Grp3 were superior to Grp4 at 1 week and 12months of treatment for headache frequency. Grp3 was superior to Grp4 at 1 week and 12months of post treatment.
Loss of follow up	7 out of 200.
Quality Score	9

Study	**McDonnell 2005**
Methods	Design: case report Baseline: not stated Treatment: 7 times over 3 months. Randomization: Not applicable.
Participants	Cervicogenic headache Sample size: 1. Age: 46yrs. Onset: 7yrs.
Interventions	Exercises: Exercises1: lower abdominal exercise. Exercise2: upper cervical flexion in supine. Exercise3: shoulder flexion in supine. Exercise4: shoulder abduction and lateral rotation in supine. Exercise5: sitting against the wall, upper cervical flexion. Exercise6: sitting against wall, cervical rotation. Exercise7: sitting against the wall shoulder abduction lateral rotation. Exercise8: sitting against the wall, shoulder abduction lateral rotation. Exercise9: facing the wall, arm slide and scapula abduction. Exercise10: facing the wall, arm slide and cervical rotation. Exercise11: supine upper cervical flexion with head lift. Exercise12: prone, arms overhead with scapula abduction. Functional activity modification.
Outcome Measures	Headache frequency. Headache intensity. Neck disability Index.
Results	Patient reported decrease in headache frequency and intensity and decrease in NDI score from 31 to 11. Patient also demonstrated improvement in upper cervical joint mobility, cervical range of motion, scapular alignment and scapulothoracic muscle strength.
Loss of follow up	Nil.
Quality Score	6

Study	**Eldridge and Russell 2005**
Methods	Design: Prospective case study with A-B-C design. Baseline: 3weeks. Treatment: 3 weeks manipulation and 3 weeks of home exercise program. Randomization: Not applicable.
Participants	Cervicogenic headache Sample size: single case experimental design (1). Age: 26yrs. Onset: 16 yrs.
Interventions	Manipulative treatment combined with prescribed exercise for deep cervical flexor musculature.
Outcome Measures	Headache pain intensity. Headache frequency (headache profile).
Results	Visual analysis of plotted outcome measure data indicated a reduction in both intensity of headache pain and frequency.
Loss of follow up	Nil (follow up period 9 weeks)
Quality score	9

Study	**Hanten et al 2005**
Methods	Design: Case report Baseline: Not specified Treatment: 1 week. Randomization: not applicable.
Participants	Cervicogenic headache Sample size: 2. Age: 42yrs and 25yrs.
Interventions	Subjects were treated with muscle energy technique to balance C1 and home exercise program of cervical retractions.
Outcome Measures	Three self report measures Numeric pain rating scale Blinded follow up phone visits
Results	Both subjects demonstrated an increase in functional activities, a decrease in average or worst pain and overall improvement in perception of change in headache.
Loss of follow up	Nil. (Follow up period =26days)
Quality Score	8

Study	**Petersen 2003**
Methods	Design: Case report Baseline: Not specified. Treatment: 8 times over 8week period. Randomization: Not applicable.

Participants	Cervicogenic headache Sample size: 1 Age: 27yrs (female).
Interventions	Interventions included Manual upper cervical mobilizations, Muscle re-education for upper cervical neck flexors and scapular stabilization exercises.
Outcome Measures	Headache intensity. Headache frequency.
Results	Following treatment, the patient demonstrated an increase in cervical mobility, improved muscular performance, a decrease in headache frequency and complete resolution of functional limitations.
Loss of follow up	Nil (Follow up period =8-12 weeks).
Quality Score	6

Study	**Whorton and Kegerreis 2000**
Methods	Design: Case series Baseline: Pre-treatment Treatment: Over an average of 5.9 sessions for an average of 3.8 wks. Randomization: Not specified.
Participants	Chronic cervicogenic headache Sample size: 6. Age: 33.3yrs (mean age)
Interventions	1. Manual therapy consisting of soft tissue mobilization including sub occipital release, scapular bordering, laminae release and joint non-thrust manipulation including 1st rib, upper thoracic and cervical regions. 2. Exercises for strengthening, stabilization, and aerobic conditioning.
Outcome Measures	Pain Disability Index.
Results	Five of the six subjects reported significant improvement. PDI scores averaged decrease in disability by 29.5% at discharge and 28.8% at six-month follow up.
Loss of follow -up	Nil (Follow up period=6months)
Quality Scores	7

Study	**Sizer et al 2002**
Methods	Design: retrospective case study Baseline: not mentioned. Treatment: 24 visits for three months. Randomization: not applicable.
Participants	Cervicogenic headache associated with pain in both cervical and thoracic region. Sample size: 1. Age: 45yr old female
Interventions	Treatment sessions consisted of 20 minutes of interferential therapy for upper thoracic spine, 15 minutes of transverse stretching techniques for upper and lower cervical muscle groups and mobilization and manipulation techniques. Subsequently, home exercise program consisting of isometrics and active range of motion exercises.
Outcome Measures	Headache intensity Headache frequency. Cervical range of motion.
Results	Significant improvement was noted in this patient, as there was decrease in headache frequency, intensity. The patient reported complete resolution of her daily headache symptoms at time of discharge.
Loss of follow up	Loss of follow up was for one week period (length of follow up was 3 months).
Quality Score	5

Study	**Schoensee et al 1995**
Methods	Design: A-B-A Single case design. Baseline: 1 month. Treatment: 9-12 treatment sessions, two times per week for 3-4 weeks. Randomisation: not applicable.
Participants	Cervicogenic headache. Sample: 10 subjects. Age:
Interventions	Mobilization of the upper cervical spine, occiput-C3.
Outcome Measures	A headache log was used to document headache frequency, duration, and intensity throughout all three phases.
Results	Visual analysis of data plots revealed a decrease in headache frequency, duration, and intensity from the baseline phase to the treatment phase. This improvement continued through the second A phase for frequency but levelled off for both duration and intensity.
Loss of follow up	Nil (follow up period =1 month).
Quality Score	6

APPENDIX B:

PEDro SCALE:	
1. Eligibility criteria were specified. [Explanation] This criterion influences external validity, but not the internal or statistical validity of the trial. It has been included in the PEDro scale so that all items the Delphi scale are represented on the PEDro scale. This item is not used to calculate the PEDro score.	no/yes
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received). [Explanation] Random allocation ensures that (within the constraints provided by chance) treatment and control groups are comparable.	no/yes
3. Allocation was concealed. [Explanation] "Concealment" refers to whether	no/yes

the person who determined if subjects were eligible for inclusion in the trial was aware, at the time he or she made this decision, which group the next subject would be allocated to. Potentially, if allocation is not concealed, the decision about whether or not to include a person in a trial could be influenced by knowledge of whether the subject was to receive treatment or not. This could produce systematic biases in otherwise random allocation. There is empirical evidence that concealment predicts effect size (concealment is associated with a finding of more modest treatment effects; see *Schulz et al. (1995), JAMA 273(5): 408-412).*	
4. The groups were similar at baseline regarding the most important prognostic indicators. [Explanation] This criterion may provide an indication of potential bias arising by chance with random allocation. Gross discrepancies between groups may be indicative of inadequate randomisation procedures.	no/yes
5. There was blinding of all subjects. [Explanation] Blinding of subjects involves ensuring that subjects were unable to discriminate whether they had or had not received the treatment. When subjects have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to placebo effects or Hawthorne effects (an experimental artifact in which subjects responses are distorted by how they expect the experimenters want them to respond).	no/yes
6. There was blinding of all therapists who administered the therapy. [Explanation] Blinding of therapists involves ensuring that therapists were unable to discriminate whether individual subjects had or had not received the treatment. When therapists have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to the therapists' enthusiasm or lack of enthusiasm for the treatment or control conditions.	no/yes
7. There was blinding of all assessors who measured at least one key outcome. [Explanation] Blinding of assessors involves ensuring that assessors were unable to discriminate whether individual subjects had or had not received the treatment. When assessors have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to the assessors' biases impinging on their measures of outcomes.	no/yes
8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups. [Explanation] It is important that measurements of outcome are made on all subjects who are randomised to groups. Subjects who are not followed up may differ systematically from those who are, and this potentially introduces bias. The magnitude of the potential bias increases with the proportion of subjects not followed up.	no/yes
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat". [Explanation] Almost inevitably there are protocol violations in clinical trials. Protocol violations may involve subjects not receiving treatment as planned, or receiving treatment when they should not have. Analysis of data according to how subjects were treated (instead of according to how subjects should have been treated) may produce biases. It is probably important that, when the data are analysed, analysis is done as if each subject received the treatment or control condition as planned. This is usually referred to as "analysis by intention to treat". For a recent discussion of analysis by intention to treat see Hollis S, Campbell F (1999) BMJ 319: 670-4.	no/yes
10. The results of between-group statistical comparisons are reported for at least one key outcome. [Explanation] In clinical trials, statistical tests are performed to determine if the difference between groups is greater than can plausibly be attributed to chance.	no/yes
11. The study provides both point measures and measures of variability for at least one key outcome. [Explanation] Clinical trials potentially provide relatively unbiased estimates of the size of treatment effects. The best estimate (point estimate) of the treatment effect is the difference between (or ratio of) the outcomes of treatment and control groups. A measure of the degree of uncertainty associated with this estimate can only be calculated if the study provides measures of variability.	no/yes

APPENDIX C:

CRITICAL APPRAISAL SKILLS TOOL- QUALITATIVE STUDIES

Screening Questions

1. Was there a clear statement of the aims of the research? Yes No
2. Is a qualitative methodology appropriate? Is it worth continuing? Yes No

Detailed questions

3. Was the research design appropriate to Write comments here address the aims of the research?

Sampling Yes No

4. Was the recruitment strategy appropriate Write comments here to the aims of the research?

Data collection Yes No

5. Were the data collected in a way that Write comments here addressed the research issue?

Reflexivity (research partnership relations/recognition of researcher bias)	Yes No
6. Has the relationship between researcher and participants been adequately considered?	Write comments here
Ethical Issues	Yes No
7. Have ethical issues been taken into consideration?	Write comments here
Data Analysis	Yes No
8. Was the data analysis sufficiently rigorous? Write comments here analysis and selection of data for presentation	
Findings	Yes No
9. Is there a clear statement of findings? Write comments here Value of the research	Yes No
10. How valuable is the research? Write comments here research may be used	Yes No

STATEMENT ABOUT OWNERSHIP AND OTHER PARTICULARS ABOUT INDIAN JOURNAL OF PHYSIOTHERAPY & OCCUPATIONAL THERAPY (See Rule 8)

1.	Place of Publication	:	Delhi
2.	Periodicity of Publication	:	Quaterly
3.	Printer's Name	:	Dr. Archna Sharma
	Nationality	:	India
	Address	:	407, Hawa Singh Block, Asiad Village, New Delhi - 110 049
4.	Publisher's Name	:	Dr. Archna Sharma
	Nationality	:	India
	Address	:	407, Hawa Singh Block, Asiad Village, New Delhi - 110 049
5.	Editor's Name	:	Dr. Archna Sharma
	Nationality	:	India
	Address	:	407, Hawa Singh Block, Asiad Village, New Delhi - 110 049
6.	Name & Address of Individuals	:	Dr. Archna Sharma
	Who own the newspaper and particulars of shareholders holding more than one percent of the total capital	:	407, Hawa Singh Block, Asiad Village, New Delhi - 110 049

I Dr. Archna Sharma, here by declare that the particulars given above are true to best of my knowlebge and belief.

Sd/-
Dr. Archna Sharma

Indian Journal of Physiotherapy and Occupational Therapy

CALL FOR SUBSCRIPTIONS

About the Journal

Print-ISSN: 0973-5666 Electronic - ISSN: 0973-5674, Frequency: Quarterly (4 issues per volume).

An essential journal for all Physiotherapists & Occupational therapists provides professionals with a forum in which to discuss today's challenges-identifying the philosophical and conceptural foundations of the practice; sharing innovative evaluation and treatment techniques; learning about and assimilating new methodologies developing in related professions; and communicating information about new practice settings. The journal serves as a valuable tool for helping therapists deal effectively with the challenges of the field. It emphasizes articles adn reports that are directly relevant to practice. The journal is internationally indexed and is also covered by Index Copernicus (Poland).

Subscription Information

Journal Title	Pricing of Journals		
IJPOT	Print Only	Print+Online	Online Only
Indian	INR 6000	INR 8000	INR 4500
Foreign	USD 400	USD 500	USD 300

Note for Subscribers

Advance payment required by Cheque / Draft in the name of **"Indian Journal of Physiotherapy and Occupational Therapy"** payable at New Delhi

Concellation not allowed except for duplicate payment.

Claim must be made within six months from issue date.

A free copy can be forwarded on request.

SEND REMITTANCE TO:

Dr. Archna Sharma, Editor

Indian Journal of Physiotherapy and Occupational Therapy

407, Hawa Singh Block, Asiad Village, New Delhi - 110 049 (India)

Tel. : 91-11-26493988 Mobile : 09891016710

Email : editor.ijpot@gmail.com Website : www.ijpot.com

Registered with Registrar of Newspapers for India
(Regd. No. DELENG/2007/20988)