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Contents

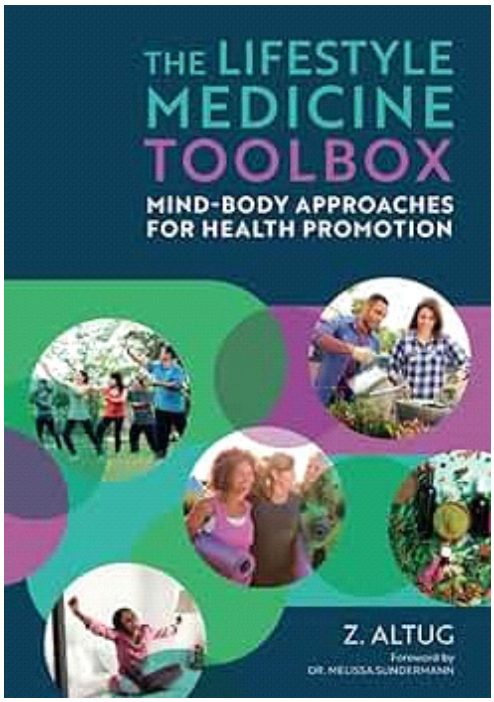
The Lifestyle Medicine Toolbox

Ziya Altug, PT, DPT, MS

Ziya Altug's *The Lifestyle Medicine Toolbox* is a comprehensive guide that bridges the gap between clinical concepts and practical patient care. This book is a valuable resource for healthcare and fitness professionals who are looking to integrate lifestyle medicine into their practice effectively.

Actionable and Practical Tips

One of the standout features of this book is its practicality. Altug excels at breaking down complex lifestyle medicine concepts into actionable steps that can be easily understood and implemented. This makes the book not only informative but also highly usable in real-world settings.



Comprehensive and Evidence-Based Exploration

The book delves into the key pillars of lifestyle medicine with a thorough and evidence-based approach:

- **Healthy Eating:** Altug demystifies the often overwhelming topic of nutrition with actionable grocery lists and practical eating tips. This approach makes healthy eating seem accessible and achievable for all.
- **Physical Movement:** The book offers detailed guidelines for adult fitness, including diverse exercise programs and plans that cater to various interests and preferences. This ensures that readers can find a physical activity regimen that works for them.
- **Mind-Body Movement:** Altug underscores the importance of mind-body techniques for pain management, introducing readers to Qigong, mindful walking, labyrinth walking, yoga, and more. These techniques are presented as essential tools for holistic wellness.
- **Stress Management:** Practical strategies for stress management, such as body scan meditation and pet therapy, are provided to help improve resilience. These methods are both simple and effective, making them accessible to a wide audience.
- **Quality Sleep:** The book offers valuable sleep management techniques, including pre-sleep routines and the use of weighted blankets, to enhance sleep quality and overall health.
- **Avoidance of Risky Substances:** Altug provides sensible alternatives to risky substances, promoting healthier choices without feeling punitive.
- **Connection and Community:** Practical social management strategies are discussed, emphasizing the importance of social connections in maintaining overall well-being.
- **Nature as Medicine:** Further strategies for holistic well-being are explored, such as gardening, soothing sounds, and biophilic design, reinforcing the book's opening theme.
- **Expressive Therapies and Healing Arts:** An unusual but welcome addition, this section covers the therapeutic use of writing, poetry, painting, music, and dancing, broadening

the scope of healing modalities beyond the conventional.

- **Self-Care Strategies:** The book explores both conventional and integrative therapies, providing a well-rounded perspective on self-care.

Tools for Healthcare Providers

For healthcare providers, the book offers practical tools, strategies, and techniques designed to create educational handouts and effective home programs using evidence-based resources. The self-care handouts are particularly useful, serving as comprehensive checklists that can be used directly with patients to ensure all essential aspects of lifestyle medicine are covered.

Conclusion

The Lifestyle Medicine Toolbox by Ziya Altug is an invaluable resource for those seeking to incorporate lifestyle medicine into their practice. With its actionable tips, evidence-based exploration, and practical tools, this book empowers healthcare and fitness professionals to deliver effective, holistic care. Whether you are a seasoned professional or new to the field, this book will enhance your ability to support your patients in achieving optimal health and well-being.

Case Series

https://doi.org/10.37506/cr12xg31

Effect of Perturbation Training and Dynamic Resistance Exercises in Patients with Grade II Knee Osteoarthritis: Case Report

Madhuripu P[1], M.Premkumar[2], Aishwarya Nitin Sonwane[3], Kamalakannan R[4], Arun Krishnan[5]

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Abstract

Osteo Arthritis of the knee manifests as stiffness, mobility restriction, and difficulty with daily activities. Perturbation training, a method for fostering the growth of motor abilities, whereas resistance training improves physical function, reduces OA pain, and lowers self-reported disability. This study is to analyze and understand the effect of perturbation training and dynamic resistance exercise training on muscle strength and knee extension range of motion in grade II knee osteoarthritis. Grade II Osteoarthritis knee patient was recruited for this study. 20 sessions of perturbation training with dynamic resistance exercises for the affected knee joint for 30 minutes, session with 5 sessions per week were given. Pre and Post Intervention values of muscle strength of 1 Repetition Maximum for knee extensor and knee extension range of motion was taken and analyzed. This case study results had shown significant improvement in the outcome of muscle strength in 10 RM and knee extension ROM after the combined intervention of perturbation training and resistance exercise for Grade II OA Knee Patients. Thus this study may be concluded that there was a significant improvement in knee extensor muscle strength (1 RM) in the affected knee joint in a patient with grade II knee osteoarthritis after combined intervention perturbation training and dynamic resistance exercises.

Keywords: Grade II OA Knee, Perturbation Training, Resistance Exercise, 10 RM, Knee extension ROM.

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Introduction

Osteoarthritis is a degenerative arthritis and a diverse group of conditions that produces joint signs and symptoms which are linked to deterioration of articular cartilage, apart from bone and at the joint margins deteriorations[1]. Although joint wear and tear is the most common cause, inflammatory, metabolic, and mechanical factors can also contribute to degenerative joint disease. Numerous environmental factors, such as profession and associated traumas, can start different disease processes.[2]

The severity of the condition might vary, but it typically affects stressful joints and results in articular cartilage damage, subchondral bone remodeling, the development of osteophytes, and subchondral cysts.[3]

Knee osteoarthritis is a common disorder in elderly adults that causes substantial functional restrictions and hardship. Physical limitations related to OA in the knee also include pain, loss of motion, and decreased quadriceps muscle strength.[3]

Secondary OA is characterized by a slow loss of cartilage in the joints, followed by restoration and bone thickening, and develops as a result of trauma, obesity, or inflammatory joint issues.[4]

Perturbation techniques are excellent techniques in patients with knee OA. The intensity should be minimized to nullify stress on knee joint structures, whose outcomes are pain, edema, and inflammatory changes. Perturbation training, a method for fostering the growth of motor abilities that guard against damaging knee stress, promotes knee stability and balance in a controlled way for the purpose of rehabilitation.[5,6.]

Perturbation improves proprioceptive impulse propagation to the muscle, decreasing injury and boosting performance. Perturbation exercise training is intended to stress the neuromuscular system, which helps with balance and daily functions.[7] Resistance training (RX) improves physical function, reduces OA pain, and lowers self-reported disability [8,9,10] Resistance exercises (RE) stand out among the many different forms of workouts, and their effectiveness necessitates special consideration.[12,13]

Since muscle weakness is the primary OA symptom, RE treatments have recently been advised.[14] Thus, there is sufficient evidence to support the benefit of muscle strength training methods in slowing disease development.[15]

Research article in 2012 **s**tated that dynamic exercise with resistance play an important role in treating the pathological mechanisms of knee joint osteoarthritis, added strength and power of the extensor muscle activation of muscle related to balance and pathomechanics and loading in cartilaginous structures. Dynamic resistance exercises can be modified based on symptoms and instruments.[16]

Lot of research work has been done and available to disclose the effectiveness of perturbation training and dynamic resistance exercise to improve the condition of osteoarthritis of the knee joint. But at the same time there are very limited study and publications are available on the combination of both these techniques in the functional outcome grade II osteoarthritis of the knee joint.

OBJECTIVE OF THIS STUDY:

To analyze and understand the effect of perturbation training and dynamic resistance exercise training on muscle strength and knee extension range of motion in grade II knee osteoarthritis.

Methodology

It is a single case study. A 52 – year – old male patient was diagnosed grade II Knee Osteoarthritis based on X ray of the knee joint of the patient (Kellergen Lawrence Classification) (Figure 1) by Orthopedic Physician referred to Abhinav Physiotherapy and Rehabilitation Centre for physiotherapy intervention. His demographic profile was undertaken including vitals and BMI. Patient's informed consent was taken. His pain in VAS, Muscle strength in 1 Repetition Maximum (1RM), Knee Extension Range of Motion was measured and documented for analysis (See Table 1). He has been recruited for treatment. He had been given perturbation training and dynamic resistance exercise training for 30 minutes a session, 4 sessions for a week for 4 weeks.

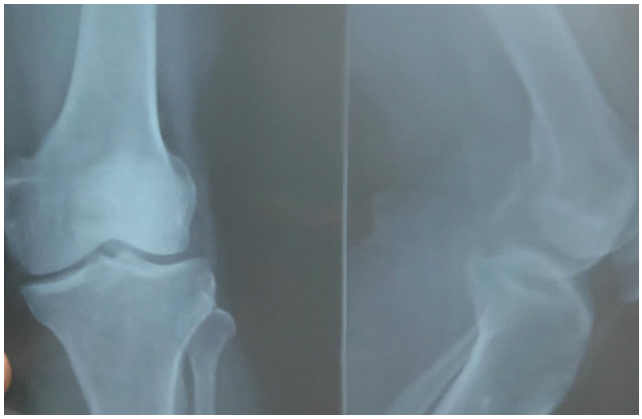

Figure 1: Grade II Osteoarthritis of Knee Joint (Source: Author)

Intervention Procedure:

Perturbation Training: A perturbation is a small change in a movement. Participants stood on a foam surface with single leg support while the therapist attempted to perturb the participants balance in various directions. Participants stood on the wobble board with double limb support and the therapist applied perturbations of the wobble board in a random fashion. After 10 to 30 seconds of perturbations on each leg, the patient switched feet and the technique were repeated. It will be done for a 30 minutes after a session of 30 repetitions. Double leg foam balance activity, Tilt board balance training, Roller board (See Figure 2)[17, 18]

Dynamic Resistance Exercises for Knee Extension: Dynamic resistance exercise is a technique, load and repetition structure with guidance of progression is a suitable alternative for patients with knee osteoarthritis. Dynamic resistance exercises were given by using weight cuffs. Patients 10 RM will be measured. 3 sets of 10 repetitions with 5 – 10 seconds held as instructed by the therapist will be given to the patients. 16 sessions of dynamic resistance exercise with perturbation training will be given to the patients of experimental group (See Figure 3).[12,13,19]

Figure 2: Subject performing perturbation training for knee joint in balance board (Source: Author)

Figure 3: Subject performing dynamic resistance exercise for knee joint in balance board (Source: Author)

Outcome measures:

Knee extensor muscle strength in 1 Repetition Maximum (1 RM) and knee extension range of motion were measured pre and post intervention in a combination of perturbation training and dynamic resistance exercise training to the patient.

Table 1: Outcome Measures (Source: Author)

Intervention	1 RM (in Kgs)	Knee extension Range of Motion (in degrees)	Visual Analogue Scale for Pain
Pre Intervention	10 Kgs	-10	9
After 1 Week	10 Kgs	-10	8

Continue.....

After 2 Weeks	12 Kgs	-8	7
After 3 Weeks	13 kgs	-8	5
Post Intervention (After 4 Weeks)	13 kgs	-5	5
Follow up 1 (After 8 Weeks)	14 Kgs	-5	4
Follow up 2 (After 20 Weeks)	14 Kgs	-5	4

Data Analysis and Results

Pre intervention, after 1 week, 2 weeks, 3 weeks, 4 weeks, and follow-up 1 (after 12 weeks), follow-up 2 (after 20 weeks) Measurements were taken for analysis. There was significant improvement in both outcome measures of 1 RM and knee extension range of motion progressively. In follow-up 1 and 2 after 12 and 20 weeks, respectively, improved 1 RM and knee extension range of motion was maintained (See Table 1)

The data analysis and results of this study demonstrate that there is uniformity of pre-intervention factors of extensor muscle strength and knee extension lag range. The improvement is a significant improvement in the strength of extensor muscle and knee extension lag range.

Discussion

Implementing rehabilitation regimens for knee OA patients using perturbation training methodologies increases therapeutic success by allowing patients to return to higher activity levels in less time. Although it is difficult to declare perturbation training approaches may assist patients to build and alter neuromuscular control mechanisms, allowing for functional performance (higher levels) than would otherwise be possible. A method of physical therapy comprising perturbation exercises was well tolerated in a symptomatic knee OA group .In comparison to other physical therapy or medicinal techniques; it was also linked to better pain, function, and balance, as well as falls.[17]

This study's findings showed that perturbation training improves the functional outcomes of muscular strength and knee extension lag in people with OA knees. Several recent research have also published comparable findings.[18,19] The results of this study demonstrate that when completing dynamic resistance exercise training and perturbation training in OA knee patients, there is a significant increase in the strength of the knee extensor muscles and extension lag range. The upshots of this study propose that combination perturbation training and dynamic resistance exercise increases knee joint functional outcomes in the form of knee extensor muscle strength and extension lag range, as well as boosting knee balance through proprioception and kinesthetic awareness, as reported in some recent studies.

Conclusion

There was significant improvement in muscle strength (1 RM) and knee extensor muscle strength in the affected knee joint in a patient with grade II knee osteoarthritis after combined intervention perturbation training and dynamic resistance exercises for knee joints for 16 sessions within the span of 4 weeks. Perturbation training will be preferable intervention for grade II knee osteoarthritis, because of perturbation training improves proprioceptive impulse propagation to the muscle, decreasing injury and boosting performance.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT:

Author a: Conceptualization, Formal Analysis, Methodology, Writing – Original Draft, Project Administration.

Author b: Conceptualization, Investigation, Writing – Original Draft, Writing – Review and Editing, Investigation, Project Supervision.

Author c: Formal Analysis, Data Collection, Methodology, Investigation.

Author d: Formal Analysis, Data Collection, Methodology, Investigation.

Author e: Formal Analysis, Data Collection, Methodology, Investigation.

CONFLICTS OF INTERESTS: There are no reported conflicts of interests.

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Review Article

https://doi.org/10.37506/p3095r09

Effects of McKenzie Exercise and other Treatment Techniques in Reducing Pain & Disability in Chronic Nonspecific Low Back Pain

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Abstract

Background: Low back pain (LBP) is rising globally due to increase in population and ageing. In adults below 45 years of age, work-related injury leads to nonspecific pain resulting in disability. Exercise therapy has proven to be effective in reducing pain and associated disability in these patients. McKenzie exercises focus on repeated end-range movement and posture correction, thereby reducing pain and disability. This study aims to compare the effectiveness of McKenzie exercise with other techniques in reducing pain and disability in nonspecific chronic LBP (NSCLBP).

Objectives: To compare the effect of alternate treatment approaches and McKenzie exercises in nonspecific chronic low back pain.

Methods: Studies that satisfied the inclusion and exclusion criteria for the review were found by searching databases like Google Scholar, Pub Med and Cochrane CENTRAL. This study comprised randomized controlled trials that compared McKenzie treatment with other therapeutic approaches for treating NSCLBP. Two independent reviewers extracted the data and evaluated the trials' quality. Forest plots were used to display the results.

Results: Eleven full-text articles were included in this study for review in order to conduct a meta-analysis and qualitative analysis. The meta-analysis of pain and functional impairment related to back pain comprised ten studies each. When comparing patients undergoing McKenzie treatment to other treatment techniques, there was a slight overall decrease in the intensity of low back pain (SMD: -0.83 [95% CI: -1.11, -0.55], I^2= 80.8%; p< 0.000). After doing McKenzie exercises, low back patients' functional impairment did not improve in comparison to other therapy methods (SMD: 0.07 [95% CI: -0.54, 0.68], I^2= 71.5%; p< 0.000).

Conclusion: McKenzie exercise is equally effective to other manual therapy techniques but slightly effective than passive treatments in decreasing pain & disability in NSCLBP.

Keywords: Low back pain, Nonspecific low back pain, McKenzie exercises in low back pain, manual therapy for chronic low back pain.

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Introduction

Low back pain (LBP) impacted 619 million people worldwide in 2020. It is predicted that by 2050, the number of cases will rise to 843 million, mostly due to aging and population growth. The majority of cases occur in the 50–54 age bracket, with the prevalence rising up to 80 years of age.[10,21] In India, the cumulative, yearly, and pooled point prevalences of lower back pain are 48%, 51%, and 66%, respectively.[19] The number of years spent as disabled is on the rise particularly in low- and middle-income nations. LBP has been linked to smoking, obesity, sedentary work, and low socioeconomic level.[20]

Pain between the buttock and lower edge of the ribs is referred to as low back pain, and it can be classified as acute, sub-acute, or chronic depending on how long it lasts. Acute pain lasts less than four weeks, sub-acute pain lasts more than four but less than twelve weeks and if pain lasts for more than 12 weeks it is chronic LBP.[10,16] LBP without any recognized anatomical aetiology is known as non-specific LBP (NSLBP).

It is one of the most common causes for disability in people under 45 and is typically linked to work-related injuries.[4] It is a non-malignant disorder that frequently resolves on its own. Patients look for therapeutic interventions to lessen the severity of their symptoms.[14]

For non-specific low back pain, guidelines suggest using physical exercise and non-pharmacological, non-invasive treatment. In order to rule out major diseases, patients should be checked for warning signs and undergo diagnostic testing. For worse results, psychosocial risk factors (yellow flags) should be evaluated. Exercise is thought to be beneficial for those with subacute or chronic LBP but useless for those with acute LBP. Through therapy, tertiary prevention of LBP seeks to lessen the detrimental effects of pain, disability, and functional loss.[16] According to a recent meta-analysis, exercise reduced the risk of LBP by 33% when done alone. Exercise is now the first line of treatment for NSCLBP and needs to be done regularly. In patients with persistent low back pain, a regular exercise program improves balance and decreases pain and impairment.

In a recent meta-analysis of the literature, it was discovered that McKenzie exercises were more effective than other rehabilitation techniques in reducing pain and functional disability in people with CNSLBP.[20]

Several randomized controlled trials (RCTs) have investigated the comparative effectiveness of different manual therapy interventions for LBP, including the McKenzie Method, orthopaedic manual therapy, and other exercise-based approaches. These trials have assessed various outcomes, including pain intensity, functional status, and disability, to provide evidence-based guidance for clinical decision-making in LBP management. Given the growing body of literature on manual therapy interventions for LBP, there is a need for comprehensive synthesis and analysis of the available evidence to guide clinical practice and inform future research directions. Therefore, this meta-analysis aims to systematically review and synthesize the findings of relevant RCTs to provide a comprehensive assessment of the effectiveness of the McKenzie Method and other manual therapy interventions for LBP.

Method

PRISMA (Preferred Reporting Items of Systematic reviews and Meta-Analysis) criteria were followed in the preparation of the protocol, which was then registered at the International Prospective Register of Systematic Reviews (PROSPERO) with Registration ID 512087.

Search strategy

The study comprised randomized controlled trials that examined the efficacy of McKenzie and other physical therapy approaches for NSCLBP. Numerous clinical trial registries, including Google Scholar, PubMed-MEDLINE, and the Cochrane Central Register of Controlled Trials (CENTRAL), have been searched for this review. Clinical trials, experimental, preclinical, comparative, case reports, case series, reviews, commentary, quasi-experimental, observational, with case controls, cohorts, correspondence to the editor, conference abstracts, editorials, methodological papers, dissertations, and studies were not included in this review. MeSH terms and key terms were used to find the studies.

Participants

Inclusion criteria:

a. Only RCTs that examine the effects of McKenzie exercise in treating NSCLBP were selected.

b. Studies with participants over 18 years old and less than 80 years who suffered from NSCLBP for more than three months.

c. Patients who could comprehend native language were included in the study.

Exclusion Criteria:

a. Patients suffering from any kind of congenital, neurological, cardiovascular, psychiatric, or gynaecological disorder.

b. LBP with particular cause (disc herniation, trauma, nerve root injury)

c. Patients with spinal or lower-limb surgery.

d. Patients suffering from spinal deformities, cancer, or autoimmune diseases.

Interventions

The trials were assigned either to a control group or an experimental group. The experimental group received McKenzie exercises and control group received any one -segmental stability, mobilization, Pilates exercises, or motor control exercises

Primary outcomes

The main findings were

i) intensity of pain (MPQ, NPRS, VAS)

j) functional disability (RMDQ, FSQ, ODI, FRI).

Screening and reviewing of studies

Zotero software was used to eliminate duplicates after searching the databases. Independently, two reviewers (RR, SS) went over the abstracts and titles of the studies that were chosen from the database search. We discovered and extracted the publications that qualified for a full text review. After conducting independent reviews, we (RR, SS) chose which full-text articles to include. Any difference during the process was settled through conversation between the reviewers (RR, SS). The articles that satisfied the inclusion and exclusion criteria served as the foundation for creating the final list.

Data collection and extraction

Using Microsoft Excel (Version 2021), a data extraction form (DEF) was created, and the necessary data was recorded. This table contained information about the study's design, sample size, mean age, back pain score at baseline and at the end of treatment, functional disability score at baseline and at the end of treatment, tools for measuring pain intensity and functional disability, and study specifics like author name, journal, and year of publication. From the included studies, the reviewers (RR, SS) independently collected information on the number of participants, the intensity of the pain (mean, standard deviation), and functional disability (mean, standard deviation). [Table 1]

Table 1: Basic characteristics of included studies

Sl No.	Journal Name	Author	Study Design	Study Setting	Partici-pants	Intervention	Outcome	Findings
1	The New England Journal of Medicine	Cherkin et al (1998)	RCT	Group Health Cooperative of Puget Sound, Washington	• 321	• McKenzie group for 1month (n=133) • Manipulation group (n=122) • Booklet group (n=66)	• Botherness of symptoms • Patient's ability to function (Roland disability scale)	The McKenzie method and chiropractic manipulation had similar effects and were mariginally better than education booklet.

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2	The Journal of Manual & Manipulative Therapy	Schenk etal (2003)	RCT	Hospital-based outpatient clinic, western New York state	• 25	• McKenzie group (n=15) • Mobilization group (n=10) • Postural correction & ambulation on treadmill for 20 minutes for both groups with 5 sets of 10 repetitions of exercise or mobilization for 3 visits	• Pain (VAS) • Perceived level of function (Oswestry Low Back Pain Disability Questionnaire)	McKenzie exercises were more beneficial in reducing pain and in recovery of function than mobilization in early stages of recovery.
3	The Journal of Manual & Manipulative Therapy	Miller (2005)	RCT	Outpatient Physical therapy clinic, New York	• 30	• McKenzie group (n=15) for 6weeks • Stabilization group (n=15) for 6weeks • Patients prescribed 10-15 mins of home exercises	• Pain (short-form McGill Pain Questionnaire) • Disability (Functional status questionnaire) • SLR test	Both groups demonstrated improvement in pain scores and disability. No statistical improvement between groups noted.
4	Journal of Rehabilitation Medicine	Paatelma etal (2008)	RCT with 1year follow-up	Occupational health care centre, Finland	• 134	• McKenzie (n=52): maximum 7 sessions of 30-45min each • Orthopedic Manual therapy (n=45): maximum 7 sessions of 30-45 mins each • Advice-only (n=37): 1 session of 60mins	• Pain (VAS) • Disability (Roland-Morris Disability Questionnaire)	No differences between OMT & McKenzie groups in pain and disability-scores.
5	Spine	Petersen (2011)	RCT	Pimary care specialist center, Copenhagen, Denmark	• 350	• McKenzie group (n=175) • Manipulation group (n=175) • Exercises to continue at home or gym for minimum 2 months after completion of treatment.	• Pain • Disability (Roland Morris Disability Questionnaire, Danish version)	McKenzie method slightly better than manipulation when used with advise & information

Continue.....

6	Physical Therapy	Garcia etal (2013)	RCT	Outpatient Physical therapy clinic, Brazil	• 148	The 4-week treatment program (one session/week) • Back School (n=74) group exercises • McKenzie (n=74) individually exercises • The participants also were instructed to perform a daily set of home exercises.	• Pain (Numeric Pain rating Scale) • Disability (Roland-Morris Disability Questionnaire) • Quality of life (World Health Organization Quality of Life–BREF instrument	Greater improvement in disability at 1month in McKenzie group.
7	Journal of Physical Therapy Science	Hosseinifar (2013)	RCT	Physiotherapy clinic, School of Rehabilitation, Tehran University of Medical Sciences, Iran	• 30	• McKenzie group (n=15) • Stabilization group (n=15) 18 sessions for both groups performed 3 times per week for 6 weeks	• Pain (VAS) • Disability (Persian version of Functional Rating Scale) • Ultrasound imaging (TrA & MF muscle thickness)	Stabilization exercises are more effective than Mc Kenzie exercises in decreasing pain & disability scores
8	International Journal of Prevention and Treatment	Kuppusamy (2013)	RCT	Modern Physiocare Rehabilitation Centre, Hyderabad	• 30	• McKenzie group (n=15) 2 sessions of 50-60 mins per week for 6 weeks • Mat based Pilates exercise (n=15) 2 session of 60 minutes each twice a week for 6 weeks	• Pain intensity (NPRS) • Functional Disability (Roland-Morris disability questionnaire) • Trunk flexion & extension (Modified Schober's index)	Both treatments equally effective but McKenzie group demonstrated more patient satisfaction (statistically significant)
9	Journal of Back and Musculoskeletal Rehabilitation	Murtezani etal (2015)	RCT with 3month follow-up	OPD at Deptt of Physical & Rehabilitation medicine, Obiliq	• 271	• McKenzie (n=134) 30-45 min sessions for 4 weeks (maximum seven sessions) • Electrophysical agents (n=138) 50 mins session for 4 weeks (10 sessions)	• Pain (VAS) • Functional disability (Oswestry questionnaire)	McKenzie reduces pain & disability. It is more effective than EPA group.

10	Journal of Orthopedic& Sports Physical Therapy	Halliday (2016)	RCT	Physiotherapy department of Concord Repatriation General Hospital, Sydney	• 70	• McKenzie exercises (n=35) • Motor Control Exercise (n=35) daily home exercise for 30 mins; clinic visit twice a week for 4 weeks & once per week for next 4 weeks	Primary outcome Ultrasound images for recruitment of trunk muscles. Secondary outcomes • Patient's perception of function (Patient-specific Functional scale) • Global improvement (Global perceived effect questionnaire) • Pain intensity (VAS)	Greater improvement in perceived recovery in McKenzie group. No significant improvement in deep trunk muscle recruitment in either groups.
11	Indian Journal of Palliative Care	Dehkordi (2017)	RCT	Physiotherapy Clinic in the School of Rehabilitation of the Shahrekord University of Medical Sciences, SouthWest Iran	•36	• McKenzie group (n=12) • Pilates (n=12) • Control (n=12) 18 sessions with 3 sessions per week for weeks	•Pain (McGill Pain Questionnaire)	McKenzie and Pilates, both treatment reduced pain but general health improved more with Pilates.

Assessment of risk of bias in included studies

The risk of each study was evaluated using Cochrane risk-of-bias tool for randomized trials (RoB2) 2.0, based on criteria that were separately defined by the two reviewers.[11] Based on the criteria provided in the Cochrane handbook, studies were classified as low risk, some concerns, or high risk. Any difference was settled by mutual conversation between the two reviewers or by involving a third assessor.

Statistical analysis

The forest plots, Cochrane-Q test and I^2 statistic were inspected to assess heterogeneity between the studies. Heterogeneity was considered if I^2 value was greater than 50% or Cochrane- Q >0.1. Heterogeneity was graded as low, moderate, and high for I^2 values of 25%, 50%, and 75%. In case of heterogeneity, random effect model was used. The sources of the heterogeneity were explored by sensitivity analysis according to the risk of bias of included studies. Statistical analyses were performed by Strata version 13 software. Two-sided P 0.05 was considered statistically significant except for the sub-group analysis and heterogeneity test, in which P value of 0.10 was considered significant.

To evaluate the degree of heterogeneity among the studies, I^2 statistic, forest plots, and Cochrane-Q test were examined. I^2 value more than 50% and Cochrane-Q larger than 0.1 were regarded indicators of heterogeneity. Heterogeneity at 25%, 50%, and 75% I^2 values was categorized as low, moderate, and high. The random effect model was applied in the situation of heterogeneity. By using sensitivity analysis, the sources of the heterogeneity were investigated in relation to the included studies' risk of bias. The statistical studies were carried out using the software Strata version 13. With the exception of the sub-group analysis and heterogeneity test, when a P value of 0.10 was deemed significant, two-sided P 0.05 was regarded as statistically significant.

Results

After 51 articles in total were searched across several databases, 17 of them were determined to be suitable for full-text selection. In the qualitative and quantitative synthesis or meta-analysis, only 11 papers were included since they satisfied the inclusion and exclusion criteria.

Outcomes

1 Pain intensity

Of the eleven articles, pain was assessed in ten articles, wherein 6 articles used visual analog scale (VAS), 2 studies each used numerical pain rating scale (NPRS) and McGill Pain Questionnaire (MPQ) for pain evaluation. When compared to other treatment, patients undergoing McKenzie exercise had significant decrease in pain severity. (SMD: -0.83 [95% CI: -1.11, -0.55], $I^2 = 80.8\%$; $p < 0.000$). [Figure 1]

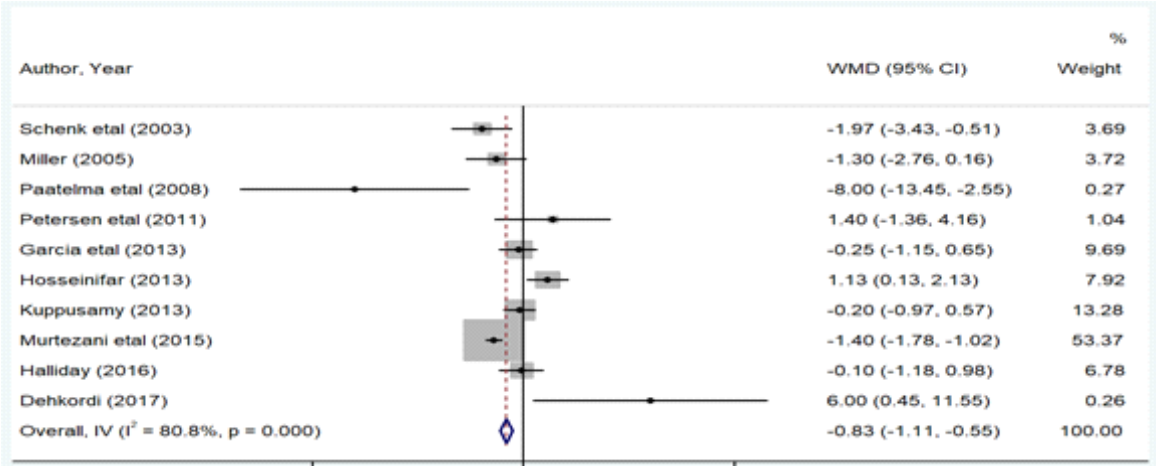

Figure 1: Meta-analysis of McKenzie exercise on intensity of pain

2. Functional disability

Ten articles evaluated functional disability; five of them used the Roland Morris Disability Scale (RMDQ), two used the Oswestry Disability Index (ODI), and the remaining three used the Functional Status Questionnaire, the Patient Specific Functional Scale, and the Functional Rating Index. After doing McKenzie exercises, low back patients' functional impairment did not improve in comparison to other therapy techniques. (SMD: 0.07 [95% CI: -0.54, 0.68], $I^2 = 71.5\%$; $p < 0.000$). [Figure 2]

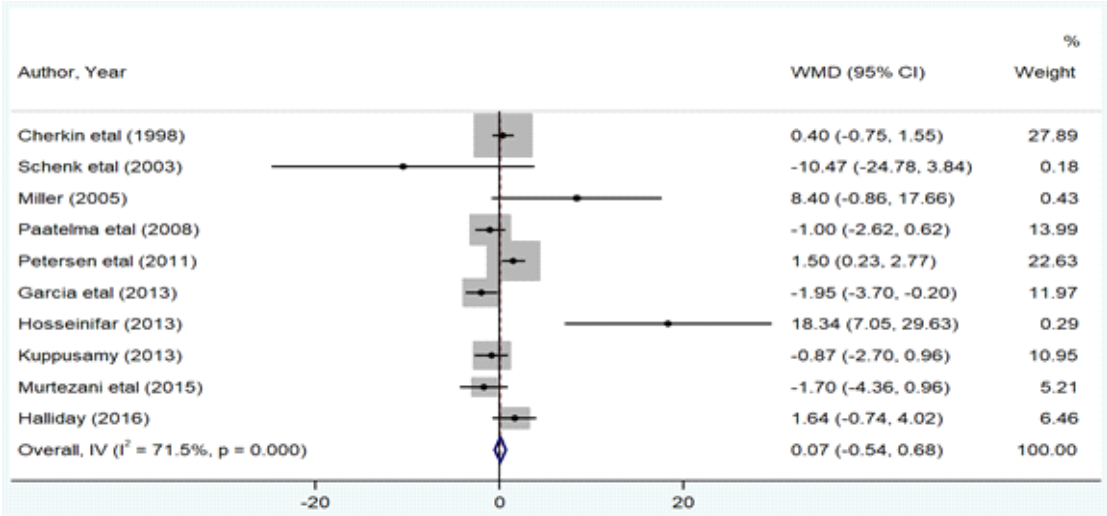

Figure 2: Meta-analysis of McKenzie exercise on functional disability

Risk of bias assessment

Figure 3 describes the risk of bias assessment for the papers that are part of this meta-analysis. Six of the 11 included studies had low risk of bias, whereas the remaining five studies had some concerns or high risk in composite evaluation. All of the studies used random allocation in accordance with the Cochrane criteria, however five of them went into great depth on the allocation concealment technique. Due to the intention-to-treat approach used in the majority of studies, bias resulting from missing data has been addressed. The majority of the eleven investigations raised issues with the significant likelihood of bias in participant, experimenter, and outcome assessment blinding. Therefore, overall risk of bias is some concerns in this study. [Figure 3]

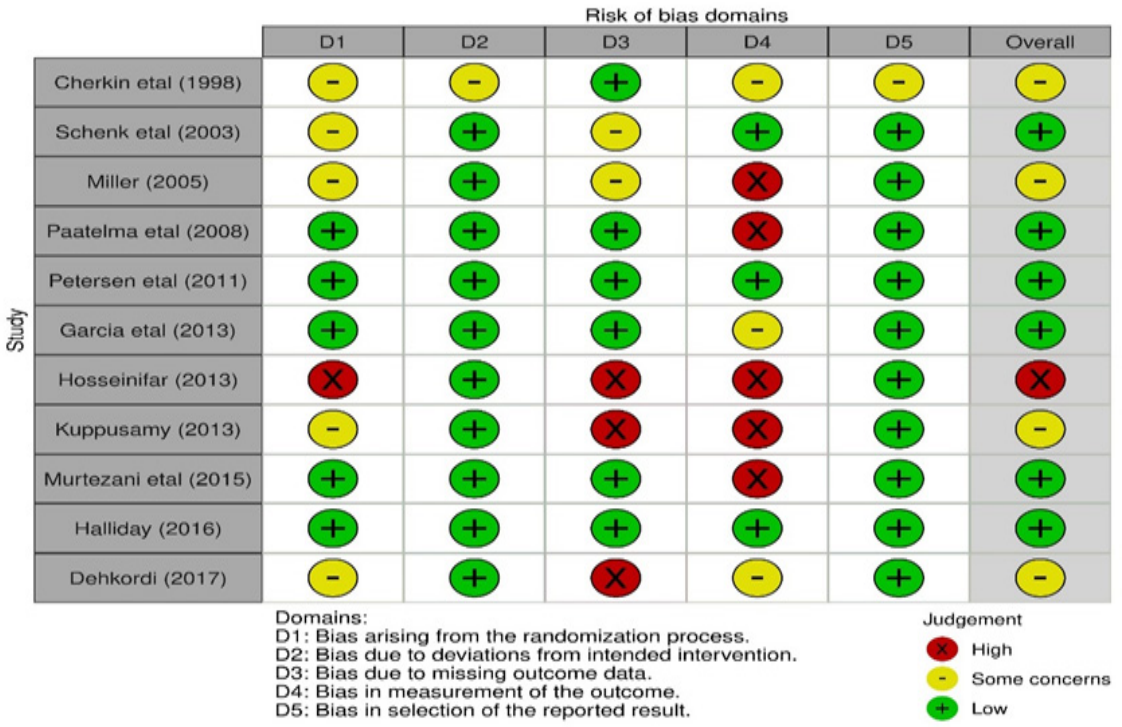

Figure 3: Risk of Bias summary of individual studies

Discussion

To determine if McKenzie exercises are superior to alternative treatment plans in terms of lowering pain and functional impairment in people with NSCLBP, a total of 11 RCTs were examined in this investigation. The Cochrane risk-of-bias instrument for randomized trials (RoB2), version 2.0, has been utilized to assess each article's bias.

We conclude that a 4–6-week McKenzie exercise training is effective in reducing pain intensity when compared to other alternatives for the treatment of nonspecific low back pain. But for functional disability the other treatment techniques fare better or they are equally effective to McKenzie exercises. This result is consistent with studies that have compared McKenzie with other manual therapy techniques where both techniques yielded similar results. Hosseinifar concluded that pain decreased in both McKenzie and spinal stabilization group but disability reduction was significant in stabilization group. As there were no changes in seen in abdominal muscle thickness post- McKenzie treatment, posture correction resulting from repeated or sustained posture might have resulted in pain reduction.[8]

Pergolizzi and Paatelma concluded concluded in their review that both McKenzie & intensive strength training or manual therapy had similar results in terms of pain relief and disability.[15,16] In their comparative trial, Kuppusamy & Dehkordi concluded that Pilates was as effective as McKenzie exercise. There was improvement in all outcomes but pain index was statistically significant. Moreover, patient satisfaction

with McKenzie was better than Pilates because of "hands-on"' approach.[7,9] Halliday also observed that participants who got the McKenzie approach had a better sense of perceived recovery compared to those who received motor control exercises, even though pain and function scores were not statistically different.[6]

It has been demonstrated that the relief of pain in the McKenzie group is due to the pain control theory of gating mechanism.[9] McKenzie approach for treating low back pain utilizes repeated movement, which could possibly lead to decrease in pain.[18]

The authors discovered that improvements in trunk range of motion in every manual therapy group are associated with improvement in trunk range of motion. Petersen concluded that in both the treatment techniques, McKenzie method and spinal manipulation it was intended to mobilize intervertebral spinal joints. Since both treatments are likely to influence the same pain mechanism, it might explain the relatively modest difference between treatments.[17]In his pilot study, Bid discovered that while McKenzie exercises are beneficial in lowering pain, pain sensitization, disability, and fear avoidance beliefs, they do not increase the endurance of the trunk flexors and extensors in NSCLBP patients.[2]Researchers have found that McKenzie is more effective in decreasing pain and disability as compared to passive treatment like electrophysical agents or advice-only treatment in their study respectively.[7,13,15]

The limitation of present study is that a sub-group analysis for heterogeneity was required. Publication bias for pain and functional disability has not been done. The studies with different follow-up time points have been included which may resulted in higher heterogeneity. Studies included have seen short term effect of McKenzie whereas some studies report better results with long term McKenzie therapy, thereby explaining statistically insignificant improvement with other manual therapy techniques. Major issue with all studies is that complete blinding is difficult, thus compromising on reliability and generalizability.

Conclusion

When compared to similar manual therapy interventions, McKenzie exercises are as successful in reducing pain and functional impairment scores in 4- to 6-week interventions, but they outperform passive therapies in this regard. **We need articles that have long term intervention of McKenzie or similar intervention time.**

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Original Research

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Vertebral Column Height and Predisposition to Low Back Pain: Observational Study

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Abstract

Background and purpose: Research was done to find out the relationship between lumbar lordosis and radiologic variables, lumbar lordosis and clinical variables, which showed that lordosis itself, do not have any predisposition to low back pain. Weak abdominal muscles are also associated with low back pain. As no previous study was done to correlate vertebral column height and low back pain, this study is intended to analyze whether these variables are predisposed to low back pain.

Case description (Subjects): 200 subjects were approached through systematic convenient sampling which included 100 people (50 males and 50 females) with back pain and 100 people (50 male and 50 female without back pain).

Intervention and methods: Subjects for the study were assessed according to the following parameters; vertebral column height, abdominal girth measurement, bilateral SLR, hip waist ratio, VAS scale.

Results: Pain scores correlated significantly to the length of spinal segment mainly cervical spine (p=0.05) and lumbar spine (p=0.01) and also to bilateral SLR hold time (p=0.01). The bilateral SLR correlates significantly to a Total spine length and length of thoracic spine (p=0.01) while there was no correlation between bilateral hold time and length of cervical spine.

Conclusion: This study has found that the length of the spinal column should be given due importance when assessing the risk of developing low back pain.

Keywords: Vertebral column, Low back ache, VAS score, Bilateral SLR.

Introduction

Back pain including neck and lower back pain is common. So it was deemed necessary to reevaluate in depth using more stringent criteria in the evaluation, treatment efficacy as well as for causality and diagnosis.

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The majority of spinal dysfunction is the result of cumulative micro trauma caused by impairments in alignments in stabilization and in movement patterns of the spine. When this dysfunction occurs, the major objective is the identification of the direction of a ligament, stress of movement of the spine that consistently elicits and increases the patient's symptoms.

Movement follows the principle of "law of physics" which states that movement takes place along the resistance. Since the vertebral column is a multi segmented system, the greatest degree of motion occurs at the most flexible segment. Thus most spine dysfunction occurs because of excessive relative flexibility, particularly at specific segment rather than at the segment of reduced flexibility. Once the appropriate trunk muscles control and lower extremity muscle flexibility are achieved, most often back pain subsides without direct treatment to spine itself.

The ideal skeletal alignment used as a standard is consistent with sound scientific principles, involves a minimal amount of stress and strain and is conductive to maximal efficiency of the body. Basmajjaiin states "Among mammals, man has the most economical of antigravity mechanisms, once the upright posture is attained. The Expenditure of muscular energy of what seems to be a most awkward position is actually extremely economical.[6]

The curvature of the vertebral column increases its resistance to axial compression faces. Engineers have shown that the resistance of a curved column is directly proportional to the square of the number of curvatures plus one. The significance of the curvatures can be quantified by the Delmas Index, which can only be measured on a skeleton.

A column with normal curvature has an index of 95 with the limit of normality ranging from 94-96. A column with exaggerated Curvatures has an index smaller than 94 signifying a marked difference between the height of the column and its fully extended length.

On the contrary, a column with attenuated curves i.e. almost straight has an index greater than 96. This anatomical classification has functional significance as Delmashas shown that the column with pronounced curvatures is of the dynamic type, while the columns with attenuated curvatures correspond to the static type. Stabilizing the lumbar spine is an important part of rehabilitation program for the patient with low back pain.

All abdominal muscles have relatively unique role in producing the necessary level of stabilization, and the participation of their muscles needs to be balanced. The patient whose abdominal muscle test at 60% to 70 % of normal strength has sufficient strength to perform most daily activities safely. The focus of a program for this patient is the control of pelvic and trunk motion.

To calculate where the excess fat collects on your body waist hip measurement should be calculated.

1. Find a non-stretchable tape measure.
2. Measure the circumference of your waist between the rib cage and the navel.
3. Measure the circumference of your hip around the buttocks.
4. Divide the Waist measurement by the Hip measurement.

(Wilmore and behnke 1969)

Waist to hip ratio	Desirable	Health risk
Woman	Less than .80	.80 and above
Men	Less than 1.0	1.0 and above

Low back pain is multi-factorial in its nature and spinal congruity as well as other radiographic finding might explain a part of it. Using recent instruments for pain assessmentsratherthanour4-grade scale should elucidate the influence of spinal congruity on symptomatology in the future.14

METHODS OF COLLECTION OF DATA

The subjects for the study were selected by systematic convenient sampling. There were 200 subjects with 100 experiencing low backache and100 without low backache. Both groups were assessed according to the following parameter.

- Vertebral column height
- Abdominal girth measurement
- Bilateral SLR-300
- Hip-waist ratio
- Visual analogue scale (VAS)

INCLUSIONCRITERIA

- Age group18-25 with or without back pain
- Both sexes 45

EXCLUSIONCRITERIA

- Malignancy
- Inflammatory condition (TB, Osteomyelitis.)
- Spinal cord compression
- Fracture
- Ankylosing
- Spondylitis

Methodology

- Patient consent was taken. A detailed assessment was obtained which includes:-
- Vertebral column height
- Abdominal girth measurements
- Bilateral SLR
- Hip waist ratioVAS

The subjects were made to stand on a firm base and with an inch tape segmental dimension of vertebral column was assessed from sub-occipit to C7,T1-T12, L1-PSIS. The abdominal girth is measured at the level of navel with and without abdomen tucked in. The hip circumference is taken at the level of greater trochanter and hip waist ratio assessed. Then the subject was made to lie on hard surface and to lift both legs 300 from the surface and asked to hold till he/she can and is recorded by a stop watch.1

RESULTS

STATISTICAL ANALYSIS

Descriptive statistics were used and co-efficient of co-relation analyzed for possible pre-disposition.

This study was carried out to 200 participants who did and did not complain of low back pain (male 100 female 100)

The following was the descriptive statistics of various measurements that were taken for the study.

Table 1 : Descriptives

Descriptive Statistics

	N	Mean		Std.Deviation
	Statistic	Statistic	Std .Error	Statistic
Total Spine Length	200	65.5475	.4653	6.5807
Waist-Hip Ratio	200	.8394	6.921E-03	9.788E-02
Bil SLR Hold Time	200	48.7650	3.8522	54.4783
VAS	200	2.8825	.2257	3.1919
Ht. in Meters	200	1.6051	6.679E-03	9.445E-02
Wt.in Kgs	200	62.4750	.7910	11.1868
Length of Cervical Spine	200	12.2175	9.402E-02	1.3296
Length of Thoracic Spine	200	38.2400	.4269	6.0378
Length of Lumber Spine	200	15.0900	.1240	1.7542
Body Mass Index	200	24.2765	.2800	3.9602
Valid N (list wise)	200			

It can be seen that the waist hip ratio and the height in meters were the parameters that showed great standard deviation.

The correlation analysis was done for the predisposition to low back pain with various spinal measurements.

Table 2: Correlation Summary

CorrelationSummaryTable

Correlation Summary Table				
Between	**And**	**KarlPearson'sr**	**p-value**	**Significance**
VAS	Wt.inKgs	-0.089	0.208	NotSignificant
VAS	Waist Hip Ratio	-0.015	0.837	Not Significant
VAS	Body Mass Index	0.004	0.958	Not Significant
VAS	Total Spine Length	0.039	0.294	Not Significant
VAS	Thoracic Spine	-0.032	0.325	Not Significant
BilSLR	C. SpineLength	0.047	0.252	Not Significant
VAS	CervicalSpine	-0.161	0.05	Significant
VAS	LumbarSpine	0.378	0.01	Significant
LBA	CervicalPain	0.870	0.01	Significant
VAS	BilSLRHoldtime	-0.432	0.01	Significant
BilSLR	TotalSpineLength	0.254	0.01	Significant
BilSLR	ThoracicSpine	0.309	0.01	Significant
BilSLR	LumbarSpine	-0.147	0.05	Significant

As it can be seen that in normal individuals there was no correlation between VAS scores and the following variables.

- Weight in Kg
- Waist-hip Ratio
- Body mass index
- Total spine length
- Length of thoracic spine

However it was seen that the pain scores correlated significantly to the length of the spinal segments, which were highly mobile mainly cervical spine (p=0.005) and lumbar spine (p=0.001).

It should be noted that greater significance of lumbar spine correlating with low back pain could be because the VAS scores also correspond to lumbar spine.

It was also seen that there existed a high significance of correlation in the pre disposition of cervical pain associated with low back pain (p=0.01).

Cross correlations were performed for possible influences of other parameters evaluated to the VAS scores, where it was noted that the VAS scores was negatively correlating with a high amount of significance to the bilateral SLR hold time (p=0.001) and the length of the cervical spine (p=0.005). Meaning that the role played by the lower abdominal musculature is important in the predisposition of a person to low back pain.

It is also noted that the bilateral SLR hold time had a negative association with the length of lumbar spine, while the length of lumbar spine itself correlated positively with VAS scores.

The bilateral SLR correlates significantly to the total spine length and length of thoracic spine, (p=0.01), while there's no correlation between bilateral hold time and length of cervical spine.

From these direct correlations and indirect interpretations of the correlative values can be shown that the length of vertebral column significantly affects the predisposition of a person to low back pain and also the strength of abdominal muscle strength.

The other point to be noted is that once there is the presence of dysfunction in the spine (lumbar spine in this area), it predisposes to the pain in other areas. The most commonly affected being the cervical spine.

Discussion

With increase in sedentary life style i.e. devoid of physical exertion and diminishes muscular strength, the occurrence of low back pain because of prolonged

postures either maintained abnormally or even normally needs to be evaluated.

The low back pain previously thought to be a musculoskeletal problem alone is now considered on a much larger basis, which includes even psychological aspects. This aspect was used to predict the persistence of pain syndromes of the spine in specified population, and the risk of persistence of pain increased when pain in more than one area of spine is present.[17]

According to Kapandji the ability of the spine to transmit forces is dependent upon its curves, which is measured as Delmas index. In this regard, it was conventional belief that an increased curvatures predisposed to pain in spinal area. This thought was rejected by Korovesis et al (2004),[18] who found that there were no significant predisposition of these individuals to low back pain, however their study had a limitation that the measurements made by surface markings do not represent the values obtained by roentgenographic evaluation.

They also noted that the shorter individuals were predisposed to low back pain than taller individuals. The lumbar spine requires to best analyzed on the pelvis and Kobayashi and associates found that the strongest alignment.[19]

The role-played by abdominal muscles in producing a support to the lumbar spine during flexion activities and their predisposition to low back pain has been researched abundantly in various studies. But most of the studies concentrate on the position of the proximal and distal joints during abdominal muscle action but have not given importance to the status of length of the spine; since it is considered non-modifiable and permanent. Based on the high amount of significance of correlation presented in our study it should be noted that the person with weak abdominal will benefit if the relative length of the lumbar spine be reduced through hip flexion and curling up of the trunk while training for these musculature.[20]

Conclusion

The conventional biomechanics places emphasize on the various kinetic and kinematic predispositions to low back pain, but gives very little importance to the dimensions of spine and its predisposition to low back pain. Through this study we have found that the length of spinal columns should be given due importance when assessing the risk of developing low back pain.

Ethical Clearance: This study was approved by our institutional ethical committee of MM college of Physiotherapy & Paramedical Sciences Jabalpur dated 09/11/2023- MMPP/ADM/2023/932.

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Conflict of interest: Nil

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Original Research

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Role of Balance Training in Bilateral Foot Drop Following Guillain-Barre Syndrome: Pretest- Posttest Research Design

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Abstract

Guillain-Barre syndrome (GBS) is a debilitating condition characterized by acute or sub-acute autoimmune inflammation affecting the peripheral nervous system. One of its most common residual defects is bilateral foot drop, significantly impairing balance, and functional independence. This article investigates the efficacy of balance training in patients with bilateral foot drop post-GBS. The study, conducted on 18 patients, aimed to assess the impact of balance exercises, including Swiss ball and wobble board exercises, over three weeks. Baseline assessments were conducted using the Berg Balance Scale, Functional Independence Measure, and Hughes GBS Disability Scale. Results showed significant improvements in balance, functional independence, and disability scores post-intervention. GBS typically presents with pain, weakness, paresthesia, and decreased reflexes, leading to various functional limitations. Rehabilitation strategies must address these challenges early on, emphasizing posture, range of motion, and muscle strength to prevent contractures and improve function. Correcting foot drop is crucial for restoring functional capacity and independence. Balance is a key aspect of functional recovery in GBS patients, as it affects mobility and reduces the risk of falls. Balance training targets proprioception, muscle strength, and coordination, facilitating improvements in postural control and gait. The study's findings suggest that balance training effectively enhances outcomes for individuals with bilateral foot drop post-GBS. However, it is essential to consider the self-limiting nature of the disease and the potential for spontaneous improvement over time. Long-term follow-up studies are warranted to evaluate the sustained benefits of balance training and the natural course of recovery in GBS patients. The article underscores the multidisciplinary approach required for GBS rehabilitation, involving physiotherapy, neurology, and other healthcare professionals. By addressing the complex impairments associated with GBS, tailored rehabilitation programs can optimize functional outcomes and improve the quality of life for affected individuals.

Keywords: Guillain-Barre syndrome, balance training, bilateral foot drop, functional independence

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Introduction

Guillain-Barre syndrome is an acute or sub-acute autoimmune, inflammatory demyelinating[2] condition with radiating features[3], involving the peripheral nervous system. It leads to axonal damage[1] following infection or stimulation of immune system[4] and progresses rapidly with reaching severity within 4 weeks. The disease is infrequent, affecting 0.81- 1.89 per 1,00,000 persons per year[5]. The incidence is proportional to the age and increases by 20% for every 10 year increase in age [6], with 40 years as mean age of onset, infrequently affecting children and men getting 1.5 times more affected than women (ratio- 3:2)[4]. The variants of GBS are classified into demyelinating and axonal types with axonal variant including AMAN (acute motor axonal neuropathy), AMSAN (acute motor sensory axonal neuropathy), MFS (miller fisher syndrome) and the demyelinating variant including AIDP (acute demyelinating polyneuropathy)[7]. Patients with GBS present with pain[3], followed by weakness in the bilateral limbs which is usually ascending, paresthesia or dysesthesias[5], decreased or absent deep tendon reflexes in the affected limbs, cranial nerve involvement, balance and gait disorders. 60% of people have mild residual deficits predominantly in lower limbs for as long as 2 years post GBS making the recovery incomplete [10].The residual deficits include bilateral foot drop (30%), limb weakness (8%), paresthesia's (38%), unsteadiness of gait (37%), painful hands or feet (24%), severe fatigue (22%), are flexia (5%), psychological problems and reduction in leisure activities (44%)[11].

Distal weakness in lower limbs is observed as the most common residual deficit following GBS resulting in foot drop which is usually bilateral[3] as GBS affects both sides of the body characterized by weakness in dorsiflexion. This is due to severe wasting of anterior tibialis muscle[8,9] by damage of common peroneal nerve in the anterior portion of the leg and demyelination of axons [12,13]. This position impairs balance by shifting the body & center of mass to the less affected side, causing a disruption in symmetrical weight shifting in response to external movement. In addition to increasing lower extremity stiffness, a decline in balance ability disrupts independent walking, exacerbating the sense of chronic disability [7]. The recovery pattern in GBS is usually from proximal to distal with foot muscles improving at last.

Correction of foot drop is required for improving functional capacity, social rejuvenation, and gait velocity [15]. Early rehabilitation will emphasise posture and range of motion, especially in cases of paralysis. Exercises that increase range of motion and static bracing are essential for preventing muscle contractures. Careful positioning will support this programme and help in the same [14]. Recovery from foot drops is essential for effective functioning and independence of patients. Therefore, this study is directed towards role of balance training in bilateral foot drop following GBS through balance training over generalized interventions.

Materials and Methods

The study conducted at the Department of Physiotherapy NIMS, Hyderabad, employed a prospective one-group pretest-post-test design to assess the effectiveness of balance training on individuals with bilateral foot drop following Guillain-Barré Syndrome (GBS). Eighteen patients meeting the inclusion criteria, including age between 15 to 60 years, and diagnosed with bilateral foot drop following GBS, were recruited through convenient sampling after obtaining ethical clearance. Each participant was provided with a comprehensive description of the study and gave informed consent before inclusion. Baseline assessments were conducted using standardized scales, including the Berg Balance Scale, Functional Independence Measure (FIM), and Hughes GBS Disability Scale, to establish the initial condition of the participants. Only one group underwent the intervention, which consisted of balance training exercises utilizing Swiss balls and balance boards.

The pretest observations of the variables were made using the aforementioned outcome measures before the commencement of the treatment. Following the implementation of the treatment, post-test assessments were conducted to evaluate the effects of balance training on balance, functional independence, and disability in the participants. The exercise protocol encompassed various activities such as sitting to standing, transfers, standing unsupported with eyes closed, reaching forward,

turning, and core stabilization exercises, tailored specifically for individuals with bilateral foot drop.

Throughout the study, each patient was followed up for three weeks, with reassessment in the final week to monitor progress and ascertain the sustained effects of the intervention. The utilization of a one-group pretest-post-test design allowed for a comprehensive examination of the impact of balance training on individuals with bilateral foot drop following GBS, providing valuable insights for rehabilitation strategies in this population.

Exercise Protocol

Sitting to standing
Standing unsupported
Transfers
Standing unsupported with eyes closed
Standing unsupported with feet together
Reaching forward with outstretched arm while standing
Pick up object from the floor from a standing position
Turning to look behind over right and left shoulders while standing
Turn 360 degrees
Place alternate foot on step or stool while standing unsupported
Standing unsupported one foot in front
Seated calf stretch
Exercises for bilateral foot drop
Wobble board exercises
Core stabilization exercises

Findings/Results:

The study investigated the efficacy of balance training in improving functional outcomes for individuals with bilateral foot drop post-GBS. The findings showcased significant enhancements in balance, functional independence, and disability scores from baseline to the third week post-intervention. This improvement indicates the promising potential of balance training as an intervention strategy for this population. The mean age of participants, at 31.6 years, sheds light on the demographic profile of the study group. Moreover, a higher prevalence of GBS among males was noted, emphasizing a potential gender-specific susceptibility to this condition. The methodology employed meticulous data collection and analysis procedures. The initial data collection on day 1 during the first visit allowed for the establishment of baseline parameters. These baseline values were crucial for gauging the effectiveness of the intervention over time. By recording averages and calculating standard deviations and standard errors, the study ensured robustness in its statistical analysis. The correlations between outcome measures and participant demographics, such as age and gender, were thoroughly examined using Microsoft Excel and GraphPad Prism software. Furthermore, statistical tests like paired t-test, Wilcoxon signed-rank test, unpaired t-test, Mann-Whitney U test, and Karl Pearson's correlation coefficient test were employed appropriately to analyze the data. The utilization of these tests allowed for a comprehensive understanding of the intervention's impact and its relationship with participant characteristics. Overall, the study's findings underscore the effectiveness of balance training as a rehabilitation intervention for individuals with bilateral foot drop post-GBS, offering hope for improved functional outcomes and quality of life for affected individuals.

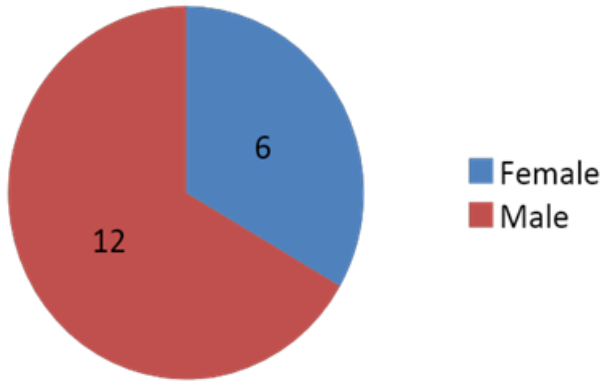

Figure 1: Gender-based results

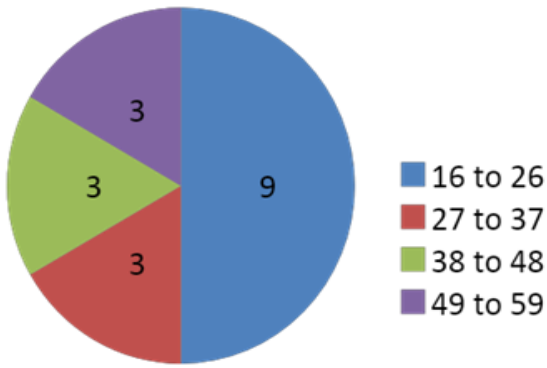

Figure 2: Age requirements

Explanation: The age requirements are 16 years minimum and 59 years maximum. The age distribution exhibits a mean of 31.6 ± 13.39 years. The age range of the subjects included in the data was 15 to 60 years, as the mean age of commencement was 40 years, and the maximum number of subjects were between the ages of 16 and 26. GBS is more prevalent among males compared to females.

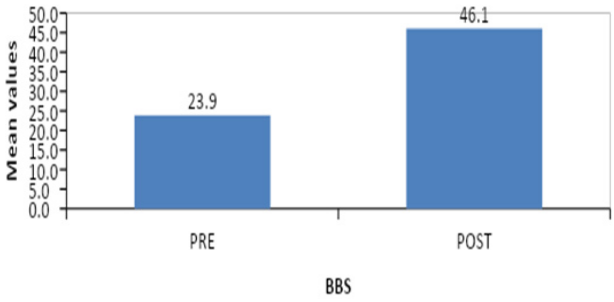

Figure 3: pre-and post-parameters

Explanation: From the first day of the study until the end of the third week, there was a statistically significant difference between the pre and post values for the BBS parameter. This difference was found in all components.

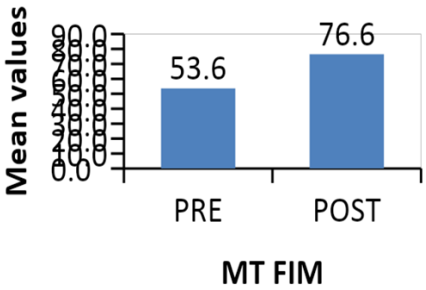

Figure 4: pre-and post-values of FIM

Explanation: There is a statistically significant difference between the pre and post parameters of the motor component of FIM, as indicated by the fact that the mean ± standard deviation value of the pre and post values of FIM are 53.6 and 76.6 respectively, and the P value is less than 0.001.

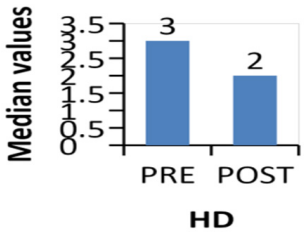

Figure 5: Comparison of the ankle dorsiflexion parameter's pre- and post-results

Discussion

The study's findings underscore the pivotal role of balance training in ameliorating balance deficits, enhancing functional independence, and mitigating disability among patients grappling with bilateral foot drop post Guillain-Barré syndrome (GBS). Notably, the observed enhancements could be attributed to the self-limiting trajectory of GBS, with the majority of patients experiencing recovery within 200 days on average. However, up to two years post-GBS onset, residual impairments persist in 60% of cases, particularly affecting the lower limbs. This suggests a complex interplay of factors influencing the trajectory of recovery beyond the acute phase.

Contrary to conventional wisdom, the severity of the initial injury may not be the sole determinant of GBS outcomes. Instead, the capacity for healing emerges as a critical factor shaping long-term recovery. Despite the heterogeneity in patients' demographics, the study found consistent improvements in balance, functional independence, and disability scores, indicating that these outcomes were independent of age and gender. This underscores the need for a nuanced understanding of the underlying mechanisms driving GBS recovery, beyond simple demographic factors.

The multifaceted nature of GBS recovery is further elucidated when considering the sensory and motor dimensions. The sensory system's contribution to balance improvement underscores the importance of holistic assessment and treatment approaches involving both neurologists and physiotherapists. Additionally, the concept of central learning and peripheral training effects suggests a dynamic interplay between neurological plasticity and targeted physical interventions, potentially amplifying the efficacy of balance training regimens.

Central to the discussion is the pivotal role of the ankle joint in facilitating balance and gait control. Beyond its mechanical support, the ankle serves as a crucial nexus for sensory feedback, constantly modulating postural adjustments during movement. The study's emphasis on ankle muscle strength and range of motion (ROM) underscores the intricate relationship between musculoskeletal integrity and balance control. By targeting ankle strength and

ROM, balance training interventions may catalyze cascading improvements in postural stability and functional mobility.

Interestingly, while the study focused on participants with bilateral foot drop, the primary objective was to enhance overall balance rather than solely addressing foot drop severity. This strategic shift reflects a broader understanding of the interconnectedness between musculoskeletal impairments and functional outcomes. Indeed, previous literature has linked diminished ankle muscle strength to compromised balance, further underscoring the rationale for prioritizing balance-focused interventions.

The implications of these findings extend beyond the confines of the study, signaling the need for a comprehensive and longitudinal approach to GBS management. By embracing a holistic perspective that encompasses both acute interventions and long-term rehabilitation strategies, clinicians can optimize outcomes and mitigate the enduring impact of GBS-related disabilities. Moreover, the study's emphasis on the self-limiting nature of GBS prompts further inquiry into the dynamic interplay between disease trajectory and rehabilitative interventions, offering fertile ground for future research endeavors.

In summary, the study underscores the transformative potential of balance training in mitigating the functional repercussions of GBS-related bilateral foot drop. By unraveling the intricate interplay of sensory, motor, and musculoskeletal factors, the findings pave the way for a more nuanced and effective approach to GBS rehabilitation. Moving forward, longitudinal research endeavors are warranted to elucidate the enduring impact of balance interventions and refine therapeutic strategies aimed at optimizing long-term functional outcomes for individuals affected by GBS.

Conclusion

The findings of this study shed light on the effectiveness of balance training as a crucial intervention for individuals grappling with bilateral foot drop post-GBS (Guillain-Barré Syndrome). GBS, known for its self-limiting nature, often resolves within a few years post-discharge, yet its impact on mobility can be profound. This study highlights that, while the disease may naturally regress, targeted interventions like balance training can significantly expedite the recovery process, leading to notable enhancements in balance, functional independence, and reduction in disability. The three-week timeframe examined in the trial illuminates a pivotal window where balance training can exert substantial benefits. During this period, patients experienced remarkable progress in their balance capabilities, functional independence, and reduction in disability levels. Notably, despite the increase in ankle dorsiflexor strength observed during the trial, it didn't correlate significantly with the measured outcomes. This raises intriguing questions about the underlying mechanisms driving these improvements, hinting at potential complexities yet to be fully understood. Moreover, the study's findings refute any influence of demographic factors such as age, gender, or BMI on the observed outcomes, further emphasizing the pivotal role of the disease trajectory itself and its capacity for healing over time. This suggests that while exercise interventions like balance training play a crucial role, the disease's intrinsic dynamics also contribute significantly to the overall recovery process. Thus, the study highlights the need for comprehensive, long-term follow-up research to elucidate the intricate interplay between disease progression, rehabilitation interventions, and patient outcomes. By delving deeper into these complexities, future studies can refine therapeutic approaches and optimize outcomes for individuals grappling with bilateral foot drop post-GBS.

Conflict of Interest: The authors, B Mayuri Chandra, Naveen Kumar Balne, and Lakshmana Prasad Gadde, declare no conflicts of interest related to this research. They have no financial or personal relationships that could bias their work or influence their interpretation of the results.

Source of Funding: The study was conducted within the Department of Physiotherapy at NIMS, Hyderabad, without financial support from any external sources. Therefore, the research was conducted independently, without any influence from external funding agencies.

Ethical Clearance: The study protocol was reviewed and approved by the ethics committee to ensure compliance with ethical standards. Informed consent was obtained from all participants, and measures were taken to protect their privacy and confidentiality throughout the study. By addressing conflict of interest, disclosing the source of funding, and obtaining ethical clearance, the authors demonstrate transparency and adherence to ethical standards in conducting medical research. These measures help to ensure the integrity and credibility of the study findings

Ethical clearance details: Ref No.EC/NIMS/2948/2022 Dated: 30.03.2022

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Original Research

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Effects of a Novel, Inexpensive Device "Striker" On Spatio-Temporal Gait Parameters in Individuals with Parkinson's Disease

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Abstract

Purpose: Problems with foot mechanics (insufficient heel strike) that are seen in individuals with Parkinson's Disease (PD), result in landing with either the middle or front of the foot. This altered pattern contributes to instability. Proper dorsiflexion of the foot resulting in heel strike can improve gait mechanics in PD, therefore the purpose of this research is to quantify the effects of a novel device on spatiotemporal gait parameters in individuals with PD.

Methods: 11 individuals diagnosed with Parkinson's disease (H & Y I -III) were recruited and screened using predetermined inclusion/exclusion criteria. Each participant wore a novel device, "Striker". All participants were tested both with and without the device in a randomly chosen order during a Six Minute Walk Test and GAITRite Mat. A researcher developed a patient survey that was provided at the end of testing to assess feasibility and confidence using the "Striker".

Results: The Wilcoxon Sign Rank test was utilized to compare within-group differences indicating an improvement in cadence ($p = 0.003$) and the associated decline in gait velocity ($p = 0.004$) while using Striker.

Conclusion: Significant change in cadence, while using "Striker" was associated with better biomechanics of the foot, initiating with a heel strike, thus decreasing the number of steps taken to cover the same distance. Additionally, most of the post-research surveys provided positive qualitative feedback. "Striker" may be used to improve heel strikes to decrease fall risk in individuals with PD.

Key Words: Parkinson's Disease, Gait, Cadence

Background and purpose

Gait abnormalities and postural instability are disabling features of Parkinson's Disease (PD). The most common gait abnormalities associated with PD are characterized by a decreased stride length and gait velocity (speed of walking), increased cadence (number of steps taken), increased duration of

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double limb support, shuffling gait, gait festination, and freezing of gait.[1,2] Individuals with PD have been shown to have significant alterations in their foot biomechanics during gait which incidentally places them at a greater risk of falls. In a healthy individual, gait is typically initiated by a heel strike when the person places their heel on the ground. As the foot lowers to the ground, the foot becomes flat for a moment, then the weight is shifted to the ball of the foot for a "push off".[3,4]Nieuwboer et al. conducted a study to identify stance phase mechanics in individuals with PD using pressure sensitive insoles and found that patients with PD show an increased amount of force under the midfoot during the stance phase creating a "foot flat" effect instead of the typical heel-to-toe mechanism.[5] Altered gait mechanics can create issues with reaction time, and weight shifting, and increase the risk of tripping over obstacles.

Falls result in a range of minor to severe injuries in individuals with PD. It is estimated that 38 - 87% of Parkinsonian patients experience falls.[6,7] These falls often result in a visit to the emergency room. An estimated U.S. prevalence of approximately one million individuals with diagnosed Parkinson's disease was reported in 2017 and a total economic burden of $51.9 billion.[8] While the economy faces financial dilemmas associated with PD, the ramifications of this diagnosis are also very personal and have a detrimental effect on patients and their families.

The myriad of impairments creates a challenge for healthcare professionals to identify and focus on the effective treatment of these patients. Qualitative data indicated patients agreed that reductions in walking impairments, speed deficiencies, and fatigue were the most critical concerns.[9]Additional evidence supports that long latency responses in Parkinsonian subjects with foot drop, lead to gait disturbances and fall risks.[10]Therefore, it is the most prioritized aspect of rehabilitation research, with a focus on finding novel ways to prevent multiple falls caused by altered gait and foot biomechanics.

There has been considerable research conducted in an attempt to facilitate motor learning for individuals with PD to prolong their walking independence, including the use of exercise training, different cueing strategies, electrical stimulation, and the use of assistive devices. Literature suggests e-stimulation (e-stim) is effective as a cueing to enhance various gait parameters in Parkinson's patients. Mann, Finn, and Taylor demonstrated that functional electrical stimulation (FES) improved gait velocity and cadence over 8 weeks, with benefits sustained post-treatment. FES also shows promise in improving bradykinesia and health-related quality of life.[11]

Although numerous intervention strategies, including exercise training, electrical stimulation, augmented feedback, and assistive devices, have demonstrated significant improvements in gait mechanics as Parkinson's disease progresses. However, many of these strategies are impractical for community ambulation beyond controlled clinical environments.Exercise training alone offers limited benefits for individuals with PD and is typically employed alongside other intervention strategies by skilled clinicians, tailored to the patient's symptoms. As PD progresses, doctors may prescribe or recommend assistive devices to enhance ambulation. However, these devices can be expensive and provide limited improvements in gait mechanics. Disease progression often necessitates additional assistive equipment, further increasing financial burdens.

Elastic band therapy is a recognized approach for improving walking patterns by supporting leg movements and ensuring correct posture during walking. This method is widely applied in therapeutic environments. For example, physical therapists often use therabands, to enhance foot dorsiflexion in individuals dealing with foot drop. Moreover, elastic bands have been used in astronaut training and space missions to combat the effects of microgravity. Astronauts, facing the challenges of limited physical activity in space, utilize special suits equipped with rubber bands that apply resistance against the body. Specially designed suits leverage elastic resistance to correct posture and walking irregularities.[12]

To address the issue of altered foot mechanics, to offset the cost of expensive assistive devices, and the progressive nature of PD, the purpose of this study is to develop a device that is inexpensive, easy to use, and effective. We hypothesize that our new device "Striker" will address impaired foot biomechanics and will require little education for its use. The device itself will be smaller, lightweight, and easy to make, potentially saving the patient hundreds of dollars. Ultimately, our goal is to make the individual's gait more efficient allowing for improved gait and decreased fatigue in an attempt to improve their perceived quality of life.

Methods

Individuals diagnosed with PD were recruited via referrals from local health and wellness centers (name not included for anonymity). A total of 43 individuals were referred to the study, of which 32 were excluded due to failure to meet inclusion/exclusion criteria. Inclusion criteria included: 50 years or older, a diagnosis of idiopathic Parkinson's Disease, the ability to walk indoors without physical assistance, and adequate hearing and vision to perceive sound and visual cues. Exclusion criteria included: recent fracture of lower extremity, significant pain in lower extremities or back, prior surgery of the spine or brain, deep brain stimulation, severe OA of the lower extremities, Rheumatoid Arthritis, or significant cognitive issues as assessed by the Montreal Cognitive Assessment (MoCA) (<20/30). A total of 11 participants were enrolled in the study after signing an informed consent form, which had received prior approval from The(name not included for anonymity) IRB. Figure 1 illustrates the patient recruitment process. Initial screening of potential participants was conducted via telephone to assess eligibility. Those who met the inclusion criteria were then scheduled for a one-time session at Russell Sage College in Troy, NY. Upon arrival, participants provided their signature on the informed consent form before starting the study. Additionally, participants were required to complete a Patient Demographic Form and undergo the MOCA assessment to confirm their eligibility for the study. For a summary of participant demographics (Table 1)

Equipment

The Striker prototype was developed in Ricketts Lab at Russell Sage College, utilizing accessible and cost-effective materials, including an ACE bandage wrap, an ACE knee wrap (available at most convenience stores), a metal key ring, bungee cords of various lengths, and a gait belt. The initial step in the prototype assembly involved attaching the metal key ring to the knee wrap, positioning it just above the knee's patella insertion point. This ring was securely sewn onto the wrap with durable material to ensure it stayed in place. To fit the device on a patient's lower leg, the process began with wrapping the ACE bandage around the ankle/foot area, even over the patient's shoes. Subsequently, the knee wrap was linked to the ACE bandage using its Velcro straps in a crosswise manner until all straps were firmly attached to the bandage. After ensuring the foot component was securely fastened, a bungee cord was employed to connect the gait belt to the foot assembly (as illustrated in Figure 2).

Procedures

After completing the necessary paperwork, participants randomly selected pre-labeled cards to determine whether they would begin the session with or without the device. The device was placed on the more affected lower extremity of all participants. Consistency was maintained across all participants regarding the sequence of events, with the primary variable being the presence or absence of the device. The sequence comprised three trials on the GAITRite, followed by a 2-minute rest, the 6-minute walk test (6MWT), a 5-minute break, and then the tasks were repeated.

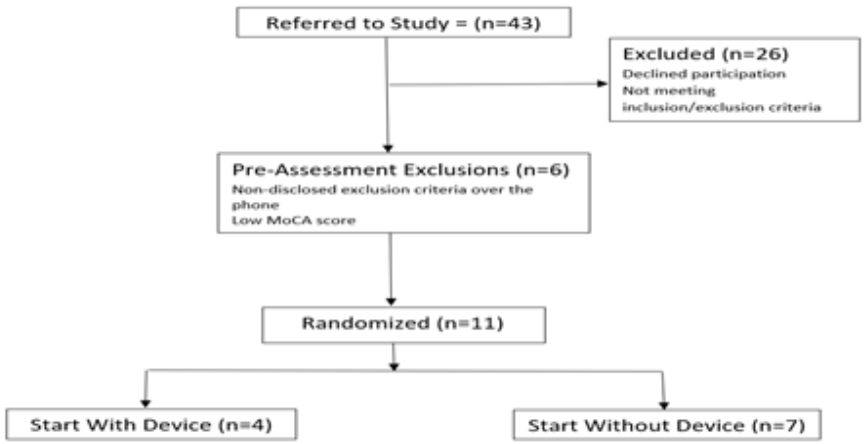

Figure 1: Participant recruitment schematic

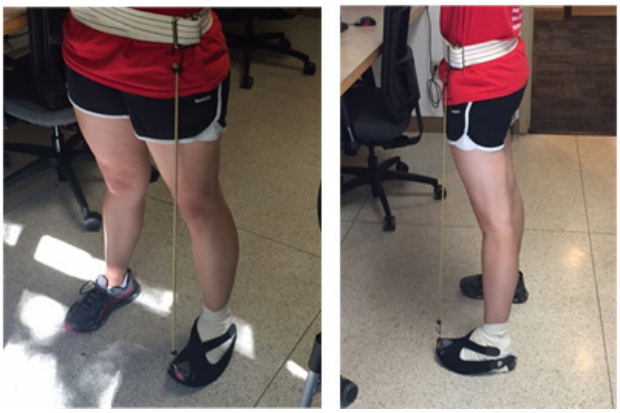

Figure 2: Device application

GAITRite setup included taped markings at both ends to designate a "starting" and "ending" point, positioned 1.5 meters away from the mat to ensure sufficient acceleration and deceleration space. Adjacent to these markers, chairs were placed on each side of the mat to offer participants a brief resting option if needed. Each participant was instructed to walk comfortably across the 10-meter GAITRite mat, starting at one marked line and continuing until reaching the line 1.5 meters from the mat's end. Before commencing the task, participants were equipped with a gait belt and closely supervised by at least one researcher throughout.Three trials were performed, and the average value was used for subsequent data analysis.

After walking over the GAITRite, participants took a brief 2-minute break before starting the 6-Minute Walk Test (6MWT). The 6MWT was conducted within a designated rectangular area measuring 46.5 ft. X 59 ft., totaling 211 feet if fully traversed. Similar to previous tasks, at least one researcher closely supervised participants throughout the test to ensure safety. Time was monitored using a stopwatch, and the total distance covered was calculated upon completion. Participants were instructed to walk comfortably for 6 minutes, with verbal reminders of the time remaining provided every 60 seconds.

Afterward, each participant took a 5-minute break for recovery before repeating both tasks under the alternative conditions. For instance, if a participant initially completed the tasks with "no device," they first performed the GAITRite walk and then the 6-minute walk test (6MWT) without any device. Following the break, they subsequently completed both tasks again, this time using the device placed around their foot and secured to their waist. Data on temporal sequencing was gathered through the GAITRiteand included gait velocity (cm/sec), cadence (steps/min), right and left step lengths (cm), and right and left stride lengths (cm).

Following the experimental procedure, patients were requested to complete a questionnaire devised by the researchers for this study. This questionnaire aimed to gather qualitative feedback on the device and assess its feasibility for implementation in a community setting.

Results

Statistical analysis was conducted using SPSS-10. Quantitative analysis in this study utilized an alpha level of 0.05 to determine outcome significance. Outcome measures included gait velocity (cm/sec), cadence (steps/min), right and left step lengths (cm), and right and left stride lengths (cm), as assessed by the GAITRite system and the 6-minute walk test (6MWT). Kolmogorov-Smirnov Normality Test indicated that the data did not meet the assumptions of normality, suggesting uneven distribution within the population (see Table 2). As a result, the nonparametric Wilcoxon Signed Ranks Test was employed for statistical analysis.

Cadence exhibited a significant decrease while ambulating with The Striker ($Z = -2.934$, $p = 0.003$) (see Table 3). Similarly, gait velocity significantly decreased while using the Striker with a ($Z = -2.845$, $p = 0.004$). However, no significant differences were observed for stride length (p-value: 0.110), step length (p-value: 0.477), or the 6MWT (p-value: 0.286).

Qualitative Data: Participants provided overall positive feedback about confidence and comfortability while wearing The Striker. All participants were asked questions regarding the device at the end of each session.

Table 1: Participant Demographic

Patient Number	Age	Gender	Weight (lbs.)	MOCA Score
PD01	72	M	160	26
PD03	74	M	167	25
PD04	85	M	160	20
PD07	67	M	240	24
PD08	71	M	200	27
PD09	76	F	132	26
PD10	58	F	179	29
PD11	75	M	215	27
PD12	78	M	153	26
PD13	68	M	173	26
PD14	60	M	160	26

Table 2: Assumptions of Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Static	df	Sig.	Static	df	Sig.
Six MWT with	0.195	11	.200*	0.904	11	0.207
Six MWT without	0.192	11	.200*	0.94	11	0.515
Gait Velocity with	0.159	11	.200*	0.918	11	0.303
Gait Velocity without	0.146	11	.200*	0.923	11	0.343
Cadence with	0.176	11	.200*	0.947	11	0.601
Cadence without	0.192	11	.200*	0.961	11	0.782
Step Length with	0.185	11	.200*	0.94	11	0.517
Step Length without	0.192	11	.200*	0.916	11	0.288
Stride Length with	0.189	11	.200*	0.968	11	0.362
Stride Length without	0.184	11	.200*	0.928	11	0.39

* This is the lower bound of true significance, a. Lilliefors Significance Correction

Table 3: Wilcoxon Signed Ranks Test[a]

	Gait Velocity (cm/sec)	Cadence steps	SixMWT (m)	Step Length(cms)	Stride Length (cms)
Without Device	92.44	105.45	1025.41	52.12 (10.7)	102.76 (4.4)
With Device	83.41	96.6	995.42	51.54 (6.7)	95.35 (6.7)
Z	-2.845[b]	-2.934[b]	-1.067[b]	-.711[b]	-1.600[b]
Asymp. Aig. (2-tailed)	0.004	0.003	0.286	0.477	0.11

a. Wilcoxon Signed Ranks Test

b. based on negative ranks

Table 4: Participant's Comments

Additional Comments/Suggestions:
Good device. PTs helped the fear of falling too
PTs on either side increased confidence
It took a few trials on the gait mat until I felt comfortable with the device. It started to feel awkward after 6 circles during 6 MWT. Need to make sure it is lined up right. It feels awkward and would take some getting used to.
Yes, where can I buy one?
Pain from the hip decreased due to the device while doing the 6MWT
First time using- need to get used to it; It rubs your knee a lot; changes the way you walk; weird/uncomfortable
Slip onto the shoe to make it more suitable to apply
The wrap-around foot was a little bulky with waist piece

Discussion

This study investigated the feasibility of using a lightweight inexpensive elastic cord device "Striker" on individuals with Parkinson's Disease. We aimed to investigate whether this device improves gait kinematics. The use of "Striker" was related to better gait outcomes, when compared to walking without the device. One of the most significant changes that was assessed via quantitative evaluation was a decrease in cadence among the participants. Previous research studies have reported that increased cadence is one of the most common gait abnormalities associated with PD and is commonly associated with decreased gait velocity, stride length, increased duration of double limb support, shuffling, and gait festination during ambulation tasks.[1-2] Our results indicate a significant decrease in cadence while maintaining the total distance covered during the 6-minute walk test. This indicates that participants were taking fewer steps to reach their destination. An improvement in cadence may lead to improvements in gait velocity, stride length, double limb support, and decreased shuffling and festination during gait. With improved standardized testing procedures, further research with this device may result in improved gait kinematics.

Individuals with Parkinson's disease often exhibit shorter, quicker steps, and although their overall gait speed is slower, they tend to increase their step frequency. This increase in cadence shifts much of their balance response to foot placement, unlike age-matched controls. This shift can be attributed to reduced proprioception in those with Parkinson's disease.[13] Diminished proprioceptive abilities may impair their sense of the center of pressure (CoP) under the stance foot, making reliance on the lateral ankle mechanism for balance less dependable. When a specific balance strategy is unreliable or infeasible, the central nervous system (CNS) adapts by utilizing other available balance mechanisms. For instance, if activation of the lateral ankle mechanism is compromised, increasing cadence to depend more on foot placement for maintaining balance appears to be a practical adaptation. Therefore, it is hypothesized that balance mechanisms influence preferred walking cadence and possibly affect gait speed as well.[14]

"Striker" used elastic bands that stretched from the front of the foot towardsthe waistline, mimicking the line of action that the lower extremity muscles use during ambulation. The elastic resistance of the bands worked similarly to the mechanical action of the skeletal muscles involved in hip, knee, and ankle dorsiflexion. Efforts were made to approximate the size of the elastic band at its full length according to the height of each individual, and efforts were made to make sure the band during the full knee extension, is not overstretching the ankle joint in excessive dorsiflexion.

When stretched by changes in joint positions, these bands facilitated muscle contractions[15]. In addition to using active properties, the elastic bands also approximated points of muscle origin and insertion. This mechanism helped muscle resetting to normal length and might improve contractile properties as greater active force is generated due to optimal cross-bridge overlap near the mid-range

of muscle length, which is especially useful for weak and elongated muscles[16]. This enhanced joint movement and muscle contraction by elastic bands, not only provides immediate improvement in the rhythmicity of movement but may aid in improving motor learning. Past studies have shown that cues can improve movement performance, with these improvements often persisting immediately after the cues are removed, suggesting early signs of learning consolidation. Furthermore, the automaticity of learning through cues was observed, as cues not only boosted performance during dual tasks but also maintained these enhancements after the cues were no longer present.[4]

Gait velocity was found to be 83.15 cm/s on average with the device, and 92.43 cm/s without the device. Gait velocity significantly decreased while participants were wearing "Striker". Using "Striker" improved the participant's foot mechanics, making participants walk with a normal heel-to-toe mechanism as well as improved vertical movement of the foot to clear the ground, thereby providing better stability at the cost of lower speed. It has been documented that improved stability and/or accuracy in older adults as well as individuals with PD is associated with walking speed.[17-18]

Our study found that following the use of Striker, walking speed declined, which could potentially result from participants' reduced comfort levels, attributed to the novelty of the device. A significant limitation was the lack of standardized lengths, which could have impeded certain individuals. Additionally, the anticipation of wearing the device might have influenced both comfort and performance. Despite these findings, qualitative data on confidence and comfort with the device conflicted with decreased velocity results, suggesting the need for further investigations on comfort levels, standardization of the cord length, and activity-based restrictions.

Step length and stride lengths did not significantly change between trials of participants ambulating with and without the device. With improvements in gait control achieved by using the "Striker", a patient will likely show improvements in stride and step length, as well as gait velocity. Improvements in cadence indicate that the participants had increased control of their gait while ambulating using "Striker" based on decreased shuffling or festination that could cause a fall. This is further evident by the subjective reports of the participants.

The 6-minute walk test (6MWT) yielded non-significant changes in the total distance covered, regardless of the use of the device, which is an encouraging finding. Despite the absence of significant alterations in distance, the reduction in cadence while maintaining the same distance suggests potential improvements in gait components such as shuffling, freezing, and mediolateral sway movements. Previous research has shown that decreased cadence is associated with better foot placement hence better dynamic balance during ambulation in individuals with PD.[17-18]These improvements (Decreased cadence while maintaining the total distance covered in 6 minutes) may indirectly indicate that "Striker" effectively provided the intended cue and pull to enhance heel strike, thereby promoting more precise foot mechanics in individuals with Parkinson's disease.

Qualitative Data- Patient Questionnaire

After each session, participants completed a subjective questionnaire to evaluate the feasibility and efficacy of "Striker". All participants reported a relatively high level of comfort while wearing the device, rating their comfort level between 1 and 10. This suggests a strong sense of comfort and stability. Participants expressed positive feedback regarding balance, with 8 indicating their balance was "very good" and 3 reporting it as "good" while using"Striker". Although no formal balance assessments were conducted, participants generally felt that their balance was not compromised and may have even been improved while using "Striker".

In terms of the weight of the "Striker", all 11 participants found it to be satisfactory. All participants expressed willingness to use "Striker" long-term, underscoring its potential for further investigation into prolonged use. However, opinions on the device's safety were mixed. While 5 participants felt safer wearing it, 6 were uncertain or felt no difference compared to not wearing it. Safety considerations should thus be paramount in future research endeavors.

In terms of fear of falling, 8 out of 11 participants reported no fear while wearing "Striker", suggesting a potential benefit in alleviating such concerns. However, opinions varied regarding whether the device directly eased their fear of falling, indicating the need for follow-up studies to elucidate this further. Participants also provided additional comments and suggestions (see Table 4), which could inform adjustments to the device for future research applications.

Study Limitations

Our study has several limitations. Firstly, the MOCA test primarily assesses short-term memory and may not fully evaluate procedural memory needed for sequential tasks. This could have affected participants' performance during the study. Secondly, the gender disparity, with only 2 female participants out of 11, may limit the generalizability of our findings. Thirdly, the presence of a physical therapist may have influenced participants' confidence and perceptions of the device. Fourthly, the one-time nature of the experiment might have prevented full adaptation to the device, affecting results. Future research should provide adequate training and assess long-term effects. Lastly, the lack of standardized device length for each participant could have impacted optimal fitting and biomechanics. Establishing a system to determine appropriate device length based on height could mitigate this issue.

Future directions and clinical relevance

Future research should focus on promoting safety using the "Striker," standardizing the elastic cord length based on body composition, and considering other co-morbidities. Understanding the long-term effects of the "Striker" on gait and balance in individuals with PD is valuable. A formal gait analysis using a motion analysis system could enhance knowledge about gait kinematics and kinetics. The Striker is an inexpensive device that may improve gait and help prevent falls. It decreases cadence and promotes a more efficient heel strike. Minor gait improvements with the "Striker" could reduce fall risk if used correctly. Early use in PD may improve gait and motor learning.

Conclusion

The device shows promise for individuals with early-stage Parkinson's disease (PD) who are mobile but face increased fall risk. Using it without proper training and supervision could be unsafe. Researchers mitigated adverse effects by closely monitoring participants to prevent balance loss or falls. Introducing a new ambulation device may initially cause balance issues or falls if used incorrectly, so thorough training is essential. While the Striker holds promise for improving gait in PD patients, future studies should focus on standardization and individual mechanics to confirm its efficacy. The device offers a cost-effective solution for enhancing gait in early-stage PD.

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Ethical Clearance/Statement of Ethics*:*

Institutional Review Board (IRB) at Russell Sage College approved the research proposal (511-2016-2017 (The Sage Colleges, Troy, NY)

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Conflicts of interest statement if applicable: n/a

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Original Research

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Immediate Effects of Premature Infant Oral Motor Intervention Protocol on Oromotor Skills and Neurobehavioral State Regulation of Preterm Infants

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Abstract

Background: Preterm infants are vulnerable population who are at highest risk of developing respiratory distress syndrome which leads them to be dependent on ventilator support for survival. They use accessory muscle for breathing leading them to affect their oral musculature more. They are the "high risk" group as they are struggling to fulfil their basic survival need of oral feed as the suck-swallow breath co-ordination is affected in them. Prolong use of nasogastric and orogastric tube for their optimum nutrition is not advisable therefore it is important to transit to oral feed as soon as they become vitally stable.

Infants who have undergone endotracheal intubation, continuous CPAP (continuous positive airway pressure) support, nasal or oral suctioning develops aversion for oral feeding due to continuous negative feedback. The preterm infant has poor oral motor control related to weaker muscle tone around the mouth, less sensitivity, less tongue strength compared to the full-term infant.

Method: Total 30 preterm infant of mean age 34.67(±2.76) weeks participated in study. Subjects were screened as per inclusion and exclusion criteria. Baseline data and outcome measure was done using non-nutritive suck score and Anderson behavioural state scale(ABSS).6 sessions were given in 3 day again they were assessed with Non nutritive suck scale, ABSS.

Conclusion: There were statistically and clinically significant changes observed in all of the outcome measures; there were significant difference seen in quantity of feed taken and weight gain of preterm infant. There were significant improvement in strength of suck and rhythm and co-ordination of oral structure during non nutritive suck.

Key words: early intervention, preterm infant, oromotor intervention, neuro behavioural state regulation.

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Introduction

The World Health Organization (WHO) defines preterm birth as any birth before 37 completed weeks of gestation since the first day of a woman's last menstrual period (LMP). In 2019, WHO reported more than 15 million preterm births globally, i.e., More than 1 in 10 babies are born preterm. India has more than 35 lakh preterm births. Premature babies have more health issues than term babies. Different systems may be involved, so they spend time in the Newborn intensive care unit (NICU). [2]

Preterm delivery disrupts the continued supply of nutrients through the placenta, essential for average fetal growth and development.[2] Preterm infant nutrition aims to meet the healthy infant's growth rate of the same gestational age and produce the same body composition. Failure to provide the necessary essential nutrients has produced growth failure, increased morbidity, and less-than-optimal neurodevelopment.[3]

Preterm infants who have intermittent sucking and feed for a shorter period have lower sucking pressure as they try to balance sucking and breathing continuously. There is increased risk of respiratory distress which leads to inadequate feeding capability, affecting the infant's nutritional status. While early use of parenteral, enteral feed helps to improve postnatal weight and helps to recover the immediate need for nutrients and minerals, it also increases the risk of sepsis, reduced gastrointestinal villous development.[4][5] Parenteral feeds increase chances of vagal nerve stimulation, causing bradycardia, hypoxemia.[5]

Oromotor skill is a 'mechanical' skill that requires synchronized work of muscles suck, swallow, respiration, and oesophagal muscles. Successful and effective feeding is an energetic activity that requires a complex suck-swallow-breathe cycle. Temporal synchrony of these muscles prevents aspiration and reduces excessive energy expenditure by the infant. [7][8] This skill depends upon brainstem central pattern generators(CPG), whose activity is influenced by chemosensory and oral tactile input. The ability to progress to successful feeding depends on the infant's ability to coordinate the jaw, lips, tongue and pharynx muscles, upper trunk and respiratory systems to support a safe swallow.

There are range of interventions to improve sucking and feeding skills in preterm infants. One such technique used is PIOMI. [11] Premature Infant Oral Motor Intervention (PIOMI) is a 5-minute oral motor intervention using a little finger in and around the mouth of preterm infants. PIOMI provides assisted movement to activate muscle contraction, increases functional response to pressure and improves control of movements for the lips, cheeks, jaw, and tongue. The stimuli include pressure, movement in a specific direction, frequency, and a specific time for a functional response. PIOMI is designed to reduce oral hypersensitivity, improve the range of motion and strength of muscles for sucking, increase oral motor organization and activate reflex behaviours that facilitate nutritive sucking. The techniques aim to restore reflexes, elicit regular oral movements of lips, tongue, jaw. Stimulation of oral structures can trigger activation of the muscles responsible for controlling the head, neck and trunk, thus improving overall motor function and Increasing tactile sensorimotor input, which in turn aids muscle tone as well as neurobehavioral organization in infants. Early oral intervention causes early neuronal growth, increased neuronal synaptic connections and maturation in response to sensory and environmental stimuli, leading to neuronal plasticity in the brain. [9,10]

One of the roles of the physical therapist is to improve the baby's oral motor control. A deficit at this level can increase the length of stay in the hospital, as the energy expenditure involved in not being able to feed properly results in delayed motor development. For this reason, achieving efficient oral motor function should be a priority.[9,11]

Materials & Methods

It is an intervention study done on 30 preterm infants in neonatal ICU unit. The samples were collected on the basis of convenience sampling. Preterm infants with feeding difficulties and Infants who had been cleared by doctor for intervention were included in study. Preterm infant who has undergone oral surgery or who are vitally unstable or seizure disorder were excluded from the study. Ethical approval was taken from the ethical board at Nanavati Max Super Speciality Hospital. Preterm infants with oral feeding difficulties were assessed for

inclusion and exclusion criteria. Parents/guardians were informed about the study and written informed consent was taken. Demographic data was recorded and outcome measures were assessed of the infants prior to the study. Infants' neurobehavioral state was assessed using Anderson behaviour state scale (ABSS). Infants' non-nutrition status was assessed using non-nutritive evaluation scale (NNS) PIOMI protocol (table 1) was applied on the selected subjects 10min before their feed time. The intervention was repeated twice a day for 3 days (6 sessions). After completion of 6 session infants neurobehavioral state regulation and non-nutritive evaluation was assessed using ABSS and NNS respectively. The Standard Package for Social Science (SPSS) version 25 was used for statistical analysis. The intragroup data was analysed by using the paired 't' test.

Table 1: PIOMI Intervention

Structure	Purpose	Frequency	Duration
Cheek C Stretch	Improve Range Of Motion, Strength Of Cheeks, Improve Lip Seal	2x On Each Cheek	30 Sec
Lip Roll	Improve Lip Range Of Motion And Seal.	1x Each Lip	30 Sec
Lip Curl	Improve Lip Strength, Range Of Motion And Seal	1x Each Lip	30 Sec
Gum Massage	Stimulate Swallow, Improve Suck	2x Times	30 Sec
Lateral Border of Tongue/ Cheek	Improve Tongue Range Of Motion And Strength	1x Each	15 Sec
Midblade of tongue/ Palate	Improve Tongue Range Of Motion And Strength, Improve Suck, Stimulate Swallow	2x	30 Sec
Elicit a suck	Improve Suck, Soft Palate Activation	NA	15 Sec
Support Non Nutritive Sucking	Improve Suck, Soft Palate Activation	NA	2 min

Anderson Behaviour Scale Score is a 12-point scale describing infants' neurobehavioral state regulation. Includes various components of sleep, body movement, eye movement, respiration, colour changes and grimaces of the infant.

Non-Nutritive Suck Score: It is a 12-item scale, in which 9 positive items and 3 negative items, positive items are scored as 0-never, 4-sometimes, 8-most part, 12-always negative items are scored as 0-never, -1-sometimes, -2 –most part, -3 – always. It includes positive components such as rooting reaction, initiation of suck, labial sealing, tongue central groove, peristaltic tongue movements, jaw raising and lowering movements, labial tongue, jaw coordination, sucking strength, and sucking rhythm. It also helps to assess negative components like bites, excessive jaw excursion, and stress signals (crying, hiccups, irritability).

Result

30 preterm infants were considered in this research whose mean gestational age(GA) when assessed was 34.67 weeks and mean birth weight was 1.539 kg.18 of the 30 samples taken were male (43%), and 24 were female (57%).

Table 2: Demographic Data

BaselineData	Subjects
Gender (M/F)	Male 35.272 ± 2.887 Female 33.783±2.4
Gestational Age When Assessed (weeks)	34.677 ± 2.7610
Gestational Age (weeks)	31.273 ± 3.1848
Birth Weight(kg)	1.539± 0.644
Mother's Age (years)	31.53 ± 4.361

Table 3: Changes in Anderson Behavioural State Scale

Behavioural State	No. of kids pre intervention	No. of kids post intervention
Fussy/Crying(Eyes open or closed)	5	1
Awake and Alert(Eyes open)	4	11
Drowsy (Eyes open or closed)	7	9
Quiet Sleep(Eyes Closed)	14	9

Table 4: Non Nutritive Suck Scale Pre and Post Intervention and p Value

Non-Nutritive Suck Scale	PRE	POST	p value
Non Nutritive Suck Score - Positive	34.83±14.218	69.33±18.903	0.00
Non Nutritive Suck Score – Negative	-5.07 ±3.542	-1.80 ±2.203	0.004
Non Nutritive Suck Score - Total	29.77 ±16.978	67.53 ±19.732	0.00

Table 5: Sucking Rhythm Pre and Post Intervention and p Value

Gestational age when assessed	Sucking rhythm PRE	Sucking pressure POST	p value
30-32 week	4	8.66	0.00
33-35 week	4.235	8	
36-38 week	5.33	9.33	
39-41 week	3	9	

Table 6: Mean Of Negative Components in Non Nutritive Suck Score Pre and Post Intervention

Weight	Mean of NNS negative components PRE	Mean of NNS negative components POST
0.5-2 kg	-5.08	-1.37
2-3.5 kg	-5	-3.5

Table 7: Togue and Jaw Co-Ordination Pre and Post Intervention and p Value

Gestational age when assessed	Tongue and jaw co-ordination PRE	Tongue and jaw co-ordination POST	p value
30-32 week	6.5	10.833	0.00
33-35 week	5.647	9.117	
36-38 week	6.666	10.333	
39-41 week	6.25	8.75	

Table 8: Weight Gain and Quantity of Feed Pre and Post Intervention and p Value

Outcome Measures	PRE	POST	p value
Weight Gain (kg)	1.8689±0.659	1.9287 ± 0.627	0.00
Quantity of Feed (ml)	299.97±61.053	317.70± 67.627	0.00

Discussion

The following study was done to find out the immediate effects of premature infant oral motor intervention (PIOMI) on oromotor skills and neurobehavioral state regulation of preterm infants in NICU.30 preterm infants considered in this research whose mean gestational age (GA) when assessed was

34.67 weeks and mean birth weight was 1.539 kg.18 of the 30 samples taken were male (43%) and 24 were female (57%).

Ultrasound imaging has shown that the development of coordinated sucking and swallowing develops around 32-34 weeks. Out of 30 preterm participants in the study, 17 were between 33 and 35 weeks of gestational age. When compared to normative data, ideally, these babies should have developed a strong suck-and-swallow response to stimuli. However, all 30 of them showed a lag.

Respiratory, cardiovascular, and gastrointestinal system affection further limits the suck, swallow, and breathing coordination. Also, due to neurological immaturity and difficulty in organizing, achieving and regulating behavioural states, infants show a stressed response when oral feeding is given. Also, the NICU environment exposes infants to multiple stressors. These stressors include painful procedures, skin-breaking procedures, and several other physical, psychological, and sensorial stressors, including nursing procedures and maternal separation. These stimuli are noxious to their brain. There is evidence which shows that rapidly accumulating neonatal stressors are associated with poorer early brain development, adverse neurodevelopment outcomes and altered programming of the hypothalamic-pituitary-adrenal axis. The above scenario disturbs the neurobehavioral state of preterm infant and also causes delays in their developmental milestones. Therefore, responding to infants' behavioural cues is essential by working on all the systems, e.g., the autonomic system and the oromotor system.[10] As the American Academy of Paediatrics recommends full oral feeding before discharge from the hospital, achieving oral feeding becomes a fundamental goal for preterm infants.[7]

The readiness for oral feeding is related to behavioural state organization. Oral feeding is usually optimal when an infant is quiet, alert, or actively awake and aroused. When an infant is in deep sleep (seldom seen in preterm infants) or in light sleep, on the one hand, or highly aroused or agitated, on the other hand, feedings do not typically go smoothly and easily because the behaviours interfere with suck, swallowing, and breathe sequencing.

Table 3 shows there is significant improvement seen in babies quiet awake alert and alert state which are appropriate states for feeding. That may indicate that PIOMI given just before the feed improves babies' Neuro-behavioural states. During feeding, alert behavioural states substantially predicted good feeding efficiency. Recognizing the importance of behavioural states in relationship to oral feeding in preterm infants is very important to positively associate with better transition and attainment of competence with oral feeding in preterm infants.

Improving the neurobehavioral state aims to conserve the infants' energy for growth and facilitate physiological stability and the infants' recovery from illness.[10] Practising non-nutritive suck has been proven to improve the organization of an infant's state and thereby improve the regulation of motor activity, sleep/wake cycles, and heart rate.[11]

Table 4 shows statistical and clinical improvement in the NNS score of the preterm infants after PIOMI. There was a significant improvement in all the components i.e. in the initiation of suck, peristaltic tongue movements while sucking, jaw raising and lowering, coordination, strength and rhythm of suck.

Table 5 shows significant improvement in sucking strength and sucking rhythm after the intervention that may be attributed to improved labial sealing tongue strength, and peristaltic movement of the tongue, leading production of negative and positive pressure for suction and expression of the feed.

Synaptogenesis peaks continuously in the 1st year of life, i.e. brain development is genetically driven. There is massive over-production of synapses, followed by gradual reduction known as pruning. This process of pruning is highly dependent on the experience and learning that occurs during the first year of life, i.e. pruning is experience-driven.

When Non nutritive suck is practised repeatedly, there is robust wiring and rewiring of the pathways formed between the neurons, i.e., there is a strengthening of the synapses, which leads to the sustenance of those connections. When these pathways undergo myelination, the electrical impulses are transmitted faster. Synaptic pruning and myelination are responsible for the precision and speed of coordinated movements. Early experiences

and practice cause frequent firing of particular neurons in particular brain areas; therefore, there are better myelinations in those areas. [16]

Table 6 shows significant improvements in negative components, i.e., bites, excessive jaw excursion and stress signals (crying, hiccups, irritability). Non nutritive suck has a positive effect on the modulation of the behavioural state of the infant. It has been found to help the infant achieve and maintain physiological homeostasis and behavioural equilibrium.

Table 7 shows significant improvements in the mean tongue and jaw coordination score pre and post-intervention. These changes may be seen as PIOMI includes stretches to the central groove and lateral blade of the tongue, which significantly improves the length-tension relationship of tongue musculature, thereby improving tongue movements and timings. Tongue and jaw coordination are also influenced by experience, implying that some motor learning is involved. The principles of practise specificity and context specificity apply to motor learning. CPG are the neuronal circuits formed after Practising rhythmic motor activity. Sensory inputs from receptors carry information about the specific timings during rhythmic activity. When practised, rhythmic movements form smaller circuits; these circuits are organized, and higher brain centres control them. [15,16]

The tongue seals the oral cavity to create the positive and negative pressure needed for expression. A lack of tongue force production could cause a disturbance in force timing, which significantly impairs swallowing coordination. [7]. Research shows that there is sigficantnegative impact on tongue thickness when the a preterm baby is on OG/NG tube for longer time. [5]

When Non nutritive suck is practised repeatedly, extensive wiring and rewiring of the routes is made, i.e., synapses are strengthened, connections are maintained. Improved precision ,speed of coordinated movements are due to synaptic pruning and myelination of these connections formed in the brain. [16]

Birth weight is an essential mediator for the association between an infant's nutritional status and feeding pattern, as well as morbidity and mortality[13] Table 8 Shows a comparison of means of weight (in kg) on day 1 of intervention and day 3. There was statistically and clinically significant improvement with the value of 1.86 kg to 1.92 kg in preterm infants, which shows a significant improvement in feeding patterns, leading to weight gain. Non nutritive suck is a precursor to nutritive sucking. Non nutritive suck elicits regular oral movements of lips, tongue, jaw for the development of sucking, facilitating the development of oral skills for eventual feeding. Infants practised Non nutritive suck in each session just before the feed when they were given the feed. [7] PIOMI involves stretching the oral structures, i.e. cheek 'C' stretch, lip rolling and curling, and gum massage, which stimulates various tactile receptors and sends sensory inputs from respective structures promoting motor activity in babies as a function of reflexes. It improves muscle tone, thereby improving the quality, coordination, and rhythm of suck, therefore, helping in improving the weight of the infant and quantity of feed taken by preterm infants. Non nutritive suck stimulates the secretion of enzymes/hormones through the vagal nerve in the oral mucosa. Lingual lipase, gastrin, insulin are enzymes/hormones secreted which help in digestion and gastric emptying during non-nutritive sucking. Gastric emptying and faster digestion will increase the uptake of the feed taken by the infant. [11]

Conclusion

PIOMI is a standard protocol which is easy to administer and safe to use; neither is it cumbersome nor a time-consuming method of oral motor stimulation applied in just 5 minutes. The immediate effect of PIOMI shows that it has a statistically and clinically significant effect on oral motor skills, i.e. sucking strength, rhythm, lips-jaw-tongue coordination, which will help their transition from enteral to oral feeding early.

PIOMI also helps improve a preterm infant's neurobehavioral state, conserves the energy for growth and development, and improves their physiological stability and homeostasis. Practising Non nutrive suck significantly brings the infant to alert to an active state, which is considered the optimum state for feeding, therefore support the

infant in gaining optimum weight as per their gestational age and increase the quantity of feed.

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Original Research

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Effect of TheraBand Exercises on Rounded Shoulders Associated with Pulmonary Capacity in Young Adults: A Pre-Post Intervention Study

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Abstract

Background: A Rounded Shoulder Posture (RSP) is characterized by physiological changes in the breathing pattern of individuals. This leads to an imbalance in scapular kinematics which is crucial for overall health. Thera band training helps to improve muscle strength and flexibility of muscle. This study aims to assess the effect of Thera band exercise training on rounded shoulders association with pulmonary capacity in young adults.

Methodology: Twenty-three participants with RSP, participated in three weeks of the Thera band training program with progression in protocol consisting of 4 sessions per week. The pulmonary capacity was assessed with the help of a Spirometer and the rounded shoulder was assessed by using inch tape. Descriptive statistics analyzed demographic data and pre/post-treatment measurements. Statistical analysis included the paired t-test.

Result: The results showed improvement in rounded shoulder posture and pulmonary capacity after 3 weeks of the exercise training program. For rounded shoulder Thera band exercises showed statistically significant values ($p<0.001$). There's a slight increase in pulmonary capacity but statistically not significant ($p>0.001$)**.**

Conclusion: This study concludes that Thera band exercises can effectively improve rounded shoulder posture in young adults.

Keywords: Rounded shoulder posture, pulmonary capacity, Thera band, PFT.

Introduction

Rounded shoulder posture (RSP) is indicated by altered scapular kinematics (scapular protraction, downward rotation, and anterior tilt), as well as increased cervical lordosis and upper thoracic kyphosis.[1] With a frequency of about 60% in the general population, it is regarded as an inherent risk factor in the population with shoulder discomfort. According to reports, 78% of persons who experience pain at work have extended shoulders.[2] The shoulder posture developed from a prolonged, anteriorly inclined, internally rotated scapula and the shortness

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of the pectoralis minor muscles shows RSP, which can be defined by the acromion forward displacement in respect to the 7th cervical spinous process.[3] RSP can result in shoulder pain and dysfunction because of altered scapular kinematics and muscle activity, consequently placing increased stress on the shoulder.[4] The habitual slouched posture which is seen in everyday tasks can lead to RSP, it has also been identified as a major factor that may lead to upper quarter pain. RSP is also linked to improper postural habits, repeated overhead motions, carrying a backpack, mouth breathing, computer use, and extended study sessions.[5] Muscle imbalance and altered scapular kinematics put the shoulder under more strain, which can result in shoulder discomfort, dysfunction, and neuromuscular symptoms.[2] There are different techniques to evaluate posture such as using a plumb line, photography, radiography, Flexi curve, moiré topography, and electromagnetic tracking device. Electromyography is commonly used to study changes in muscle activity resulting from postural changes.[6]

The ideal respiratory function is made possible by the position of the neck and shoulder muscles, which directly support breathing.[7] This relationship between vital capacity and posture has previously been explored. Due to the posture-related tasks of respiratory muscles, any variation from the norm makes it more difficult for these muscles to efficiently carry out their duties. Previous studies it, has shown that lung capacity might fluctuate somewhat with changes in position.[8] The most often used objective functional respiratory assessments are pulmonary function tests (PFTs), which include spirometry, diffusion capacity, and lung volumes. The study of the features of the lung may be improved.[9]

Elastic resistance training (ERT) has gained popularity since the 1980s and is now widely used as a clinical tool. It provides several benefits, such as improved functional capacity, increased muscle activation, enhanced strength and endurance, better body composition, and improved quality of life. In ERT, elastic bands provide a combination of resistance and elasticity, allowing for adjustable resistance velocity and intensity. They offer a safe and convenient way to boost muscular strength, flexibility, and balance in people of all ages and genders, individuals with or without disorders can benefit from exercising with elastic bands.[10,11] However, there is a dearth of literature, and the effectiveness of Thera band training in improving pulmonary capacity remains unclear. Therefore, the study is to ascertain the effect of Thera Band exercises on rounded shoulders in pulmonary capacity in young adults.

In previous studies, Tae-Woon Kim investigates the effect of the elastic band exercise program on the posture of subjects with rounded shoulder and forward head postures. The findings of this study suggest that the elastic band exercise program is effective for lengthening the pectoralis major and correcting rounded shoulder and forward head posture.[12]

Materials and Methodology

The study was an experimental pre-post type of investigation for 2 months of the study duration, which was from May 2023 to July 2023, and was carried out at the Srinivas Institute of Physiotherapy in Pandeshwar, Mangalore. 23 young adults in this study, both male and female with ages varying between 18-23 years were included in this study. The three-week intervention for four days per week was the Thera band training program and pectoralis minor and major muscle stretching. Different resistance Thera bands were utilized for each week of the exercise program: red for the first week, green for the second, and blue for the third. Subjects who signed the consent forms were enrolled in this study. Approval for this study was given by an ethical committee of the Srinivas Institute of Physiotherapy, Pandeshwar, Mangalore.

History of cardiac surgeries, orthopedic conditions (Ex: shoulder impingement, rotator cuff injury), neuromuscular conditions (Ex: paresthesia, neuritis, nerve compression), respiratory conditions (Ex: asthma, pneumonia, dysphagia, breathlessness), recent fractures of rib, scapula, shoulder, clavicle

were part of the exclusion criteria of the study.

Participants were positioned in a supine (lying on their back) posture and asked to relax. The distance from the table to the highest point of their shoulder was measured. If this distance exceeded 2.5 centimeters, they were classified as having rounded shoulders. For the spirometry procedure, participants were seated, and a nose clip was applied. Using a portable spirometer (SP10 - RMS HELIOS 702 PFT) pulmonary capacity was assessed. The recorded pulmonary parameters included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and Peak Expiratory Flow Rate (PEFR). Before the actual measurement, participants were explained the procedure and instructed to take a few normal breaths, inhale deeply, and then exhale forcefully until their lungs were fully emptied.[8] To ensure accuracy, three attempts were made to familiarize participants with the process, and the mean value of these attempts, all the pre/post-treatment data were measured and recorded with descriptive statistics used in the SPSS software 24.0 version for statistical analysis.

Results and Discussion

The study included 23 participants who met the inclusion criteria. The pre-assessment revealed that the arithmetic mean for the rounded shoulder was 12.461 for the right side and 12.096 for the left side. After the intervention, the arithmetic mean for the rounded shoulder decreased to 11.460 for the right side and 10.99 for the left side. The study demonstrated a significant improvement in rounded shoulder posture on both sides ($p<0.01$) following the exercise protocol. The improvement in rounded shoulder posture is particularly important in alleviating shoulder pain, dysfunction, and neuromuscular symptoms that can arise from altered scapular kinematics and muscle activity. By restoring proper scapular positioning, the humeral head can be centered in the glenoid fossa, providing a stable foundation for shoulder motion and optimizing shoulder joint function.

Our study found a slight improvement in forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) after the three-week intervention, although the changes were not statistically significant ($p>0.05$). However, the short duration of the intervention may not have been sufficient to produce significant changes in pulmonary capacity.

Previous research has explored the relationship between rounded shoulders and pulmonary capacity, and it has been suggested that any deviation from normal posture can affect the efficiency of respiratory muscles. In individuals with rounded shoulders, the respiratory muscles, particularly the diaphragm and intercostal muscles, may not function optimally. Various studies showed that stabilization exercises and stretching exercises help improve rounded shoulder posture[12]. In general, respiration is an activity influenced by complex biomechanical factors and the stability of the cervical and thoracic regions of the spine is of great importance to smooth respiratory function[13].

The study's important finding is that Thera Band exercises can effectively enhance muscular strength and flexibility in different populations. The elastic bands provide both resistance and elasticity, enabling adjustable intensity and velocity of resistance during exercise. Thera Bands are also convenient, affordable, and safe to use, making them an attractive exercise option. Therefore, incorporating Thera Band exercises into rehabilitation programs for individuals with rounded shoulders could be a valuable and accessible intervention.

Further research with larger and more diverse samples, equal gender distribution, longer follow-up periods, assessing functional outcomes beyond muscle strength and pulmonary capacity, determining optimal training protocols, and exploring the benefits of combining Thera band with other interventions is warranted to enhance our insight into the prolonged effects and optimal protocols of Thera band training. The outcome of this study contributes to the growing body of knowledge on effective interventions for rounded shoulder with decreased pulmonary capacity and provides a foundation for future investigations in this field.

Table 1: Comparison of pre & post-rounded shoulder.

	Mean	N	Std. Deviation	P value
ROUNDED SHOULDER -Right (Pre-test)	12.461	23	1.2883	.008
ROUNDED SHOULDER -Right (Post-test)	11.460870	23	1.2346288	
ROUNDED SHOULDER -Left (Pre-test)	12.096	23	1.3670	.002
ROUNDED SHOULDER -Left (Pos- test)	10.995652	23	1.2469885	

Table 1 represents the comparison of pre and post-test outcome measures among the study participants. It may be observed from the above table that the pre-test and post-test rounded shoulder (Right) scores are 12.4 ± 1.2 and 11.4 ± 1.2 respectively and the difference is found to be statistically highly significant($p<0.01$). Further the pre-test and post-test rounded shoulder (Left) score is 12.09 ± 1.3 and 10.99 ± 1.2 4 respectively and using Paired-t test the difference is found to be statistically highly significant($p<0.01$).

Table 2: Comparison of pre & post-pulmonary function test

	Mean	N	Std. Deviation	P value
PFT FVC (Pre-test)	2.213043	23	.6757988	.001
PFT FVC (Post-test)	2.476087	23	.5905755	
PFT FEV1 (Pre-test)	2.166522	23	.8021313	.261
PFT FEV1(Post-test)	2.286087	23	.6304165	
PFT PEFR (Pre-test)	4.249565	23	1.7050793	.553
PFT PEFR(Post-test)	4.413478	23	1.7293026	

Table 2 represents the comparison of pre and post-test outcome measures among the study participants. It may be observed from the above table that the pre-test and post-test PFT FVC is 2.2 ± 0.67 and 2.47 ± 0.59 respectively and the difference is seen to be statistically highly significant($p<0.01$). The mean FEV1 pre-test and post-test values are found to be 2.16 ± 0.8 and 2.26 ± 0.63 respectively and the mean PEFR pre-test and post-test values were 4.24 ± 1.7 and 4.41 ± 1.7 respectively with $p>0.05$.

Conclusion

Our study's findings suggest that Thera Band exercises can be an effective intervention for improving rounded shoulder posture in young adults. Although the changes in pulmonary capacity were not statistically significant in this short-term study, the exercises could still be considered a viable option for improving posture and potentially enhancing shoulder function. Clinicians and physiotherapists may consider incorporating Thera Band exercises into rehabilitation programs for individuals with rounded shoulders to help achieve these goals.

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Original Research

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Additional Effects of Suboccipital Muscle Inhibition along with Conventional Approach on Pain, Physical Function and Range of Motion in Patients With Chronic Mechanical Low Back Pain: An Experimental Study

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Abstract

Background: Mechanical low back pain refers to back pain that starts intrinsically from the spine, intervertebral discs, or surrounding soft tissues. This includes lumbosacral muscle strain, disc herniation, lumbar spondylosis, spondylolisthesis, spondylolysis, etc. and this accounts for 97% of cases. It is characterized by increased pain with motion and decreased pain with rest. Repetitive trauma and overuse are common causative factors of chronic mechanical low back pain. The suboccipital muscle inhibition technique (SMIT) has been reported to be beneficial in reducing pain, increasing hamstring extensibility and reducing functional disability in chronic low back pain patients. So, the aim was to compare the effectiveness of suboccipital muscle inhibition technique along with conventional approach and conventional approach alone on pain, physical function and range of motion in patients with chronic mechanical low back pain.

Method: Total 46 patients were included and divided into two groups (23 in each group). Experimental group was treated with suboccipital muscle inhibition along with conventional approach and Control group was treated with conventional approach alone for 5 days a week for4 weeks. Inter-group analysis by Mann Whitney U-test and Unpaired t-test showed statistically significant difference in pain, physical function and lumbar flexion range of motion (P value ≤ 0.001).

Conclusion: Suboccipital muscle inhibition along with conventional approach was found to be more predominant in improving pain, physical functional and lumbar range of motion (flexion) in chronic mechanical low back pain than conventional approach. Also, suboccipital muscle inhibition and conventional approach were equally effective in improving lumbar range of motion (extension).

Keywords: Suboccipital muscle inhibition, Modified Modified Schober's Test, Modified Oswestry Disability Index

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Introduction

Low back pain (LBP) is the most common musculoskeletal symptom for referral to a medical practitioner (Dagenais, Caro, & Haldeman, 2008) [1] which results in a huge medical burden and economic cost [2,3] and one of the major global public health problems.[4-6] The World Health Organisation (WHO) defined LBP as pain localized below the margin of the last ribs (costal margin) and above the inferior gluteal lines, with or without lower limb pain and it is one of the most frequent causes of disability [7,8] all over the world. LBP is usually categorized in 3 subtypes: acute, sub-acute and chronic low back pain. These subdivisions are based on the duration of the back pain. Acute low back pain is an episode of low back pain for less than 6 weeks, sub-acute low back pain between 6 and 12 weeks and chronic low back pain for 12 weeks or more.[9]

The rate of prevalence of low back pain is reported to be as high as 84%, and the prevalence of chronic low back pain is about 23%, with 11–12% of the individuals being disabled by low back pain.[10]

Systematic reviews of risk factors for low back pain have suggested that physical risk factors such as prolonged standing and lifting heavy weights, an unhealthy lifestyle such as smoking and obesity and psychological factors such as distress increases the risk of a back pain episode.[11] A more recent systemic review found manual handling, bending, twisting and whole body vibration to be predisposing factors for LBP.[12] Red flag signs in LBP include saddle anesthesia, bladder/bowel involvement, asymmetric loss of deep tendon reflexes, pulse inequality, hypotension or circulatory instability.[13]

Mechanical low back pain is characterized by increased pain with motion and decreased pain with rest, whereas the pain of non-mechanical low back pain generally occurs at rest and is less affected by movement.[14] Typical physical findings are nonspecific, including restricted range of motion of the spine, tight hamstring muscles, paravertebral muscle spasms, muscular trigger points, tenderness and aggravation of symptoms on flexion or extension and straight leg raising tests.[15] There are several physiotherapy treatments for managing mechanical low back pain which include exercise therapy, manual therapy techniques, ergonomic advice, electrotherapy, spinal manipulative therapy.[16]

When the tone of suboccipital muscles reduces, it has been reported that the tone of knee flexors such as the hamstrings also reduces due to relaxation of the myofascia.[17] This is because the hamstrings and suboccipital muscles are connected by one neural system, which passes through the dura mater [18] which is called Myer's superficial back line.[19] The superficial back line is a fascial tract which connect various sections of the body to one another which comprises of the epicranial fascia, erector spinae cords, sacro-tuberous ligament, hamstrings, triceps surae and plantar fascia.[20] So, tightness or tender points in one or more muscles of the fascial tract can affect the movement of other joints which are included in the similar fascial tract.

The trigger points or tightness in suboccipital muscles may disrupt the function of hamstring muscle and tightness of hamstring muscle may be a contributing factor for development of low back pain. The hamstring is the muscle which often gets tight and its flexibility is important for the normal lumbar spine mechanics.[21,22] This can have profound effect on seated postural alignment of body and number of literatures showed positive correlation between decreased hamstring flexibility and low back pain of lumbar intervertebral disc pathology.[23,24]

The suboccipital muscle inhibition technique (SMIT) is one of the approach for the treatment of back pain. This is a manual and indirect technique which helps in relaxation of the suboccipital muscles by reducing myofascial restriction in the suboccipital region which can further help in increasing hamstring flexibility. So, the sub-occipital muscle inhibition technique has been reported to be beneficial in reducing pain, increasing hamstring extensibility and reducing functional disability in hamstring tightness and chronic low back pain patients.[25]

Materials and Method

Study design: An Experimental study

Study population: Patients with chronic mechanical low back pain.

Study setting: Physiotherapy OPDs in Vadodara

Study period: 4 weeks (5 times per week)

Study duration: 8 months (October 2022 – May 2023)

Sampling design: Convenient sampling method
Sample size: 46 patients

Inclusion criteria:

- Patients with mechanical low back pain (includes lumbosacral muscle strain, disc herniation, lumbar spondylosis, spondylolisthesis, spondylolysis, etc)
- Age group: 18-45 years
- Gender: Male and female
- Pain in low back lasting for more than 3 months
- Pain often referred to the buttocks and thighs
- Slump test positive
- Patients who were willing to participate in the study

Exclusion criteria:

- Any neurological conditions which affected the outcome and treatment protocol of the study
- Any systemic disease like rheumatoid arthritis, ankylosing spondylitis etc
- Any cardiorespiratory conditions which affected the outcome and treatment protocol of thestudy
- History of abdominal or back surgeries
- Any congenital deformities of lumbar spine or pelvis
- Pregnancy Materials used:
- Pen
- Measuring tape
- Plinth
- Consent form
- Hot pack
- Towel
- Weight cuff

Figure 1: Materials used

Outcome Measures:

1. Modified Oswestry Disability Index [MODI]

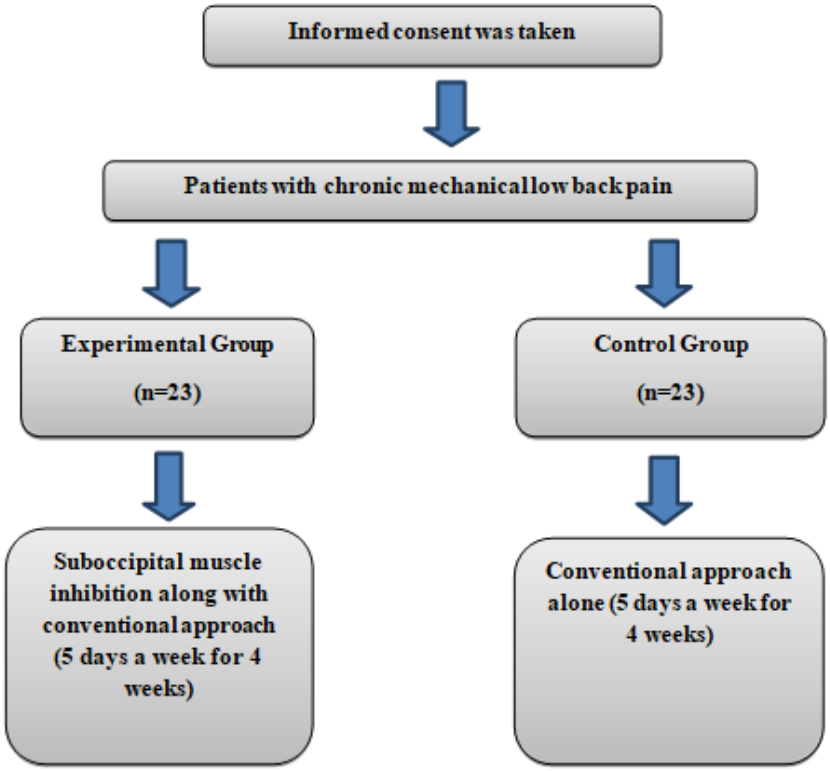
It is a valid and reliable 10-point patient-reported outcome questionnaire. It is considered the gold standard for measuring pain and physical function for adults with LBP. It has a Cronbach's alpha score of 0.892. The 10 factors which constitute the MODI criteria for assessing patients' functional impairment are pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, travelling and employement/homemaking.[26,27]

2. Modified Modified Schober's Test [MMST]

MMST is a valid and reliable method used for measuring lumbar flexion and extension ROM. MMST demonstrates moderate validity (r= 0.67; 95% CI 0.44 – 0.84), excellent reliability (intra:ICC= 0.95; 95% CI 0.89 – 0.97; inter: ICC= 0.91; 95% CI 0.83 – 0.96).[28] During lumbar flexion assessment, patients are taken in the standing position, whereas the examiner is in a kneeling position behind the patient. The posterior superior iliac spines are identified. A horizontal line is made between both posterior superior iliac spines. One ink mark is made at the level of the S2 vertebra, and another mark is made 15 cm above this mark. The examiner then fixes a tape measure between these marks. Next, the examiner instructs the patient to bend forward. The new distance between the two marks is measured. The change in the difference between the measurement marks in standing and in flexion are used to denote the amount of lumbar flexion. Lumbar extension is performed with the exception that the examiner instructs the patient to bend backward. Then, the new distance between the two marks is measured, and the change in the difference between the measurement marks in standing and in extension are used to denote the amount of lumbar extension.

Figure 2: Markings of MMST

Figure 3: MMST (Flexion and Extension)



Experimental group:

23 patients received suboccipital muscle inhibition along with conventional approach (5 days a week for 4 weeks). Patients were asked to lie flat on the plinth with eyes closed while suboccipital muscle inhibition technique was performed. In this, the therapist was in sitting behind the patient's head and placed both the hands under the patient's head making contact with the suboccipital muscles in the region of the posterior arch of the atlas, and the pressure was applied in the upward direction towards the ceiling for nearly 4 minutes until the tissues and muscles got relaxed. During this procedure, patient was asked to keep his eyes closed to avoid eye movements which affected the suboccipital muscle tone. Thereafter, SMIT was

followed by conventional approach which included series of exercises.

Figure 4: Suboccipital muscle inhibition

Control group:

23 patients received conventional approach alone (5 days a week for 4 weeks)

1. Static abdominals (10 seconds hold with 10 repetitions)
2. Prone straight leg raise with knee flexion (10 seconds hold with 10 repetitions) (Bilaterally)
3. Trunk extension exercise (10 seconds hold with 10 repetitions)
4. Latissimusdorsi stretch (30 seconds hold with 3 repetitions) (Bilaterally)
5. Stretching of lumbar spine muscles (30 seconds hold with 3 repetitions)
6. Iliopsoas stretch (30 seconds hold with 3 repetitions) (Bilaterally)
7. Single knee to chest: Lie in supine with knees bent and feet flat on the floor. Slowly pull the right knee towards the shoulder and hold 5 to 10 seconds. Lower the knee and repeat with theother knee (5 to 8 repetitions).
8. Lumbar flexion with rotation: Lie in supine with the arms stretched in abduction and knees bent. Rotate the knees on both sides alternatively (5 to 8 repetitions).

Results and Discussion

Data was analysed by IBM SPSS 29.0 software and Microsoft Excel 2019. Prior to the statistical analysis test, data was screened for normal distribution by Shapiro-Wilk test. According to normal distribution, tests were applied for within group (Wilcoxon Signed Rank Test) and between group (Mann Whitney U-test) for MMST and for MODI, within group (Paired t-test) and between group (Unpaired t-test).

Table 1: Baseline Data

GROUPS	EXPERIMENTAL GROUP	CONTROL GROUP
NO. OF SUBJECTS	23	23
	MEAN±SD	**MEAN±SD**
AGE	36.17±6.73	37.5±4.51
GENDER	FEMALE: 15	FEMALE: 11
	MALE: 8	MALE: 12

Table 2: Results of MMST and MODI Analysis (Between Experimental and Controlgroups)

Outcome Measures		Experimental Group	Control Group	U/t Value	P Value	Remarks
		Mean±SD	**Mean±SD**			
MMST	Flexion	3.86± 0.91	2.17 ± 0.17	-5.001	<0.001	Significant
	Extension	1.04 ± 0.76	0.78 ± 0.67	-1.19	0.234	Not Significant
MODI		23.47 ± 6.11	8.08 ± 3.04	10.801	<0.001	Significant

Here, the absolute difference was measured by Mann Whitney U-test for MMST (Flexion and Extension) and Unpaired t-test for MODI. As shown in the graph 1, it showed statistically significant difference in MMST (Flexion) and MODI. But, for MMST (Extension), it showed no statistically significant difference.

Hence, suboccipital muscle inhibition along with conventional approach was found to be more predominant in improving pain, physical function (MODI) and lumbar range of motion (flexion) than conventional approach. Also, suboccipital muscle inhibition and conventional approach were equally effective in improving lumbar range of motion (extension).

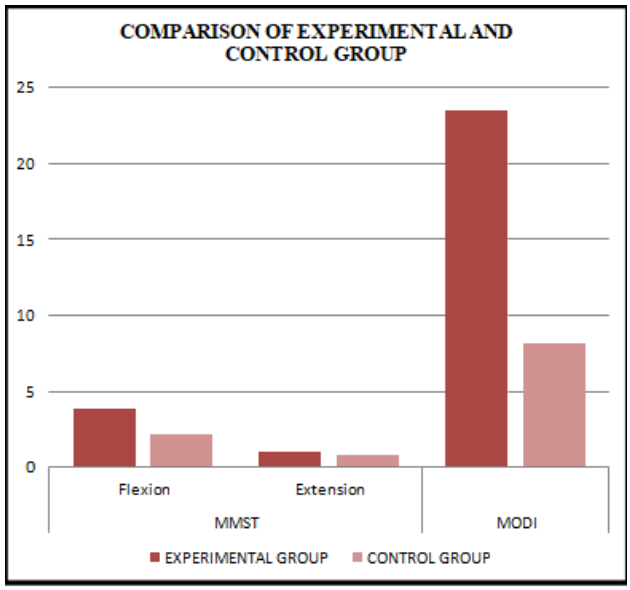


Figure 5: Mean difference between Experimental and Control groups (Pre vs Post)

In this study, additional effects of suboccipital muscle inhibition along with conventional approach in patients with chronic mechanical low back pain were examined. Pain, physical function were assessed by MODI and lumbar range of motion was assessed by MMST.

The first objective of this study was to determine the effects of suboccipital muscle inhibition on pain, physical function (MODI) and range of motion (MMST) in patients with chronic mechanical low back pain.

The basic component of the correlation between suboccipital muscles and human posture is the existence of muscle-fascial chains (MFC). Fasciae are dense, fibrous connective tissues that interpenetrate and surround the human body to protect, nourish and hold organs in original position. They surround muscles, bones, nerves and blood vessels and is densely populated with myofibroblasts and several types of receptors (nociceptors, proprioceptors, mechanoreceptors, chemoreceptors, thermoreceptors).[29] The fact that SMIT could increase the flexibility of lower limb muscles might be because the MFC was relaxed through relaxation of the suboccipital muscles.[30]

The results of Joshi Shabnam et al (2021) showed that a four-week treatment of suboccipital muscle inhibition technique in combination with interferential therapy and exercises significantly improved lumbar flexion and extension, reduced pain, functional disability, and enhanced the quality of life for patients with chronic lower back pain. This might be due to the fact that the lumbar spine and dura mater have an anatomical attachment, and changes in lumbar spine mechanics can affect dural tension, potentially leading to low back pain.[31]

The second objective of this study was to determine the effects of conventional approach on pain, physical function (MODI) and range of motion (MMST) in patients with chronic mechanical low back pain.

Hasaneen et al (2017) stated that the improvement in pain experienced by exercise group may be explained by physiological changes brought about by exercises, specifically the improvement in tissue blood flow. This improvement may facilitate the healing process by providing the affected area with more nutrients and oxygen, as well as facilitating the removal of irritant substances and waste products, thereby reducing low back pain. On the other hand, the improvement in the range of motion (ROM) of the lumbar spine in exercise group may be attributed to the effects of stretching exercises, which decreased excessive lumbar lordosis and reduced compressive force on the lumbar discs.[32]

The third objective of this study was to compare the effects of suboccipital muscle inhibition along with conventional approach and conventional approach alone on pain, physical function (MODI) and range of motion (MMST) in patients with chronic mechanical low back pain.

Basma H. Hasaneen et al in 2017 conducted a study named "Effects of the suboccipital muscle inhibition technique on pain intensity, range of motion, and functional disability in patients with chronic mechanical low back pain." 30 female patients with a mean age of 23.8±0.86 years with chronic mechanical low back pain were randomly assigned to two equal groups. Group A received exercise training (stretching and strengthening) plus suboccipital muscle inhibition treatment for five consecutive sessions. Group B received only exercise training (stretching and strengthening) for five consecutive sessions. Pre and post visual analog

scale and modified modified schober's test were used to analyze pain and range of motion. Study concluded that the suboccipital muscle inhibition technique combined with exercises had better clinical effects than exercises alone in patients with chronic mechanical low back pain.

In the current study, patients were assessed at baseline and after 4 weeks of therapy with suboccipital muscle inhibition and conventional approach. The results of this study showed statistically significant improvement in pain, physical function (MODI) and range of motion (flexion and extension) with the use of suboccipital muscle inhibition along with conventional approach and conventional approach alone (within group analysis). But, in between group analysis, suboccipital muscle inhibition along with conventional approach was found to be more predominant in improving pain, physical function (MODI) and lumbar range of motion (flexion) than conventional approach alone. Also, suboccipital muscle inhibition and conventional approach were equally effective in improving lumbar range of motion (extension).

Thus, suboccipital muscle inhibition along with conventional approach can be best implemented in the clinical practice for relieving pain, improving physical function and range of motion related to chronic mechanical back pain.

Conclusion

The results of this study supported the alternative hypothesis and showed statistically significant improvement in pain, physical function and lumbar range of motion in patients with chronic mechanical low back pain with the use of suboccipital muscle inhibition and conventional approach (within group analysis) by Wilcoxon's Signed Ranked Test and Paired t-test.

But, in between group analysis by Mann Whitney U-test and Unpaired t-test, suboccipital muscle inhibition along with conventional approach was found to be more effective than conventional approach alone.

All findings support the idea and concluded that suboccipital muscle inhibition along with conventional approach was found to be more predominant in improving pain, physical function and lumbar range of motion (flexion) than conventional approach alone. Also, suboccipital muscle inhibition and conventional approach were equally effective in improving lumbar rangeof motion (extension).

Limitations

- The duration of treatment was only 4 weeks, which was relatively short for determining thelong-lasting effects in chronic mechanical low back pain.
- In addition, there was no follow up assessment.
- Gender distribution was unequal.

Ethical clearance: Ethical clearance was obtained from The Institutional Review Board(PPC/OW/4018A/2022) from Pioneer Physiotherapy College, Vadodara.

Source of funding: Self

Conflict of interest: Nil

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Original Research

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A Comparison between Open Kinetic and Closed Kinetic Chain Exercises Along with Conservative Treatment in Grade-I ACL Injury in Sprinters: A Randomized Controlled Trail

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Abstract

Background: Anterior Cruciate Ligament (ACL) injury is most common in sports players such as soccer, basketball, sprinters, which causes alleviated strength in quadriceps muscles, and Range of Motion (ROM) of Knee Joint, and along with this, decrease in efficiency of knee that impacts person's Activity of daily living (ADL). So, after ACL injury, Rehabilitation protocol plays a great role in maintaining knee ROM, increases the strength of quadriceps muscles. This study aims to compare the effect of open kinetic chain exercises and closed kinetic chain exercises and compare to asses which type of protocol is much efficient for ACL-Injury rehab protocol.

Methodology: A comparative study was done over 50 male sprinters of 18-25 years old to assess the effect of Open Kinetic chain exercises (OKC) and closed kinetic chain exercises (CKC). Study was divided into 2 groups: OKC group and CKC group. In OKC Group, subject has to do flexor-extensor bench, isotonic quadriceps exercise and long leg press-off exercises with the conventional physiotherapy whereas in CKC group, subjects has to do wall sits exercises, standing weight shift, one-legged dips exercise, and squatting lunges along with the conventional physiotherapy. Each exercise was performed with 3 sets of 20 repetition, 3 days/week for 45 days. The data was collected from various academies of Satara, Maharashtra after obtaining the ethical permission. Subjects were explained about the procedure and protocol of research. ROM, Numeric Pain Rating Scale (NPRS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) scale were used as Outcome measures. Readings were noted on Day 0 and Day 45. The data was analyzed by using JASP Software.

Results: 25 subjects were there in both groups, with the mean age of 23.4 years in CKC group whereas the mean age is 23.44 in OKC group. The mean value of NPRS in OKC group is 4.280±0.843 and that of CKC groups is 4.160±0.624. And the mean value of Knee ROM in CKC group is 118±5 while that of in OKC group is 107.2±4.52.

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Conclusion: In summary, this study highlights the importance of a tailored rehabilitation program combining OKC and CKC exercises for Grade-I ACL injuries in sprinters. Both exercise types play a crucial role in restoring knee function and strength. As per our study, CKC exercises are better than OKC exercises. So, CKC exercises should be incorporated into rehabilitation program of grade-I ACL injuries.

Keywords: OKC Exercise, CKC exercise, KOOS Scale.

Introduction

Knee orthopedic disorders are widespread and can result in an athlete's withdrawal from training and competition. ACL injuries are common in sports where the knee rotates, such as soccer, basketball, sprinters, and skiing [(1)].ACL injuries in sub-elite and elite football players may be caused by a combination of external and intrinsic factors. Australians Rules Footballers (ARF) exposes patients to high-risk behaviors such as cutting, rotating, and landing regularly; these motions are often recognized mechanisms for ACL injury [(2)]. Anterior cruciate ligament (ACL) injury and reconstruction alters the kinematic characteristics of the knee joint during walking. The changed gait pattern could be caused by quadriceps femoris muscle weakness, knee joint edema, joint tissue derangement, or muscle inhibition caused by discomfort [(3)]. The restoration of muscle volume and strength (force-generating ability) following anterior cruciate ligament repair (ACL-R) remains a recovery issue. Interventions that can safely and efficiently overload muscle early are required to reduce the residual atrophy and weakening that is often resistant to normal management measures[(4)]. As per previous studies, the use of progressive, high-force eccentric resistance is found to safely increase muscle volume and strength in a variety of populations, including people who have had an ACL-R reconstruction[(4)]. Various studies demonstrated that it is possible to do OKC exercises for quadriceps strengthening without overloading the graft by giving a restricted ROM, performing quadriceps activation between 90° and 45° of knee flexion [(5)]. While few studies suggest that CKC exercises are popular and more effective because they are safer, more useful, and equally effective in increasing quadriceps femoris muscle force generation. They are thought to be a better alternative to OKC exercises because they are less likely to produce patellofemoral pain, imitate functional movements, and lead to increased function [(6)] So, there is a dire need to study the effect of OKC and CKC exercises on quadriceps muscle strengthening, ROM of Knee flexion, Pain and compare the effect of both so as to conclude that which one is better.

Materials & Methodology

A comparative study was done on 50 sprinters of the age group 18-25 years old male to analyze the comparative effect of open chain kinetic exercises and closed chain kinetic exercises on all components of ACL grade-1 tear. Sprinters of age 18-25 years old male who are long jumpers were included in this study. Sprinters with a previous history of surgery of lower extremities, previous history of Physiotherapy for ACL repair in the last 6 months, and with history of any pathological condition in lower extremities were excluded from the study. After obtaining the ethical approval from IEC of MCPRC with reference no. MCP/RP/2023/009 and date 17 September 2023, approached coaches of various sports academies of sprinters of Satara and few of them allowed for the study. Then, Data was collected from academies of Satara, Maharashtra and were randomly divided into 2 groups: Group A (OKC Group) and Group B (CKC Group). All the procedures were explained to each and every subject and a formal written informed consent was taken from each subject. After all this, NPRS reading, ROM of Knee joint, and KOOS reading were noted at day 0 on MS-Excel.

Group A (OKC Group) subjects have to perform Conventional Physiotherapy such as ATM (Ankle toe movement), Quadriceps, Hamstrings isometrics, and SLR for up to 50 degrees; and open kinetic chain exercises of knee joint such as flexor-extensor bench, isotonic quadriceps exercises, long leg press on-off exercises.

Group B (CKC Group) subjects have to do conventional physiotherapy and Closed chain kinetic exercises such as wall sits exercises, standing weight shifts, one-legged dips exercises, and squatting lunges.

Each exercise was performed with 3 sets of 20 repetitions and the protocol was given for 3 days/ week with alternate rest periods. This protocol was continued for 45 days.

After the whole protocol of 45 days, ROM of the knee joint, NPRS, and KOOS were noted. The data was analyzed using paired t-tests in within the groups and between two groups using JASP Software.

Results

Table no. 1: shows the demographic detail of CKC and OKC groups

Demographic Details				
	CKC Group		OKC Group	
	n	Mean ± SD	n	Mean ± SD
Age	25	23.4±1.118	25	23.44±1.083
Weight (Kg)	25	76.6±1.08	25	74.12±1.092
Height (m)	25	1.78±0.022	25	1.77±0.013
BMI	25	24.18±0.782	25	23.662±0.48

According to table no. 1:

The mean age of group CKC is 23.4±1.118 while that for the group OKC is 23.44±1.083. The mean value of Weight (Kg) for the CKC group is 76.6±1.08 and that of the OKC group is 74.12±1.092.The mean value for height (m) for the CKC group is 1.78±0.022 whereas that of the OKC group is 1.77±0.013. The mean value for BMI in the CKC group is 24.18±0.782 and that for the OKC group is 23.662±0.48.

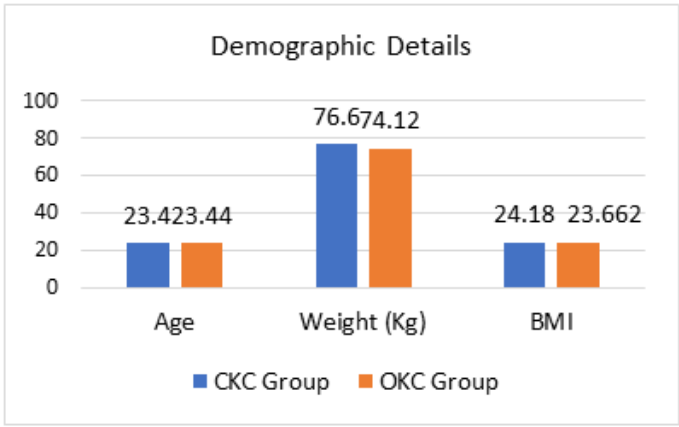

Figure No. 1 Shows the demographic details of various parameters of CKC and OKC Group

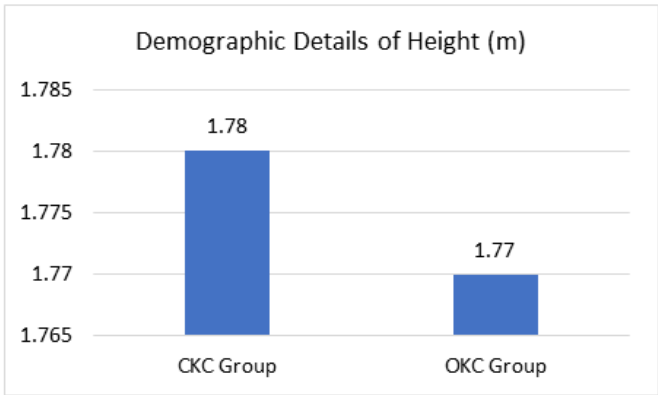

Figure No. 2 show the demographic details of height (in m) for OKC and CKC Group

Table no.2: shows the pre and post values of various parameters of CKC group

			Mean ± SD	t-Value	df	p-value
	NPRS	Pre	7.4±0.5	22.394	24	< .001
		Post	4.160±0.624			
	Knee ROM	Pre	40.36±3.094	-64.709	24	< .001
		Post	118.0±5			
KOOS	Symptom	Pre	46.52±2.502	-27.436	24	< .001
		Post	65.920±2.04			
	Pain	Pre	42.92±3.957	-34.779	24	< .001
		Post	72.04±3.129			
	ADL	Pre	49.16±1.179	-77.864	24	< .001
		Post	78.68±1.406			
	Sports/Recreational Activity	Pre	41.2±4.153	-32.441	24	< .001
		Post	74.6±3.2			
	QOL	Pre	38.24±4.918	-23.792	24	< .001
		Post	67.8±3			

According to table no. 2:

The mean value of NPRS for Pre- data is 7.4±0.5 whereas that of post-NPRS is 4.160±0.624, and the t-value for NPRS is 22.394, and the significance value is <0.001. The mean value of Knee flexion ROM for pre is 40.36±3.094 and that of post value is118.0±5; & t-value for ROM is -64.709 with a p-value is <0.001. The mean value of symptom for pre-data is 46.52±2.502 whereas that of post value is 65.920±2.04 and the t-value for this is -27.436 and the p-value is <0.001. The mean value of pre for KOOS-Pain is 42.92±3.957, the post value is 72.04±3.129 and the t-value for this is -34.779 and the p-value is <0.001.The mean value of KOOS-ADL for pre- is 49.16±1.179 and that of the post is 78.68±1.406; the t-value is -77.86 and the p-value <0.001. Mean value of Sports/ Recreational Activity for pre-value is 41.2±4.153 while that of the post is 74.6±3.2; the t-value is -32.44 and the p-value is <0.001. The mean value of KOOS-QOL for pre-data is 38.24±4.918 and that for the post is 67.8±3; the t-value is -23.79 and the significance value is <0.001.

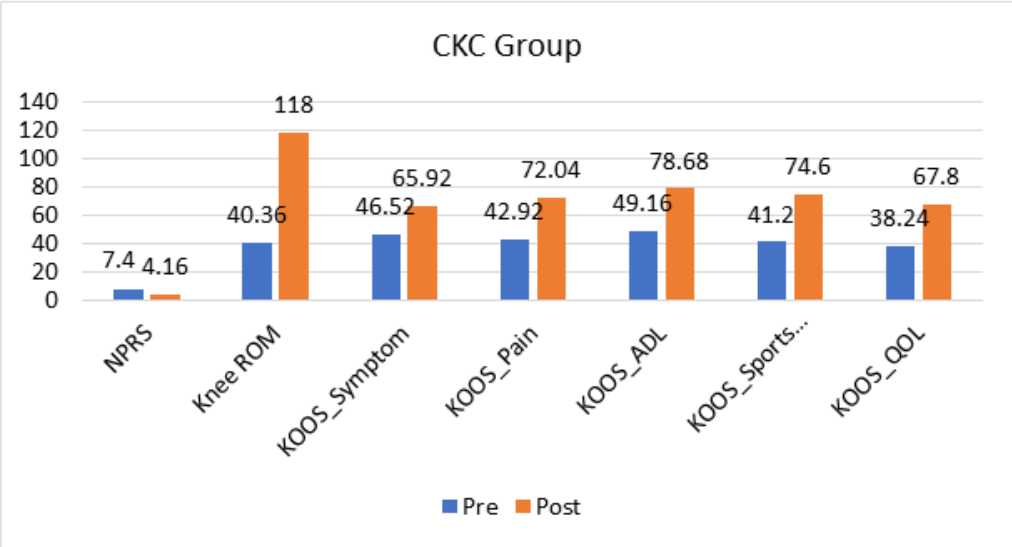

Figure No. 3: Shows the mean values of pre and post values of all parameters for CKC Group.

Table no. 3: Shows the pre and post values of various parameters of OKC group.

			Mean ± SD	t-Value	df	p-value
	NPRS	Pre	6.560±0.507	21.049	24	< .001
		Post	4.280±0.843			
	Knee ROM	Pre	45.440±4.417	-49.119	24	< .001
		Post	107.2±4.528			
K O O S	Symptom	Pre	42.280±2.77	-21.264	24	< .001
		Post	61±2.958			
	Pain	Pre	42.640±2.58	-32.750	24	< .001
		Post	65.68±2.795			
	ADL	Pre	40.6±1.871	-89.077	24	< .001
		Post	66.56±1.685			
	Sports/Recreational Activity	Pre	35.6±4.163	-26.400	24	< .001
		Post	64.8±3.055			
	QOL	Pre	39.04±4.532	-27.149	24	< .001
		Post	65.64±3.04			

According to Table No. 3:

The mean value of NPRS for Pre- data is 6.56±0.507 whereas that of post-NPRS is 4.28±0.843, and the t-value for NPRS is 21.049, and the significance value is <0.001. The mean value of Knee flexion ROM for pre is 45.44±4.417 and that of post value is107.2±4.528; & the t-value for ROM is -49.119 with a p-value is <0.001. The mean value of KOOS-Symptom for pre-data is 42.28±2.77 whereas that of post value is 61±2.958 and the t-value for this is -21.264 and the p-value is <0.001. The mean value of pre for KOOS-Pain is 42.64±2.58, the post value is 65.68±2.795 and the t-value for this is -32.75 and the p-value is <0.001. The mean value of KOOS-ADL for pre- is 40.6±1.871 and that of the post is 66.56±1.685; the t-value is -89.077 and the p-value <0.001. Mean value of KOOS-Sports/ Recreational Activity for pre-value is 35.6±4.163 while that of the post is 64.8±3.055; the t-value is -26.4 and the p-value is <0.001. The mean value of KOOS-QOL for pre-data is 39.04±4.532 and that for the post is 65.64±3.04; the t-value is -27.149 and the significance value is <0.001.

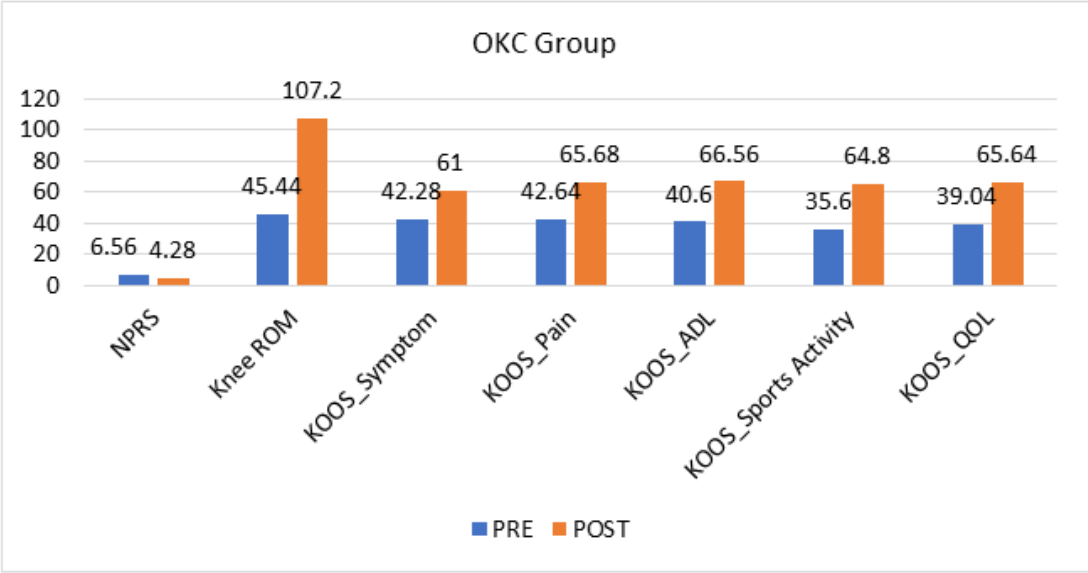

Figure No.4: Shows the mean values of pre and post values of all parameters for OKC Group

Table No. 4: Shows the post values of various parameters of CKC and OKC group.

			Mean ± SD	t-Value	df	p-value
	NPRS	CKC	4.160±0.624	-0.549	24	0.588
		OKC	4.280±0.843			
	Knee ROM	CKC	118±5	7.63	24	< .001
		OKC	107.2±4.528			
KOOS	Symptom	CKC	65.92±2.04	7.23	24	< .001
		OKC	61±2.958			
	Pain	CKC	72.04±3.129	10.757	24	< .001
		OKC	65.68±2.795			
	ADL	CKC	78.68±1.406	28.224	24	< .001
		OKC	66.56±1.685			
	Sports/Recreational Activity	CKC	74.6±3.202	10.019	24	< .001
		OKC	64.8±3.055			
	QOL	CKC	67.8±3	2.377	24	0.026
		OKC	65.64±3.04			

According to Table No. 4:

The mean value of NPRS for CKC- data is 4.16±0.624, whereas that of OKC- NPRS is 4.28±0.843, the t-value for NPRS is -0.549, and the significance value is 0.588. The mean value of Knee flexion ROM for CKC is 118±5 and that of OKC value is107.2±4.528; & t-value for ROM is 7.63 with a p-value is <0.001. The mean value of KOOS-Symptom for CKC data is 65.92±2.04 whereas that of OKC value is 61±2.958 and the t-value for this is 7.23 and the p-value is <0.001. The mean value of CKC for KOOS-Pain is 72.04±3.129, the OKC value is 65.68±2.795 and the t-value for this is 10.757, and the p-value is <0.001.The mean value of KOOS-ADL for CKC is 78.68±1.406 and that of the OKC is 66.56±1.685; the t-value is 28.224 and the p-value <0.001. Mean value of KOOS-Sports/ Recreational Activity for CKC-value is 74.6±3.202 while that of the OKC is 64.8±3.055; the t-value is 10.019 and the p-value is <0.001. The mean value of KOOS-QOL for CKC- data is 67.8±3 and that for the OKC is 65.64±3.04; the t-value is 2.377 and the significance value is 0.026.

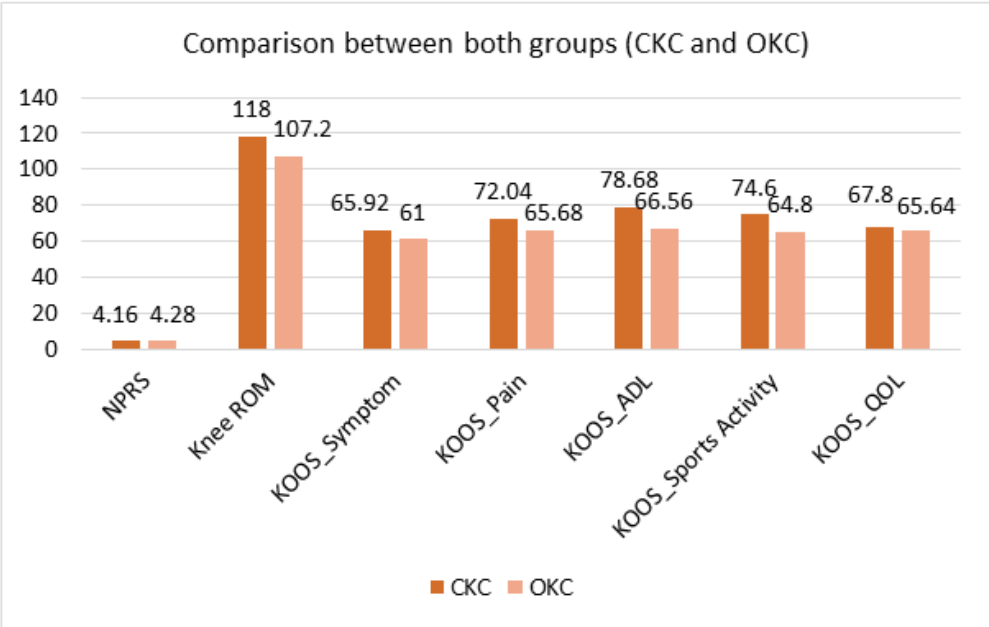

Figure No. 5: Shows the post mean values of CKC and OKC groups

Discussion

This randomized controlled trial is conducted on 50 Sprinters to evaluate the effect of OKC group of exercises and CKC group of exercises in ACL Grade-I injury on NPRS, maintaining Knee ROM, KOOS-scale. There are various studies conducted till now on open and closed chain kinetic exercises but very few of them shows comparison in between these. In this current study, sprinters were divided into 2 groups i.e. CKC and OKC groups. This study includes NPRS, Knee flexion ROM and KOOS scale as outcome measures.

According to this study, there is significant improvement in pain in CKC group as the mean value of CKC group is 4.16±0.624 whereas mean value of OKC group is 4.28±0.843. A study conducted by *MehmatUcar; 2014; Journal of Physical Sciences;* shows that there is significant changes in pain rating due to CKC group of exercises as compared to OKC group[7].

The current census shows that improvement in knee Flexion ROM in both groups but there is significant improvement in CKC group as compared to OKC group. CKC exercises performed while weight-bearing are more effective at muscle strengthening and increasing joint range of motion. CKC exercises are considered to be better for restoring normal knee function and weight-bearing [7].As per the previous study, closed kinetic chain exercises are conclusively better in improving quadriceps strength and Functional status of patients suffering from Anterior cruciate ligament reconstruction than open kinetic chain exercises [8, 9].

The current study suggests that there is improvement in KOOS scale in both groups but a significant improvement in CKC group as compared to OKC group. Studies suggest that rehabilitation of ACL reconstruction, CKC exercises are more effective than OKC exercises, at providing mobilization and enabling a quicker return to daily and sporting activities.

So, according to the current study, CKC group of exercises are better than OKC group of exercises therefore, we should incorporate these exercises in the rehabilitation protocol of ACL injury patients.

Limitation of the study:

This study is subject to a small sample size, potentially limiting the generalizability of findings. Furthermore, the utilization of a limited number of outcome measures may restrict the comprehensiveness of the investigation.

Conclusion

In conclusion, this study highlights the significance of a personalized rehabilitation program combining open kinetic chain (OKC) and closed kinetic chain (CKC) activities for sprinters with Grade-I ACL injuries. Both types of exercises are critical in recovering knee function and strength. According to our research, CKC exercises are superior to OKC exercises. As a result, CKC exercises should be included in the rehabilitation program for grade I ACL injury.

Conf ict of interest: There is no conflict of interest

Source of Funding: self

Ethical clearance: From MCPRC with reference no.

MCP/RP/2023/009 and date 17 September 2023

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Original Research

https://doi.org/10.37506/rrjjf209

Grip Strength Assessed using a Hand Grip Dynamometer and Michigan Hand Outcome Questionnaire as Predictors of Work-Related Musculoskeletal Disorders using Rapid Upper Limb Assessment among Power Loom Silk Weavers

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Abstract

Background: Sericulture is a labor-oriented agro-based industry that significantly elevates India's rural economy. During weaving operations, workers adopt awkward postures and work long hours, which is one of the most important factors in their poor working efficiency and prevalence of musculoskeletal disorders.

Objectives: This study aimed to find the correlation between grip strength, the Michigan hand outcome questionnaire (MHQ), and work-related postural disorders among power loom silk weavers.

Design: Correlation study.

Methods: This study was conducted in a community setting. 120 power loom silk weavers were screened for work-related musculoskeletal disorders. A face-to-face interview was conducted to assess Grip strength, hand function, and work-related musculoskeletal disorders using the Hand dynamometer, MHQ, and RULA scales, respectively.

Results: By Spearman's correlation, the correlation between Bilateral Hand grip strength and MHQ was statistically significant $p<0.001$ and shows a strong positive correlation ($r = 0.787$) for right hand and ($r = 0.741$), a strong negative correlation ($r = -0.594$) for right hand and ($r = -0.538$) for left hand was found between bilateral hand grip strength and RULA and the correlation between MHQ and RULA scores were statistically significant ($p<0.001$) shows a strong negative correlation ($r = -0.583$).The intercept is 8.298. An increase in MHQ (-0.022) and right-hand grip strength (- 0.030) will decrease RULA scores.

Conclusion: The study concluded that subjects with reduced hand grip strength and hand function were at higher risks of developing work-related musculoskeletal disorders, and hand grip strength and MHQ are equally good predictors of these disorders.

Key Words: RULA, Grip strength, MHQ.

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Introduction

Weaving is among the foremost tedious professions requiring long hours of static work. Joint and back pain are highly significant thanks to their working postures like bending, stretching, and moving front to back.[4] Despite the national importance of the weaving industry and its impact on the country's overall economy, there needs to be more ergonomic studies of weavers' work.[5]

Musculoskeletal disorders (MSDs) are disorders of the soft tissues and their surrounding structures that do not result from an acute or instantaneous event.[6] Work-related musculoskeletal disorders is a term used to describe a painful or disabling injury to the muscle, tendon, or nerves caused or aggravated by work.[7] Work-related musculoskeletal disorders (WMSDs) of the upper extremities are common causes of pain and functional decline and may cause significant distress and disability. Identifying the factors related to reduced upper extremity function may cause the event of more straightforward interventions. Various risk factors may include biomechanical and environmental conditions such as physical workload, unfavorable body posture, vibration, and psychosocial factors such as time pressure and repetitive or monotonous tasks.[8] One of the most contributing factors to upper extremity work-related musculoskeletal disorders (WMSD) is forceful exertions.[9]

The majority of workers in the power-loom industry are involved in repetitive tasks, unnoticed, and suffering from acute repetitive strain injuries; hence, it was felt essential to explore the prevalence of musculoskeletal disorders[8].

Many daily activities require grip movements, which are vital in many workplace environments; much research has been done to identify different biomechanical aspects of grip strength. In the workplace, manual activities involving grip represent a continuum of tasks, ranging from relatively dynamic movements that involve concentric and eccentric muscular contractions to relatively static functions that require a continual, steady force, typically producing an isometric contraction over a reasonably prolonged period.[10]. For a worker to perform the job without fatigue and possible musculoskeletal disorders, the worker's strength must meet or exceed the force demanded to finish the tasks. Maximal grip strength is measured using dynamometers, which estimate the muscle strength primarily generated by the hand's flexor muscles and forearm.[8] Literature states that complaining of upper extremity pain in a work environment can result in decreased handgrip power, which can be used as a diagnostic measure of functional decline. Hand function has excellent significance for occupational performance. The greater the difficulties with hand function, the greater the impairment in skills that allow independence and participation in academic and social activities.[11]

Studies showed handgrip strength can be used as a diagnostic tool in musculoskeletal disorders of the upper extremities.

An improved understanding and awareness of potential environmental causes of work-related musculoskeletal problems may contribute to work organization and workplace design improvements. Improvedergonomics could result in reduced stress levels and musculoskeletal complaints.

Methodology

Inclusion Criteria:

- The subject population is between the ages of 21 and 65.
- Weaver population in power loom silk industry
- Subjects willing to participate and willing to sign a consent form

Exclusion Criteria:

- Known cardiovascular/ neuromuscular dysfunction. - Any pain related to trauma or recent fractures (within 2 years).
- History of pre-existing metabolic, endocrine disorder, or infection that might affect the musculoskeletal system.
- Subjects participated in similar studies previously.

Procedure

This study was done in Channapatna, Kanakapura, Magadi, and Ramanagara Taluka of Ramanagara district. Workers aged 21 to 65 years

were screened for work-related musculoskeletal disorders and requested to participate as volunteers in the study. After explaining the purpose of the study, informed consent was obtained from the selected subjects. Subjects were recruited based on the inclusion and exclusion criteria.

Rapid upper limb assessment for work-related posture- RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. The RULA ergonomic assessment tool considers biomechanical and postural load requirements for job tasks/demands on the neck, trunk, and upper extremities. A single-page worksheet evaluates required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist and section B for the neck and trunk. After the data for each area is collected and scored, tables on the form compile the risk factor variables, generating a single score representing the MSD risk level.

Michigan Hand Outcome Questionnaire for hand function- The Michigan Hand Outcomes Questionnaire (MHQ) assesses patients with hand disorders by measuring 6 health domains: overall hand function, activities of daily living (ADLs), pain, work performance, aesthetics, and patient satisfaction. Grip Strength using Charder Handgrip dynamometer. [MG4800]

The participants would be comfortably seated on a seat without an armrest, with the shoulders abducted to the side, the elbow at 90^0 flexion, and the forearm in a neutral position. Standardized instructions were adopted and used as the American Society of Hand Therapists (ASHT) suggests. Three trials wer given, and an average was obtained for both hands.

Results

Table No. 1: Spearman's Rank correlation between the variables

Correlation between	r – value	P-value
Right-hand grip strength and MHQ (Right hand)	0.721	< 0.001
Right-hand grip strength and MHQ (Left hand)	0.738	< 0.001
Right-hand grip strength and MHQ	0.787	< 0.001
Right-hand grip strength and RULA	-0.594	< 0.001
Left-hand grip strength and MHQ (Right hand)	0.697	< 0.001
Left-hand grip strength and MHQ (Left hand)	0.703	< 0.001
Left-hand grip strength and MHQ	0.741	< 0.001
Left-hand grip strength and RULA	-0.538	< 0.001
RULA and MHQ (Right hand)	-0.532	< 0.001
RULA and MHQ (Left hand)	-0.548	< 0.001
RULA and MHQ (Total)	-0.583	< 0.001

This study did not usually distribute the data, so Spearman's rank correlation was calculated.

- The Spearman's rank correlation between Right-hand grip strength and MHQ Right hand is (r=0.721, p <0.001), which is a strong positive correlation.
- By Spearman's correlation, there is a strong positive correlation between Right-hand grip strength and MHQ Left hand (r= 0.738, p <0.001)
- By Spearman's correlation, there is a strong positive correlation between Right-hand grip strength and MHQ (r= 0.787, p <0.001),
- The Spearman's rank correlation between Left-hand grip strength and MHQ Right hand is (r=0.697,p<0.001), which is a strong positive correlation.
- By Spearman's correlation, there is a strong positive correlation between Left-hand grip strength and MHQ Left hand (r=0.703,p < 0.001),
- By Spearman's correlation, there is a strong positive correlation between Left-hand grip strength and MHQ (r=0.741, p < 0.001)
- By Spearman's correlation, there is a statistically significant negative correlation between Right-hand grip strength and RULA(r = -0.594, p<0.001),
- The Spearman's rank correlation between

Left-hand grip strength and RULAis (r= -0.538, p < 0.001), a moderate negative correlation.

- By Spearman's correlation, there is a moderate negative correlation between RULA and MHQ Right hand (r= -0.532, p< 0.001),
- By Spearman's correlation, there is a moderate negative correlation between RULA v/s MHQ Left hand (r = -0.548, p< 0.001) and
- By Spearman's correlation, there is a moderate negative correlation between RULA and MHQ Total (r = -0.583, p< 0.001)

Table 2: Regression

Multivariate regression model of RULA with MHOQ, right-hand grip, and left-handgrip	RULA = 8.298 -0.022 = MHQ - 0.030 = Right-hand grip strength + 0.011 = Left-hand grip strength

Taking RULA as a dependent variable, a multivariate regression model was fitted, taking MHQ, Right-Hand, and left-hand grip strength.

It was observed that the regression of MHQ is—0.022, for right-hand grip strength—0.03, and for left-hand grip strength + 0.011. Further, the RULA with MHQ and right and grip strength are negatively correlated, while Left-hand grip strength was positively correlated.

Discussion

The current study assessed grip strength and hand function as predictors of work-related musculoskeletal injuries in power loom silk weavers. Grip strength was evaluated using a hand dynamometer; the Michigan hand outcome questionnaire was used to assess hand functioning, and rapid upper limb assessment was used to evaluate the risk of musculoskeletal injuries in power loom silk weavers. 120 subjects, with a maximum of male workers (80%), participated in this study after signing the informed consent form. All the variables of grip strength, hand functions, and musculoskeletal risks were assessed along with other demographic data, and the findings were recorded. This study showed a significant correlation between the variables that accepted the alternate hypothesis and those that rejected the null hypothesis.

Sericulture is a labor-oriented agro-based industry that plays a significant role in elevating India's rural economy. India is the largest producer and consumer of silk in the world. During the weaving operation, workers adopt awkward postures and long working hours, which is one of the most critical factors for their poor working efficiency and the prevalence of musculoskeletal disorders. The current study found that 60% of weavers work 10-12 hours daily, whereas 40% work 13-16 hours daily. Musculoskeletal disorders (MSDs) are a common health problem and a significant cause of disability throughout the world. The economic loss due to such disorders affects the individual, the organization, and society.[27] Organizations and individuals can become better informed to reduce MSD injury risk by being aware of risk factors, becoming skilled in recognizing and categorizing these factors, and examining options to reduce the frequency or duration of exposure to the risk factors. Reducing exposure to risk factors should make the task smoother and more predictable. Reducing risk factor exposure should make task performance less variable. Although the causes of any case of MSD are exceedingly difficult to identify with complete accuracy, certain risk factors are typically discussed in the field of ergonomic studies.[28]

Hence, 120 power loom weavers were screened for work-related musculoskeletal disorders in the current study. It was observed that 70% of the workers faced various problems during their working hours, and the remaining 30% were at a high risk for developing work-related musculoskeletal disorders.

Hand grip strength is a practical, functional measure of the integrity of the upper extremity. An association between lower grip strength and future function or functional declines has also been reported. 29 In the present study, a moderate negative correlation was found between the hand grip strength of both hands and the risk of developing work-related musculoskeletal disorders. The results were like studies conducted to find the association between hand grip strength, cardiometabolic markers, and musculoskeletal disorders in Koreans. 30 Thus, it is concluded that hand grip strength is a

convenient and reliable measure to screen for work-related musculoskeletal risks. MHQ questionnaire includes (1) overall hand function, (2) activities of daily living (ADL), (3) pain, (4) work performance, (5) aesthetics, and (6) patient satisfaction with hand function. The MHQ is a reliable and valid instrument for measuring hand outcomes.[13] The present study shows a significant positive correlation(r = 0.787 for right hand & r= 0.741 for left hand) between hand grip strength and hand function; thus, a decreased hand grip strength can affect the hand functioning indirectly affecting the work performance and quality of life. It was also observed that according to Spearman's correlation, there was a moderate negative correlation (r= -0.583) between MHQ and RULA. In the regression analysis, the intercept is 8.298. An increase in MHQ and right-hand grip strength will decrease RULA scores. Indicating reduced grip strength and hand function can increase an individual's risk of developing work-related musculoskeletal disorders.

Limitations

- A larger geographical area could have been considered for better interpretation.
- Gender could have been equally considered.
- Other factors causing work-related musculoskeletal risks could have been documented.

Conclusion

The objectives of the study were to screen for work-related musculoskeletal disorders, assess Grip strength using a hand-held dynamometer and hand function using the Michigan hand outcome measure, fit a regression model of musculoskeletal disorder on grip strength and the Michigan hand outcome measure, and find the correlation between grip strength, the Michigan hand outcome questionnaire, and work-related postural disorders among power loom silk weavers.

By Spearman's correlation, the correlation between Bilateral Hand grip strength and the Michigan Hand Outcome questionnaire was statistically significant $p<0.001$ and shows a strong positive correlation ($r = 0.787$) for the right hand and ($r = 0.741$), a moderate negative correlation ($r = -0.594$) for the right hand and ($r = -0.538$) for the left hand was found between bilateral hand grip strength and RULA and the correlation between MHQ and RULA scores were statistically significant ($p<0.001$) shows a moderate negative correlation. ($r = -0.583$). The intercept is 8.298. An increase in MHQ (-0.022) and right-hand grip strength (- 0.030) will decrease RULA scores. Thus, the study concluded that subjects with reduced hand grip strength and hand function were at a higher risk of developing work-related musculoskeletal Conditions.

Ethical Clearance: Approval was obtained from the Institutional Ethics Committee (IEC) ofRV College of Physiotherapy®.(No: RVCP/RESEARCH/0620, Dated24.08.2021)

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Original Research

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COVID-19 Effects on Well-being and Academic Performance in Physical Therapy Graduate Students: A Cross-Sectional Study

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Abstract

Background: This study explores how the COVID-19 pandemic impacts sleep, fatigue, and academic performance in graduate students, including those in physical therapy programs, to guide support strategies during these challenging times.

Methods: A cross-sectional survey was conducted at Russell Sage College. Participants provided demographic information and reported their COVID-19 infection status, sleep quality, fatigue levels, and self-reported GPA. Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), fatigue was measured with the Fatigue Assessment Scale (FAS), and academic performance was assessed via grade point average (GPA). Given the limited sample size, data analysis utilized non-parametric tests, including the Mann-Whitney and Spearman's Rho tests.

Results: Sixty-two graduate students participated in the study, with 31 reporting a history of COVID-19 infection. Results showed no significant difference in sleep quality, fatigue, or GPA between students with and without a COVID-19 diagnosis. However, students with a COVID-19 diagnosis reported slightly higher scores than those without on the PSQI (7.39 vs. 6.91) and FAS general fatigue (26.17 vs. 24.17), and slightly lower GPA (3.67 vs. 3.7), although these differences were not statistically significant. The study also found a negative association between GPA and overall fatigue (r=-0.449; *P*=0.028) and mental fatigue (r=-0.422; *P*=0.04) in students with a COVID-19 infection.

Conclusion: This study suggests COVID-19 may affect fatigue levels in grad students, possibly impacting academic performance. Larger studies are needed for confirmation. Physical therapy students face challenges like disrupted sleep, heightened fatigue, and academic setbacks. Educators can adjust teaching methods to support students better.

Keywords: COVID-19, graduate students, sleep, fatigue, GPA, cross-sectional study.

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Introduction

In December 2019, in Wuhan, China, the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), also known as the pathogen of COVID-19, emerged.[1-5] The coronavirus is the largest known genome of RNA viruses, which had predominantly resided in animals but developed seven human strains. 535.8 million cases of COVID-19 have been confirmed globally and 85 million cases in the US since January 3, 2020.[6] Since the beginning of the COVID-19 pandemic, there have been 6.3 million deaths globally and 1 million deaths in the US between January 3, 2020, and June 16, 2022.[6] The pandemic swiftly overwhelmed healthcare and economic systems. Still, to reduce mortality rates, emergency treatment and prevention were prioritized. Treatment and management of COVID-19 are based on the symptoms and severity, and symptoms can vary between individuals. Still, the typical treatment includes supportive care, such as oxygen therapy or mechanical ventilation, antiviral agents, corticosteroids, convalescent plasma, and immunomodulatory agents.[2]

Clinical Manifestations

Acute

The most common symptoms reported among patients with COVID-19 include sleep impairments/insomnia[1,7-9], shortness of breath[8-11], fatigue/exhaustion[8-14], joint pain[10,14-16], chest pain[10,15,16], fever[1,11,14], dysguesia[7,17,18], headache[7,14,18,19], hyposmia[7,18], anosmia[17] depression[7,18], and anxiety.[18]

Post-COVID Syndrome

Post-COVID syndrome encompasses persistent symptoms lasting beyond the initial infection, even in mild or asymptomatic cases, with fatigue, shortness of breath, chest pain, brain fog, memory loss, and attention issues being common. [20] The most common persistent symptoms include fatigue[8,15,19,21], shortness of breath/dyspnea[8,11,15], chest pain[15], brain fog, memory loss, and attention/concentration issues are becoming key features of the post-COVID-19 phase.[21]Neurological complications such as encephalitis, neuroinflammation, and altered neurotransmission are noted, with memory loss potentially taking up to three years to recover.[22-25] Executive function and other symptoms like sleep disorders, depression, and anxiety also emerge, warranting further investigation.

Who is suffering?

It is approximated that between 30-35%[20] and 40%[26] of the general health population is affected by sleep problems related to COVID-19, with patients being infected even more likely to have sleeping problems.[20,26] Patients recovering from an acute infection are more likely to report insomnia and fatigue than symptoms such as dyspnea and depression.[20] Patients who developed increased psychological distress/poorer mental health and increased sleep disturbances/insomnia included those who were women, married, had higher fatigue[9], had a positive infection status, were older in age, and received information regarding the pandemic via social media/online sources.[9,20] There is a complex association between fatigue, anxiety, and insomnia.[9] Fatigue has been associated with negative psychological outcomes including but not limited to cognitive impairment, depression, and a higher risk of insomnia in COVID-19 inpatients.[9] The inverse relationship also exists. Higher levels of anxiety in COVID-19 inpatients are associated with insomnia.[9] In France, during the last weeks of confinement, sleep problem prevalence decreased and continued to trend downwards one month after confinement.[27]Students in particular were affected more by confinement than workers.[27]

Fatigue is one of the most common symptoms that is present with COVID-19 infection.[28] Fatigue following COVID-19 infection is reported as a long-term outcome, with 64% reporting fatigue 3 months after, 54% at 6 months and 60% at 12 months.[29] Fatigue is defined as "a deliberating, non-transient feeling of physical and mental tiredness or exhaustion characterized by lack of energy, muscle weakness, slow reactions, drowsiness, and deficit in concentration".[30] The development of headaches during the acute phase of infection could promote the likelihood of post-COVID-19 fatigue.[19] There is a great amount of both central nervous system (CNS) and peripheral nervous system (PNS) involvement in COVID-19. Chronic post-inflammatory CNS disturbances may negatively impact sleep, pain sensitivity, and energy leading to the development of fatigue syndrome.[18] Patients who experienced COVID-19 report cognitive,

mental, and neuromuscular fatigue as COVID-19 manifestations. Cognitive fatigue is the decline in cognitive functioning including vigilance, executive function, judgment, and long-term memory recall. Fatigue is assessed through a number of instruments including the Fatigue Rating Scale (FRS)[30], Fatigue Severity Scale (FSS)[13], Chadler Fatigue Scale (CFQ-11)[28], and questionnaires. The Fatigue Rating Scale is based on the perceived intensity of fatigue from zero to ten, respectively from no fatigue to extreme fatigue, where greater than or equal to six indicates a substantial level of fatigue.[30] The results from these scales demonstrate that post-COVID-19 patients experience a sense of tiredness and lack of energy which affects activities of daily living.[30]

The only way to collect data on who has or has had a COVID-19 infection is from individuals who self-report to agencies who specifically collect that information such as doctors offices, workplaces, etc. Among American college students, racial and ethnic minorities, lower socioeconomic households, individuals with children, and working and athletic students are more likely to report a COVID-19 infection.[31]

COVID-19 has been investigated in severe or general older adult populations, but not in specific younger adult populations, such as graduate students. Besides the typical clinical manifestations of COVID-19, a variety of neurological manifestations have been uncovered that could lead to long-term sequelae relevant to the graduate student population, such as memory loss, potential executive function issues, fatigue, and decreased quality of sleep.[10,21] Short-term responses of sleep disruption specifically, include an increase in stress response, somatic problems and increase of the sympathetic nervous system, lowered quality of life, emotional distress, mood/mental health disorders, and memory/ performance impairments compared to those with regular sleep patterns.[32] All could affect a student's grade point average (GPA).[33] Graduate programs are highly rigorous and require specific GPAs as a means to continue.[33] The symptoms persisting beyond the acute phase of COVID-19 infection, like fatigue, brain fog, and sleep difficulties, have an impact on mental health.[34] The average perceived fatigue score indicated moderate fatigue among students. Many students reported experiencing fatigue more than five days per week.[35] There is a positive correlation between fatigue and psychological distress among students. This may be due to the compounding psychological and physiological stress associated with the unprecedented COVID-19 experience.[35]

The current research consists of the effect of sleep, unrelated to COVID-19, on the academic success/ GPA of physical therapy graduate students.[33] There is no research identifying the effects of COVID-19 on graduate students, sleep quality, fatigue, and GPA. Examining the effect of these on graduate students would benefit not only the specific population but also expand the knowledge of COVID-19 literature and identify potential differences amongst populations. This research compares the effects on sleep, fatigue, and GPA in graduate students at Russell Sage College with COVID-19 versus graduate students without COVID-19 infection.

Methods

Aim and design

This study was a cross-sectional design using a digital survey to assess the impact of COVID-19 on graduate students' sleep quality, fatigue level, and GPA. All participants provided written informed consent before beginning the study.

Participants

Participants were required to be Russell Sage College graduate students. The primary principal investigator sent a digital copy of the survey via global email to all graduate students at Russell Sage College.

Data Collection

Measures

Sleep: Pittsburgh Sleep Quality Index (PSQI)- The PSQI is a self-reported questionnaire that is aimed to assess sleep quality and disturbances over the past 1 month.[36] The questionnaire includes nineteen items, which make up seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, disturbances in sleep, sleep medication use, and daytime dysfunction, and takes 5-10 minutes to complete.[36,37] Questions are a mix of Likert-type

and open-ended questions.[37] Likert-type questions are scored 0-3, with higher scores indicating more sleep disturbances.[37] Scores are added to create a "global score."

The developer's psychometric analysis of the PSQI was conducted on people between the ages of 24 and 83 years old and has been validated in populations such as those with disorders of initiating and maintaining sleep.[37] The PSQI has an internal reliability (Cronbach's a) of 0.83, test-retest reliability of 0.85 for the global scale, the sensitivity of 89.6%, and specificity of 86.5%.[36,37] The PSQI has strong validity and is a valid index supported by its ability to distinguish between patients and controls.[36,38]

Fatigue: The Fatigue Assessment Scale (FAS) is a self-report evaluation tool to assess the symptoms of chronic fatigue.[39] This scale contains ten statements that participants are encouraged to rate from one to five. One = never; two = sometimes; three = regularly; four = often; and five = always.[39] The statements represent both physical and mental symptoms of fatigue. Depending on the answers of the participant, a score is generated which equates to their level of fatigue.[39] Scores are evaluated on a scale from 10 to 50. A higher score denotes a greater level of fatigue.

In a cross-sectional study involving 73 subjects with systemic lupus erythematosus (SLE), the FAS was shown to have internal reliability (Cronbach's a) of 0.93 and test-retest reliability of 0.90.[40] In a study measuring fatigue in sarcoidosis, the FAS scale is shown to have good content validity, construct validity, and internal consistency.[41] Results of this scale were consistent with other measures containing fatigue-related subscales.[39] Analysis of the FAS also showed a gender bias among four of the ten statements, where women scored significantly higher than men.[39]

Academic Performance: Grade Point Average (GPA) was used to assess academic performance among graduate students. Most studies have identified GPA as a significant predictor of academic success.[42,43] Questions regarding overall GPA and the semester of and after COVID-19 infection GPA were collected. Regardingthe validity and reliability of self-reported GPA in research, GPA reasonably reflects actual grades.[44]

Demographics

Basic demographics such as age, gender, year in graduate program, and caregiver or dependent status were collected. Questions inquiring about the timeline of COVID-19 infection, such as when it was contracted and how it was diagnosed, were included. Also, questions on vaccination status, level, and type were included.

Process and procedure

Upon IRB approval, the PPI invited students from the Russell Sage College Physical Therapy Department to participate in this research study via email. The first initial survey was sent out via email. The student investigators collected the data from the survey and input it manually into an Excel spreadsheet for data analysis using SPSS.

Statistical Analysis

Outcome measures were analyzed for normal distribution. Due to a small sample and lack of normally distributed data, non-parametric tests were used. The Mann-Whitney test was used to test the difference in outcome measures (sleep, fatigue, and GPA) between subjects with COVID-19 and those without. A significance level of 0.05 was utilized for all testing. Spearman rank correlation coefficients were also calculated to explore the relationship between sleep and fatigue scores with GPA in participants with COVID-19.A positive correlation indicates both variables constantly increase together.[45]Positive correlation indicates both variables increase together, while negative correlation indicates one variable increases as the other decreases.[45]

Results

Surveys were received from 80 subjects (51 diagnosed with COVID-19, 29 without COVID-19 diagnosis) with a 100% informed consent rate. The mean age of respondents was 27.6 years (SD=7.5). Subjects included 67.5% female, 31.3% male, and 1.2% other (non-binary). Of the 80 surveys received, 88.8% of subjects were fully vaccinated and up to date on boosters, 8.8% were vaccinated and not boosted, and 2.5% were unvaccinated. Subjects included 20% first-year graduate students, 55% second-year students, 21.3% third-year students, and 3.7% fourth-year students.

A total of 18 surveys were excluded from analysis due to inaccurate GPA, PSQI, or FAS reports, or missing answers. Table 1 presents the demographics of 62 subjects in the final data analysis. Subjects included 39 who had a COVID-19 diagnosis and 23 who did not have a COVID-19 diagnosis.

The results of the Mann-Whitney test indicated higher scores in all outcome measures (refer to Table 2). While subjects with COVID-19 generally scored higher across all measures, these differences did not reach statistical significance.The Spearman rank correlation analysis revealed a negative association between the semester GPA following COVID-19 and general fatigue (r= -0.449; p=0.028) and mental fatigue (r=-0.422; p=0.04).

Discussion

Past research has shown that fatigue levels and sleep disturbances are higher in people following a diagnosis of COVID-19 infection.[20,28] In this current study, results show higher fatigue levels in students with COVID-19 infection compared to those without a COVID-19 infection,showing supportive data compared to existing research. Physiological responses to fatigue included tiredness after exertion, low energy levels, muscular fatigue, muscle weakness, slow reactions, drowsiness, and a concentration deficit.[13,30] With results showing higher fatigue levels in this population, graduate students are also compelled to attain academic excellence, causing strenuous mental/physical loads on students.

COVID-19 causes significant sleep impairments in infected patients.[1,10,21] Chronic post-inflammatory central nervous system disturbances associated with COVID-19 negatively impact memory and sleep, leading to fatigue syndrome in graduate students.[1,10,21]Sleep disruption leads to short-term physiological responses such as increased stress, somatic issues, heightened sympathetic nervous system activity, mental health disorders, and memory impairments. Patakaet al. estimated 30-35% of the general public and health care professionals and up to 50-75% of active COVID-19 patients suffered from sleep disturbances.[20] This current study suggests, while not significant, graduate students were diagnosed with a COVID-19 infection reported higher sleep disturbances than those who did not have a COVID-19 infection, which again supports the previously published research.

This is the first study investigating the effect of COVID-19 on academic performance. There is no previous literature indicating COVID-19's impact directly on graduate student's GPA. There is previous literature about the impact of sleep on undergraduate medical students, specifically how poor sleep quality can negatively affect academic performance in medical students.[33] PQSI scores of ≥5, indicating poor sleep quality, demonstrated significantly lower GPAs.[33] Therefore, sleep-related issues from COVID-19 could potentially impact graduate students' GPAs due to higher fatigue levels. This current study also found higher PSQI scores in subjects with COVID-19 infection. Although the results were insignificant, they can point towards the previously established fact that sleep problems are commonly seen in patients with COVID-19 infection.[1,7,9,10,18,20,21,26,27,32,34] We were also able to determine the negative association of GPA with general fatigue (*r*= -0.449; *P*=0.028) and mental fatigue (*r*=-0.422; *P*=0.04) in subjects with COVID-19 infection meaning GPA is seen to decrease as fatigue increases. With this relationship, a low negative association is seen with the higher levels of fatigue and outcomes of GPA, as the *r* values trend in a negative direction and are within the 0.26-0.49 Spearman's rho strength range. This could be due to students having decreased cognitive function, attention, and other fatigue-related physiological effects, as mentioned previously. GPA could also have been affected by the online delivery of classes during the COVID-19 pandemic, psychological and social stressors, and illness.

Limitations

This study's limitations include a small sample size (62 participants from a single private college), potential selection bias due to student investigators' influence on participation, and the cross-sectional survey design, which captures only a snapshot of relationships that may change over time. Surveys may have had confusing wording, leading to incorrect or incomplete responses. Eighteen surveys were excluded due to missing or incorrect data out of 80 total responses. Timing of survey distribution during the semester could have influenced participant responses. Additionally, the inability to verify self-reported GPAs against school records limits the reliability of GPA as an outcome measure.

Future direction for research

There is a significant literature gap on COVID-19's impact on graduate students, particularly concerning sleep, fatigue, and GPA. Further research is needed to compare these effects and address this gap. Future studies should aim for larger, more diverse samples to enhance generalizability. Longitudinal studies would better capture individual changes over time compared to cross-sectional designs. Using structured survey formats could minimize errors in self-reporting, and accessing school-reported grades would enhance the reliability of GPA as an outcome measure.

Table 1: Baseline Demographics of the Subjects in This Study

Number of Responses After Exclusion	**n=62**
Age	27.6 ± 7.7
Sex	
Female	43 (69.35%)
Male	18 (29.03%)
Other: Non-Binary	1 (1.61%)
Caretaker	
Yes	8 (12.9%)
No	54 (87.1%)
Vaccination Status	
Fully vaccinated (up to date on boosters)	56 (90.32%)
Vaccinated (not boosted)	4 (6.45%)
Unvaccinated	2 (3.32%)
Vaccination Type	
Pfizer	32 (51.61%)
Moderna	26 (41.94%)
Johnson & Johnson	2 (3.23%)
Not answered/unvaccinated	2 (3.23%)
Vaccination Dosage	
2 doses and a booster	42 (67.74%)
2 doses and 2 boosters	6 (9.68%)
2 doses	5 (8.06%)
1 dose	2 (3.23%)
1 dose and 2 boosters	1 (1.61%)
1 dose and a booster	4 (6.45%)
N/A	2 (3.32%)
Graduate Class Year	
First Year	11 (17.74%)
Second Year	37 (59.68%)
Third Year	13 (20.97%)
Fourth Year	1 (1.61%)
COVID-19 Diagnosis	
Yes	39 (62.9%)
No	23 (37.1%)

Table 2: Statistical Analysis of Sleep, Fatigue, and GPA

Outcome Measure COVID-19	**COVID-19**	**Control (Subjects without COVID-19)**	**P value**
Subjects (n)	39	23	
PSQI	7.39 ± 4.06	6.91 ± 3.45	0.855
FAS	General Fatigue 26.87 ± 6.09 Mental Fatigue 12.19 ± 4.35 Physical Fatigue 14.64 ± 2.40	General Fatigue 24.17 ± 4.23 Mental Fatigue 10.61 ± 3.47 Physical Fatigue 13.57 ± 2.09	General Fatigue 0.054 Mental Fatigue 0.173 Physical Fatigue 0.072
GPA (Cumulative GPA)	3.67 ± 0.235	3.70 ± 0.298	0.384

Values are presented as mean ± standard deviation

PSQI = Pittsburgh Sleep Quality Index

FAS = Fatigue Assessment Scale

GPA = Grade point average

Conflict of interest: I confirm that there are no conflicts of interest that could potentially influence or bias the work presented in this manuscript.

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Original Research

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The role of Respiratoy Physiotherapy in improvement of Consious level (GCS) and Cognitive level (RLA-R) score in Acquired Brain Injury patients admitted in Intensive care unit: A Comparative Study

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Abstract

It was accounted for ABI as damage to the brain which brings about disintegration in subjective, physical, enthusiastic and autonomous working. Acquired brain injury can occur due to injury, hypoxia, contamination, tumor, substance manhandle, degenerative neurological sickness and stroke[1,2]. Serious ABI is characterized as a GCS of 3-8 after cardiopulmonary revival in a patient with an irregular computer tomography (CT) output of the head which shows haematomas, wounds, oedema, and compacted basal cisterns[3,4]. The definitions gave in this passage were embraced for use in this ABI investigation.

The Glasgow Coma Scale (GCS) is used to objectively describe the extent of impaired consciousness in all types of acute medical and trauma patients. The Glasgow Coma Scale divides into three parameters: best eye response (E), best verbal response (V) and best motor response (M). The levels of response in the components of the Glasgow Coma Scale are 'scored' from 1, for no response, up to normal values of 4 (Eye-opening response) 5 (Verbal response) and 6 (Motor response). The total Coma Score thus has values between three and 15, three being the worst and 15 being the highest. The score is the sum of the scores as well as the individual elements. For example, a score of 10 might be expressed as GCS10 = E3V4M3.

The Rancho Los Amigos (RLA-R) Levels of Cognitive Functioning Scale is a renowned clinical tool used to rate how people with brain injury are recovering. The ten levels of recovery noted in the scale also help to decide when a patient is ready for rehabilitation. As patients "wake up" after a head injury, they go through different levels of recovery on the Rancho Scale. Each level describes a general pattern of recovery, with a focus on cognition and behavior.

Methods: Respiratory physiotherapy procedures assists to expand lung volumes, enhance gas diffuson, reduce work of breathing, reduce MV stay of patients and induce optimum recovery. In this the respiratory physiotherapy

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applications involved a regimen of Positioning, Manual Hyperinflation (MH), Airway Suctioning, PNF for Respiration, Passive Limb Movement protocol and Early Mobilisation protocol.

Results: The results shows that the Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge the significance of P<.005

Conclusion: Respiratory physiotherapy managed Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome of the ABI patients.

Keywords: Acquired Brain Injury, Moderate to Severe Head Injury, Respiratory Physiotherapy, Chronic Pulmonary Infection Score, Intensive Care Unit, Cognition, Conscious.

Introduction

Acquired brain injury patients treated with mechanical ventilation (MV) usually develop Ventilator-associated pneumonia (VAP) that is an serious complex health hazard. Pneumonia occurs due to microbial attack of the ordinarily sterile lower respiratory tract. The dominant part of pneumonia is that, this diseaseoccurs due to potential pathogens that have colonized the oropharyngeal airway route. When VAP occurs the stay of patient on MV, the stay of patient in ICU and the stay of patient in hospital increases. There is a significant finding of ABI patients those admitted in ICU may develop VAP, which could effect on ICU results. It has been generally shown that VAP in ABI patients induces huge expanded expenses to the social insurance framework, an expanded danger of horribleness and mortality emerging.[5,6]

Respiratory physiotherapy interventions are a generally reasonable and broadly accessible administration technique that may profit patients in the ICU by reducing the rate of VAP and its related outcomes. Hypothetically respiratory physiotherapy reduce the stay on MV and improve ventilation which may decrease the frequency of VAP. In this way, respiratory physiotherapy may reduce the stay on MV, requirement of tracheostomy, expenses and hospital stay.[7] Respiratory physiotherapy managed Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome of the ABI patients.

AIMS

This study aimed to provide the first comprehensive objective evaluation of the effectiveness of respiratory physiotherapy services for patients admitted to the ICU of ABI patients by managing Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome.

- Investigating the clinical effectiveness and cost effectiveness of respiratory physiotherapy interventions in altering the incidence of VAP and other important clinical outcomes such as duration of MV and length of ICU stay.
- Providing justification of respiratory physiotherapy service provision to the ICU in terms of clinical effectiveness and cost effectiveness for patients with VAP following ABI.
- Providing validation of the required level of respiratory physiotherapy services and staffing in the ICU based on clinical outcomes.

Material and Methods

A prospective randomized study was done to assess the effects of respiratory physiotherapy on the incidence and resolution of VAP in patients admitted with ABI to the ICU at SH. The aim of Part A of the study was that the provision of regular prophylactic respiratory physiotherapy interventions along with routine medical and nursing care Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome. In part A of this study subjects were randomised.

In part A of this study male and female patients according to inclusion criteria received 24-hour respiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilisation.

The aim of part B of this study was that the provision of regular respiratory physiotherapy interventions along with routine medical and nursing care Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome.

Subjects from part A who developed VAP were transferred to Part B of the study based on inclusion criteria as outlined in dependent variable.

In part B of this study male and female patients according to inclusion criteria received 24-hour respiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilisation.

SUBJECTS

ABI patients admitted to the ICU at SH who satisfied the inclusion criteria were eligible for participation in the study.

INCLUSION CRITERIA

Inclusion criteria comprised of the following:

- Age between 16-85years[8]
- GCS less than or equal to nine (≤) 9 on admission to the SH ICU
- Presence of an ICP monitor or drain
- Invasive mechanical ventilator support for greater than twenty four hours (>) 24 hours
- Eligible subjects were prospectively randomised to a study group on admission to the SH ICU

EXCLUSION CRITERIA

Exclusion criteria comprised of the following:

- Patients on active therapy
- Patients with excessive respiratory support as:

Nitric oxide ventilation, Fraction of inspired oxygen [FiO2] > 0.8, Positive end expiratory Pressure [PEEP] >10 centimetres of water [cmH2O].

- Patients with excessive oxygen consumption they would not receive MH, Positioning and Airway suctioning according to SH ICU standard operating policy.
- Patients with unstable haemodynamic status as:
    - MAP [in millimetres of Mercury (mmHg)] > 120 or < 60
    - HR (in beats per minute) > 120 or < 60
    - Labile MAP or HR
    - Presence of new cardiac arrhythmias
    - Excessive inotropic support as Noradrenaline or Adrenaline infusion at > 30 milligrams per hour

These MAP and HR criteria are based on greater than 10 percent change from the normal range[9]. In the ABI patients optimization of tissue perfusion and cerebral oxygenation level may be a special issue if significant change occur from the normal level. Exclusion criteria based on the clinician's clinical experience, the dosage of vasoactive drugs titrated according to patient's body weight and clinical effects.

Patients with unstable neurological status as:

- Labile ICP or CPP,
- Sustained ICP > 25 mmHg,
- Sustained CPP <70 mmHg.

The primary focus of ICU management of ABI patients is to prevent secondary cerebral damage characterised by a reduction in cerebral perfusion pressure due to hypotension and hypoxia[10]. The above neurological criteria are from the Brain Trauma Foundation management guidelines[11].

For the purpose of this study 'labile' was considered as a clinically significant changes in any of: MAP, HR, ICP and CPP of 20 per cent or more of normal values required definitive intervention. MacIntyre described an acute increase or decrease in blood pressure atleast 20 percent is indication of haemodynamic instability[12].

Results and Discussion

Table 1: Demographic and clinical characteristics of the study subjects

Age (in years)	
Mean ± SD	45.54 ±11.56
Median (Range)	47 (21 – 78)
Gender	
Male	82 (71.9%)
Female	32 (28.1%)
Residence	
Urban	67 (58.8%)
Countryside	47 (41.2%)
BMI	
<25 Kg/m^2	28 (24.6%)
25 – 29 Kg/m^2	60 (52.6%)
≥30 Kg/m^2	26 (22.8%)
Reason for admission	
Assault	5 (4.4%)
ICH	29 (25.4%)
MBA	27 (23.7%)
MVA	27 (23.7%)
SAH	26 (22.8%)
Comorbidity	
H/O COPD	70 (61.4%)
Smoking	53 (46.5%)
Chronic sputum production	49 (43%)

Table 1: shows demographic and clinical characteristics of the study subjects.

According to the objectives of this study the comparison of the groups determines that the randomization process was followed on the basis of inclusion criteria. In the treatment there were significantly more males than females. Results of the Levene's test defined that equality of changesbetween the groups based on demographic variables. The Levene test checks whether several groups have the same variance in the population. Levene test is therefore used to test the null hypothesis that the samples to be compared come from a population with the same variance.

Table 2: Comparison of GCS among study subjects

Time	GCS	Mean difference	Test of significance
At admission	8.31±0.74	4.23±0.93	t=48.46 at 113 df, P<0.001 (S)
At discharge	12.54±0.92		

Table 2: shows that GCS score improved from at the time of admission to at the time of discharge among study subjects. Thus level of significance p0.005.

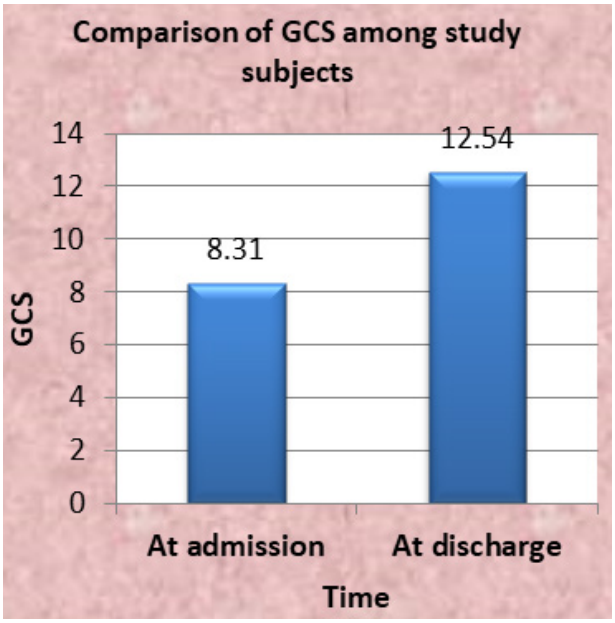

Fig 1: Comparison of GCS of study subjects at the time of admission and at the time of discharge.

Table 3: Comparison of RLA-R among study subjects

Time	RLA-R	Mean difference	Test of significance
At admission	1.58±0.56	7.98±0.50	t=111.51 at 113 df, **P<0.001 (S)**
At discharge	9.56±0.50		

Table 3: shows that RLA-R score improved from at the time of admission to at the time of discharge among study subjects. Thus level of significance p0.05.

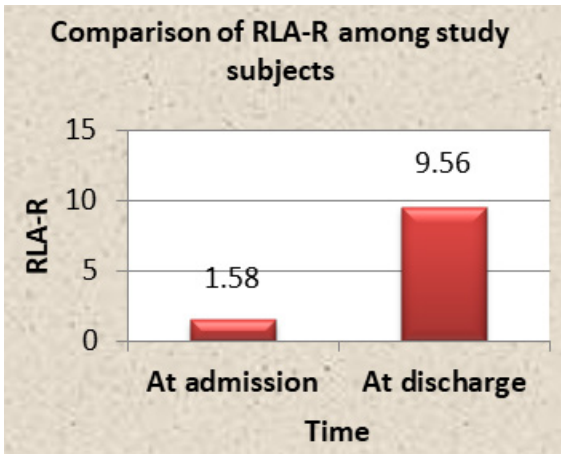

Fig 2: Comparison of RLA-R of study subjects at the time of admission and at the time of discharge.

This segment of the Discussion defines that the provision of regular prophylactic respiratory physiotherapy interventions along with routine medical and nursing care Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and also improved the outcome and reduced the occurrence of VAP in form of CPIS score, term of stay on MV and length of ICU stay.

The numbers of patients of ABI was 114 who satisfied inclusion criteria assessment. Respiratory physiotherapy particularly focus on the distinguished causes of VAP. Various elements and occasions are responsible for course of pathogenesis of VAP. In ICU the arrangement of Respiratory physiotherapy required where premorbid factors like age, smoking and seriousness of ABI induces endotracheal intubation of patients.[13]

Physiologically the prophylactic respiratory physiotherapy helpedto change the rate of VAP with clearance of airway route, enhancing oxygenation and lung consistence, that's why lower respiratory tract has not been imperiled with microscopic organisms.

Conclusions

Respiratory physiotherapy managed Conscious level (GCS) and Cognitive level (RLA-R) Score improved from at the time of admission to at the time of discharge and improved the outcome of the ABI patients. The impact of prophylactic respiratory physiotherapy reduced CPIS score in acquired brain injury patients from at the time of admission to at the time of discharge[14,15].

The fundamental conclusion from this study was that the utilization of 24-hour respiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilization reduced occurrence of VAP, stay on MV and stay of ICU of ABI patients in ICU at SH. When critical illness ICU parameters were assessed with clinical factors the arrangement of a prophylactic respiratory physiotherapy regimen is recommended intentional to avoid VAP in ABI patients. The study provides comparison between subject's GCS and RLA-R score at the time of admission and at the time of discharge. Subjects those developed VAP were significantly male and admitted with a lower GCS. Duration of MV, length of ICU stay and length of hospital stay were significantly increased in subjects with VAP.[16,17,18]

Consent: Informed consent was taken from all participants in the study for publication work in the journal. If patient was conscious then consent was read and signed by himself or herself. If patient was not conscious then his/ her LAR read and signed the Informed consent.

Conflict of interest- Nil

Source of Funding- Self

Ethical clearance- Ref no.07/ EC/RENEW/ INST/2021/12208

SOLANKI HOSPITAL INSTITUTIONAL ETHICS COMMITTEE

ABBREVIATIONS

ABI	Acquired Brain Injury
GCS	Glasgow Coma Scale
RLA-R	Rancho Los Amigos revised Scale
CT	Computer Tomography
PNF	Proprioceptive Neuromuscular Facilitation
ICU	Intensive Care Unit
VAP	Ventilator Associated Pneumonia
SH	Solanki Hospital
ICP	Intracranial Pressure
MAP	Mean Arterial Pressure
HR	Heart Rate
CPP	Cerebral Perfusion Pressure
ETT	Endotracheal Tube

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Original Research

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Short-term Effects of Thoracic Kinesiotaping in Children with Bronchopneumonia: A Randomized Controlled Trial

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Abstract

Background: Respiratory infections, particularly bronchopneumonia, pose a significant health challenge in paediatric populations, often leading to respiratory distress and compromised well-being. In the context of managing bronchopneumonia in children, exploring non-invasive interventions becomes beneficial. The application of thoracic kinesiotaping is hypothesized to positively impact lung volumes by assisting respiratory function and facilitating breathing pattern.

Methodology: To determine the effectiveness of thoracic kinesiotaping on the functional capacities in children with bronchopneumonia, a group of 32 children aged 5 to 12 years were selected adhering to specific inclusion criteria. These participants were then randomly assigned to two groups. Group A underwent conventional respiratory physiotherapy exclusively while Group B participants received a combination of thoracic kinesiotaping and conventional respiratory physiotherapy. Pre-intervention assessment included baseline data, pulmonary function tests (PFT), Paediatric Dyspnea Scale (PDS) and Chest expansion. The treatment protocol spanned a period of three days. Analysis of data was done through Instat software.

Conclusion: The analysis revealed a notable increase in Forced Expiratory Volume in 1 second (FEV1) and the FEV1/Forced Vital Capacity (FVC) Ratio during pulmonary function testing (PFT), accompanied by a marginal improvement in chest expansion. These findings suggest a positive impact of kinesiotaping on respiratory parameters, indicating potential benefits for children with pulmonary conditions.

Keywords: Thoracic kinesiotaping, Bronchopneumonia, Respiratory function, Children, Pulmonary Function test

Introduction

Bronchopneumonia, marked by inflammation in bronchial and bronchiolar regions resulting in lung parenchyma solidification, primarily presents acutely, often affecting lower lobes [(1)]. Globally concerning, a child succumbs to pneumonia every 43

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seconds, with a prevalence of one case per 71 children annually, notably higher in South Asia [2].

Various agents contribute to pneumonia, including Streptococcus pneumoniae, Haemophilus influenzae type b (Hib), Respiratory Syncytial Virus, and in HIV-infected infants, Pneumocystis jiroveci fungi [2].

Early recognition of signs and symptoms is vital. Bacterial pneumonia may feature cough, expectoration, vomiting, diarrhea, loss of appetite, fatigue, and fever, while viral pneumonia symptoms progress slowly, potentially increasing bacterial pneumonia risk. Additional symptoms include chills, tachypnea, dyspnea, headache, and irritability [3].

Children face challenges due to physiological factors like lower lung volume and weakened respiratory muscles, contributing to the disease's rapid progression [3].

Bronchopneumonia is a restrictive lung disease that primarily affects inspiration, with the diaphragm and external intercostal muscles being the primary inspiration muscles[4]. Common conventional therapies aiding mucociliary clearance include postural drainage, vibration, percussion, puffing, coughing, and thoracic squeezing [5,6,7,8].

Recent exploration into kinesiotaping reveals potential benefits in pediatric respiratory care. Thoracic kinesiotaping, utilizing an elastic, epidermal-thickness tape, may aid in increasing blood and lymph circulation, reducing pain, stimulating proprioception, stabilizing articular surfaces, and restoring muscle tone [9,10]. Application technique influences the tape's impact on muscular strength, with taping from muscle origin to insertion facilitating function, while taping in reverse inhibits function [11]. Taping on the diaphragm, combined with breathing exercises, shows immediate improvement in respiratory muscle tone, aerobic performance, pulmonary function, and dyspnea perception [12,13,14].

The purpose of this study is to investigate the effects of thoracic kinesiotaping on the improvement of chest expansion and functional capacities in children with bronchopneumonia.The aim is determine short-term effects of thoracic kinesiotaping in children with bronchopneumonia.

Materials and Methods

This study aims to assess the effectiveness of thoracic kinesiotaping in improving functional capacities and chest expansion in children with bronchopneumonia. Additionally, it seeks to compare the outcomes of conventional physiotherapy alone versus combined with thoracic kinesiotaping.

The samples for this study were collected from the In-patient department (IPD) of Dr. VitthalraoVikhe Patil Pravara Rural Hospital, Loni. The study was conducted within the pediatric In-patient department (IPD) focusing on children admitted with bronchopneumonia. Data collection was performed through primary methods with a total of 32 children included overall. The study spanned over a duration of 1 year (2023-2024), allowing for comprehensive data collection and analysis to evaluate the outcomes of interest effectively.

SELECTION CRITERIA:

INCLUSION: Participants meeting the inclusion criteria for this study were clinically diagnosed cases of bronchopneumonia by a pediatrician, aged between 5 to 12 years. Additionally, they were required to be conscious, follow commands precisely, and able to perform exercise programs, demonstrating cooperation during the study procedures. Written informed consent from a parent or legal guardian was also mandatory for inclusion in the research.

EXCLUSION: Patients presenting with secondary complications that could potentially interfere with the study procedures, as well as those diagnosed with multiple diseases, were excluded from participation. Additionally, children with hearing impairments or cognitive impairments were not included in the study.

PROCEDURE:

Before commencing the study, approval from the Institutional Ethical Committee (IEC) was obtained through the period 7/04/2023 to 7/04/2024 with registration no. Dr.APJAKCOPT/BPT/UG/2023/62. The research study has undergone formal registration with the Clinical Trials Registry - India (CTRI), and has been assigned the unique CTRI number: CTRI/2023/08/056726.

Informed consent was acquired from parents or their legal guardians after screening them based on inclusion and exclusion criteria. Using OpenEpi version 3, 32 children diagnosed with bronchopneumonia

were enrolled, with each group initially comprising 16 individuals, later reduced to 15 due to mid-intervention discharge. Various parameters, including chest expansion, pulmonary function tests (PFT), and pediatric respiratory distress scale (PDS), were measured pre-test and after 72 hours.

The study was conducted as a single-blinded trial, with the assessor being fully aware of the interventions while ensuring that the participants remained blinded throughout the intervention process. Simple random sampling method was conducted involving the generation of random numbers in Microsoft Excel. Participants were then assigned to either Group A or Group B based on the assigned random numbers. Sealed envelopes containing the group allocations were provided to each participant accordingly. The principal assessor generated the allocation sequence, enrolled and assigned the patients using the method described above.

Group A received conventional physiotherapy, while Group B received conventional physiotherapy combined with thoracic kinesiotaping, involving the application of two "I" strips to specific areas of the thorax. The first strip was applied centrally at the xiphoid process and laterally to the costal arch with 75% tension. The ends were attached unstretched, and the strip was applied with the arm in flexion while the patient inhaled deeply. The second strip was applied from the right to the left armpit at the same level as the first strip with the base affixed centrally at T12. The second strip was attached to the posterior inferior rib cage with the same method as the first strip, and the ends were attached unstretched [15].

Figure 1 - PFT Assessment

a) b)

Figure 2 -Thoracic Kinesiotaping : a)Anterior View b) Posterior View

Results

In this research, we administered a three-day treatment to clinically diagnosed children with Bronchopneumonia, with an average age of 8.4±2.03 for Group A group and 7.93±1.98 for Group B group. The participants were selected from Dr. VitthalraoVikhe Patil Pravara Rural Hospital, Pravara Institute of Medical Sciences-DU, Loni BK, based on specific inclusion and exclusion criteria. The primary outcome measure was the Pulmonary Function Test (PFT), conducted before and after the three-day treatment period.

Table 1: Gender wise distribution of children with Bronchopneumonia

	Group A	Group B	P Value	Relative Risk
Male	8	9	1	0.874
Female	7	6		

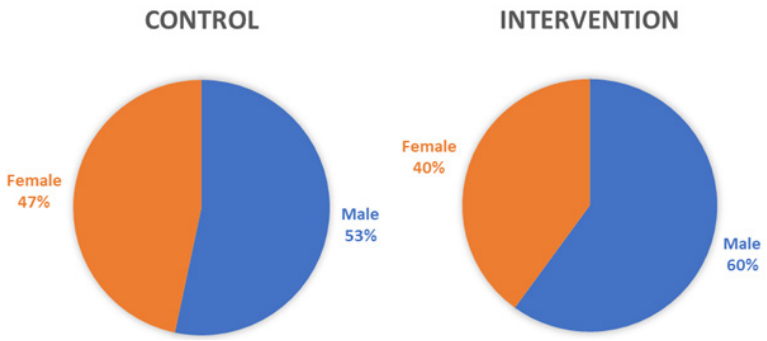

Fig 1: Gender distribution between Group A and Group B

Group A averaged 8.4±2.03 years in age, 22.27±6.62 kg in weight, and 127.27±16.5 cm in height. Group B had mean values of 7.93±1.98 years in age, 21.53±7.22 kg in weight, and 118.6±12.52 cm in height. Statistical comparison revealed no significant differences in age, height, or weight between the groups, ensuring baseline uniformity.

Table 2: Distribution of demographic data - Group A and Group B

Variables	Group A (Mean±SD)	Group B (Mean±SD)	t Value	P Value*
Age	8.4±2.03	7.93±1.98	0.6375	0.2645 (not significant)

* - Unpaired t test

Variables	Group A (Mean±SD)	Group B (Mean±SD)	U-Value	P Value*
Height	127.27±16.5	118.6±12.52	74	0.0574 (not quite significant

* - Mann-Whitney Test

Variables	Group A (Mean±SD)	Group B (Mean±SD)	t Value	P Value*
Weight	22.27±6.62	21.53±7.22	0.29	0.387 (not significant

* - Unpaired t test

PULMONARY FUNCTION TEST (PFT)

In the Pulmonary Function Test (PFT), % predicted values of FVC, FEV1, and FEV1/FVC Ratio were compared to establish baselines. In Group A, before treatment, mean FVC% was 55.07±17.04, FEV1% was 65.2±22.5, and ratio was 117.6±10.45. After treatment, FVC% increased to 65.53±17.14, FEV1 to 71.6±22.66, and the ratio decreased to 110.73±9.45. All changes were statistically significant ($p < 0.05$).

Table 3: Pre and Post Treatment PFT - Group A

	Pre (Mean±SD)	Post (Mean±SD)	t Value	P Value*
FVC%	55.07±17.04	65.53±17.14	5.495	< 0.0001 (extremely significant)
FEV1%	65.2±22.5	71.6±22.66	3.189	0.0033 (very significant)
FEV1/FVC Ratio	117.6±10.45	110.73±9.45	4.553	0.0002 (extremely significant)

*- Paired t test

For Group B, before intervention, mean FVC% was 65.53±17.14, FEV1% was 73.53±20.68, and ratio was 111.8±8.19. After intervention, FVC% increased to 77.73±15.34, FEV1 to 79.4±17.75, and the ratio decreased to 102.33±11.15. All changes were statistically significant ($p < 0.05$), indicating the effectiveness.

Table 4: Pre and Post Treatment PFT - Group B

	Pre	Post	t Value/ r Value	P Value
FVC%	65.53±17.14	77.73±15.34	5.859 (t)	< 0.0001 (extremely significant)*
FEV1%	73.53±20.68	79.4±17.75	2.282 (t)	0.0193 (significant)*
FEV1/FVC Ratio	111.8±8.19	102.33±11.15	0.6844 (r)	0.0001 (extremely significant)^

*- Paired t test

^- Wilcoxon matched-pairs signed-ranks test

Variations in lung volumes (FVC, FEV1, and FEV1/FVC ratio) were assessed by comparing pre and post-intervention measurements in Group A and Group B. Group A showed FVC difference of 8.93±6.3, FEV1 difference of 6.4±7.77, and ratio difference of 6.87±5.84. In Group B, FVC difference was 12.2±8.06, FEV1 difference was 5.87±9.96, and ratio difference was 9.47±6.45. These findings highlight distinct changes in lung volumes following interventions.

Table 5: Comparison of lung volumes between Group A and Group B

Difference	Group A	Group B	t Value/U value	P Value
FVC	8.93±6.3	12.2±8.06	1.237 (t)	0.1132 (not significant) *
FEV1	6.4±7.77	5.87±9.96	3.987 (t)	0.0002 (extremely significant) *
FEV1/FVC Ratio	6.87±5.84	9.47±6.45	33.5 (u)	0.0006 (extremely significant) ^

*- Unpaired t test

^- Mann-Whitney Test

PEDIATRIC DYSPNEA SCALE (PDS)

The study evaluated dyspnea severity before and after intervention in both groups, ensuring uniformity in comparison. No significant difference in dyspnea severity was noted between pre- and post-intervention assessments in both groups.

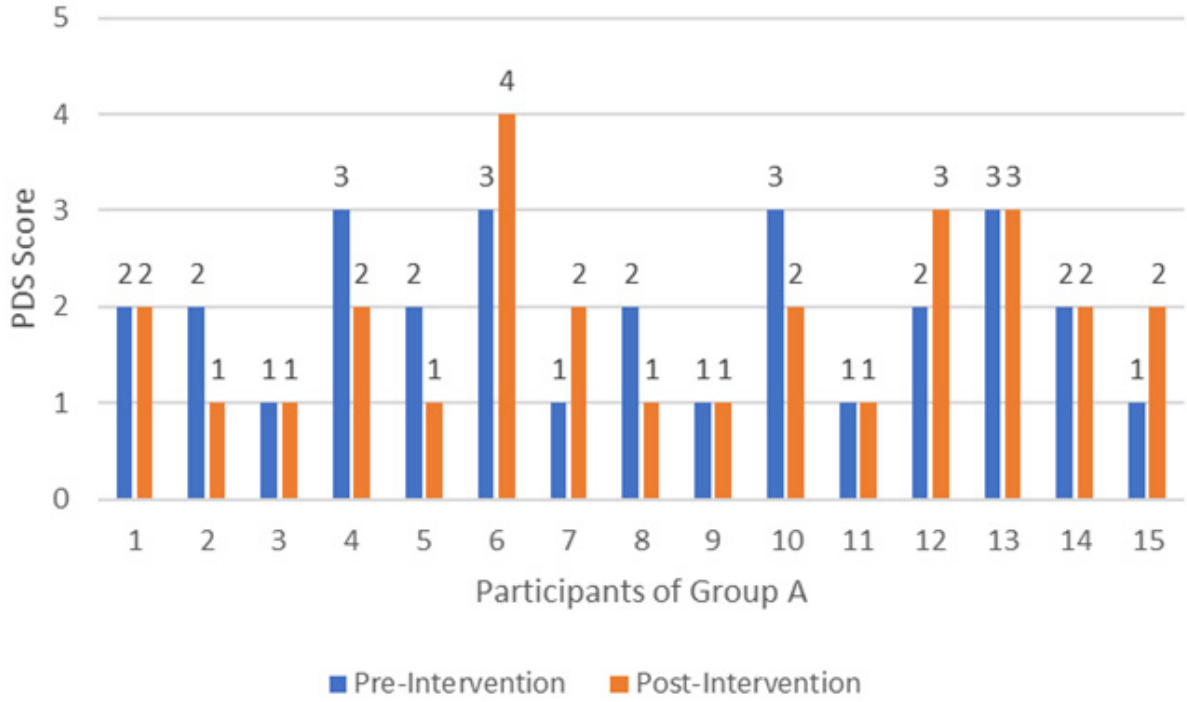

Fig 6- PDS Score- Group A

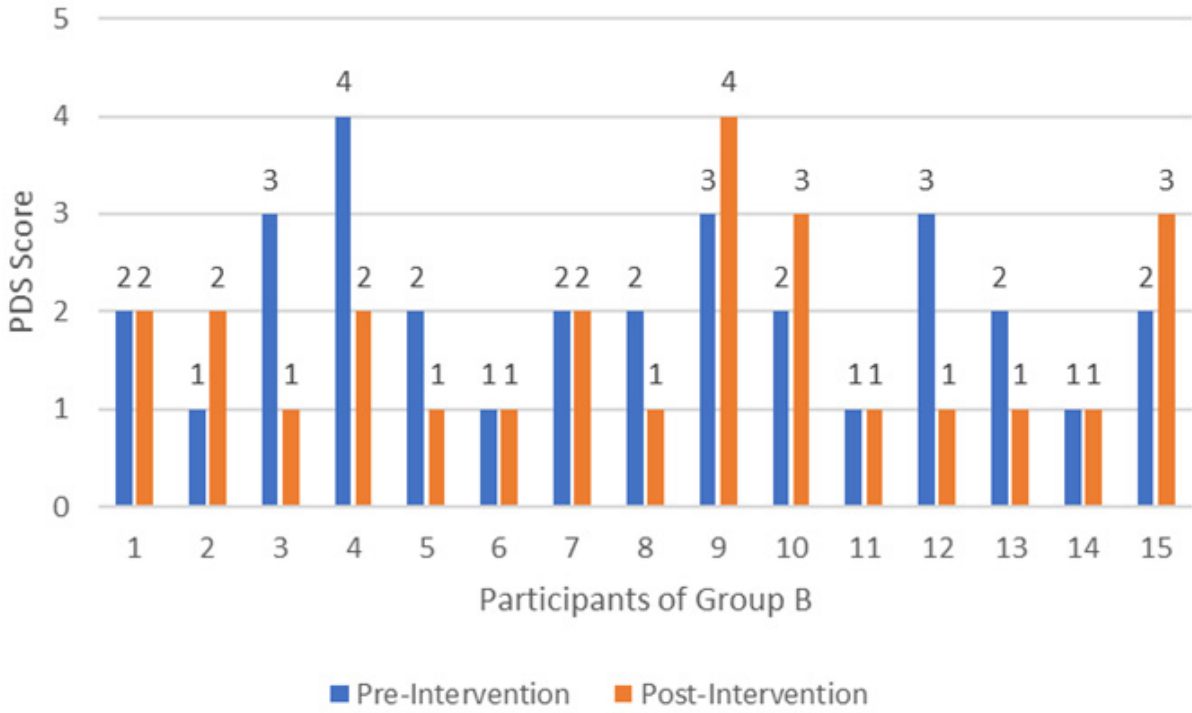

Fig 7- PDS Score- Group B

CHEST EXPANSION

Chest expansion was assessed through circumferential measurements using a tape, capturing the variance between deep inspiration and deep expiration by recording chest circumferences at the fourth intercostal space level. The comparison revealed no statistically significant difference in chest expansion between the children in Group A and those in Group B.

Table 6: Comparison of Chest Expansion between Group A and Group B

Variable	Group A (Mean±SD)	Group B (Mean±SD)	t Value	P Value*
Chest Expansion	0.4±0.34	0.37±0.3	t = 0.92	0.1817 (not significant)

*- Mann-Whitney Test

Discussion

The current study aimed to explore the impact of conventional physiotherapy and thoracic kinesiotaping on pulmonary function tests in children diagnosed with bronchopneumonia. Thoracic kinesiotaping involved the application of two strips anteriorly and posteriorly on the diaphragm, combined with conventional physiotherapy, to assess its influence on lung volumes.

The intervention resulted in a significant improvement in lung volumes, with all 3 PFT values showing statistically significant improvement. This highlights the positive impact of combined conventional physiotherapy and thoracic kinesiotaping on pulmonary function in bronchopneumonia children within a short treatment duration.

By specifically targeting the primary inspiratory muscle i.e. the diaphragm, with proprioceptive stimulation, we aimed to explore the potential multifaceted benefits of kinesiotape [16]. Proprioceptive feedback is provided by assisting individuals with restrictive lung diseases to become more aware of their breathing patterns and make adjustments as needed which can lead to more efficient breathing techniques, reducing respiratory effort and improving oxygenation[17].

Pulmonary function test (PFT) patterns in restrictive conditions such as bronchopneumonia typically manifest as a normal or increased FEV1/FVC ratio (>0.70) alongside a reduced Forced Vital Capacity (FVC) (less than 80%) [18].

Post-intervention, both Group A and Group B showed increased FVC% and FEV1%, indicating improved lung volumes. Group B demonstrated a more substantial increase compared to Group A. Additionally, both groups exhibited an elevated FEV1/FVC ratio initially, reflecting a restrictive pattern, but post-intervention, this ratio reduced, indicating improvement. Importantly, Group B showed a greater reduction in the ratio compared to Group A, suggesting a decrease in the restrictive pattern with thoracic kinesiotaping and conventional physiotherapy.

Restrictive lung diseases often involve stiffness or reduced flexibility of the chest wall, making it difficult to expand the lungs fully during inhalation. kinesiotape can be applied to promote greater mobility of the chest wall, facilitating deeper breathing and improved lung expansion [19]. Many individuals with restrictive lung diseases experience discomfort associated with breathing due to the increased effort required to expand the lungs against stiffness or resistance. kinesiotape can help alleviate this pain by providing support to the chest wall and reducing muscle tension, allowing for more comfortable and efficient breathing.

The Pediatric Dyspnea Scale was chosen due to dyspnea's prevalence as a symptom in pediatric bronchopneumonia. Most children experienced mild dyspnea, primarily falling within Grades 1 and 2. In Group A, 5 out of 15 children showed improvement, while in Group B, 8 out of 15 children improved. Kase et al. proposed that kinesiotaping stimulates mechanoreceptors proportionally to tape tension, triggering positional stimuli in the skin, which are transformed into sensory stimuli, enhancing or reducing movement[20]. Burcu Metin Ökmen et al. observed improvement in mMRC Dyspnea Scale scores pre- and post-treatment in adult participants [21].

The diaphragrm aids chest expansion contracting and descending during inhalation, allowing for lung expansion. In this study, circumferential chest expansion at the 4th intercostal space was measured using an inch tape, with a normal value of 2.5cm for children aged 5-12 years[22]. While various studies have explored the correlation between kinesiotaping

and chest expansion, our study found only marginal increases: 0.4 cm in Group A and 0.37 cm in Group B compared to baseline measures. However, there was no statistically significant difference in chest expansion between Group B and Group A.

Conclusion

The present study has concluded that kinesiotaping elicits short-term effects on pulmonary function test (PFT) parameters, particularly enhancing Forced Expiratory Volume in 1 second (FEV1) and the FEV1/Forced Vital Capacity (FVC) ratio. These improvements signify an enhancement in lung function following kinesiotape application, highlighting its potential as a therapeutic intervention for respiratory conditions.

LIMITATIONS AND FUTURE SCOPE

The study's limitations include its small sample size, the need for comparing multiple kinesiotape placements to determine the most effective method, and the lack of isolation of the impact of medications and physiotherapy treatment. However, it presents an opportunity for future exploration in a larger population to assess the effects of kinesiotape application on the duration of hospital stays. Conducting such a study on a broader scale could elucidate whether the use of kinesiotape contributes to shorter hospital stays, potentially facilitating faster patient discharge and improving overall healthcare efficiency.

DECLARATION OF CONFLICTS AND FUNDINGS

There were no potential conflicts of interest observed in the study. This research study received no external funding.

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