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Effectiveness Of Open Kinematic Chain Exercises Versus Closed Kinematic Chain Exercises Along With Interferential Therapy On Pain And Functional Disability Among Patients With Chronic Neck Pain - A Randomized Controlled Trial (Rct)

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ABSTRACT

Background: Patients with idiopathic persistent neck pain may exhibit weakness in axioscapular muscles, including the levator scapulae, serratus anterior, rhomboid major, and minor, according to EMG research. However, the majority of physical therapy treatments ignore the fact that axioscapular muscle weakening is the root cause of persistent neck pain. Axioscapular muscle weakness can be addressed using open and closed kinematic chain workouts. The purpose of this study was to evaluate the impact of IFT with open and closed kinematic chain exercises on pain and functional impairment in patients with chronic neck pain.

Method: Fifty samples in all were gathered from Puducherry's Aarupadai Veedu Medical College & Hospital's Outpatient Physiotherapy Department (OPD). They were split up into two groups, Group A and Group B, each with twenty-five subjects. Interferential therapy was administered in conjunction with Open-Kinematic Chain exercises (Group A) and Closed-Kinematic Chain exercises (Group B). For a duration of two weeks, the workouts were performed four days a week, before and after the two-week intervention, the Neck Disability Index (NDI) and Numeric Pain Rating Scale (NPRS) pre- and post-test results were recorded.

Results: The study's findings showed that closed kinematic chain exercises with interferential therapy significantly improved performance compared to open kinematic chain workouts with interferential therapy.

Conclusion: The study found that in individuals with persistent neck pain, closed kinematic chain exercises combined with interferential therapy were beneficial in lowering pain and enhancing functional ability.

Keywords - Chronic neck pain, Axioscapular muscles, Open kinematic chain exercises, Closed kinematic chain exercises, Interferential therapy.

INTRODUCTION

The scapula is a vital component that provides stability and movement to the neck/shoulder area, acting as a link between the cervical spine and the shoulder complex. [1] The axioscapular muscles including the levator scapulae, serratus anterior, rhomboid major and minor, and trapezius are attached to the scapular bone and can attribute to movement of the neck and shoulder. The axioscapular muscles cooperate to cause the scapula to rotate upward on the thorax. Several investigations showed that aberrant scapula posture or movement could result from axioscapular muscle stiffness or weakening. **[2]** It can cause irregular rhythms in the scapulohumeral joint and cause pain in the neck and shoulders.

One of the most prevalent musculoskeletal conditions among middle-aged adults is neck pain. Between 30% and 50% of people are affected by non specific neck pain annually. [3] A neckache is classified as chronic if it persists for three months or longer. Muscle activation patterns and changes in scapular position are mentioned as possible risk factors for persistent neck pain.In patients experiencing cervical pain, a modified scapular position is frequently observed.[2] Daily tasks are probably dependent on forward flexion exercises, which in turn affect the muscular imbalance. [4] Maintaining a forward head posture all the time puts more strain on the posterior cervical structure, which includes the scapular kinematic and kinetic changes caused by the bone, ligament, joint capsule, and muscle. Rehabilitation of the neck and shoulders requires the scapulothoracic muscles to be activated normally again.

The displacement (the change in position over time) or motion of a segment without taking into account the forces causing that movement is described by kinematics. [5] An exercise or pattern known as an "open kinematic chain" occurs when the distal end of an extremity ends freely in space and is not fixed to anything. There is no external resistance involved. Furthermore, most OKCE movements are non-weight-bearing exercises. Since a limited degree of muscular co-contraction is innate, OKCE and movement patterns also provide greater isolated muscle activation.
The distal part of the extremities is fixed to an object that is either moving or stationary in the Closed Kinematic Chain workout or movement pattern. These workouts usually include many joints and weight bearing. The CKC exercises will limit the ability of muscle and joint proprioceptors to react to sensory information. Proprioceptor, joint stability is enhanced by CKC, and more functional movement patterns are made possible by higher coactivation.[6]

Cervical flexor and extensor stabilization exercises have become the mainstay of physical therapy treatment for neck discomfort in recent years. The effect of the scapula in treating neck pain with OKC and CKC factors has not been extensively examined in the majority of research. It has been demonstrated that adjusting the scapula passively or aggressively reduces persistent neck pain. To get a satisfactory outcome, rehabilitation exercises designed to restore the functionality of the scapular muscles are considered essential. Thus, the goal of this study is to assess how well training in OKC and CKC exercises affects pain and chronic neck discomfort. [4]

SUBJECTS AND METHODS

The study was carried out at the Aarupadai Veedu Medical College and Hospital's Out-Patient Department of Physiotherapy (OPD) in Puducherry. Simple random sampling was used in this randomised controlled trial, and data was gathered before and after therapy. Group A and Group B are the two groups made up of the fifty subjects that met the inclusion criteria and were diagnosed with persistent neck pain.

Patients between the ages of 18 and 40 who had persistent neck discomfort (duration: more than 12 weeks) were included in the study. This study did not include neurological disorders, degenerative disc disease, or congenital diseases, who have fracture or a recent neck injury Interferential therapy was administered in conjunction with open-kinematic chain exercises (Group A) and closed-kinematic chain exercises (Group B). All participants received explanations of the study's goals and procedures before the treatment, and they signed written informed consent and information forms. Before and after the two-week intervention, the Neck Disability Index (NDI) and Numeric Pain Rating Scale (NPRS) pre and post-test results were recorded. The researcher instructed and demonstrated the activities, after which the individuals were forced to complete them. For duration of two weeks, the workouts were performed four days a week.

TREATMENT PROCEDURE:

- **Group A:** was administered a treatment regimen that included open kinematic chain exercises and interferential therapy.

OPEN KINEMATIC CHAIN EXERCISES [7]:

Dynamic hug

Standing with the back to the wall, knees slightly bent, and feet shoulder-width apart, one did the dynamic embrace. The subject started with the shoulder internally rotated at 45°, the elbow flexed at 45°, and the arm abducted at 60°. The patient then made a hugging motion, flexing his humerus horizontally by following an arc indicated by his hands. The patient slowly reverted to his initial position after his hands made contact (maximum scapular protraction). Repeat the procedure for five times.

Wall slide

The patient is instructed to perform five repetitions of the wall slide exercise while standing on his back in front of the wall. The lower arms are to be slipped upward against the wall with the elbow and shoulder joints extended to 90 degrees and the trunk fixed in a standing position.

Prone rowing

The patient is requested to elevate their head and chest slightly while simultaneously lifting and dragging their arms backward. The patient is positioned in a prone position with their arms aloft, palms down, fingers extended, and thumbs extended. Hands form fists as they approach the shoulders; after five repetitions, ask the patient to return to the starting position.

- **Group B**: was administered a treatment plan that included closed kinematic chain exercises and interferential therapy.

CLOSED KINEMATIC CHAIN EXERCISES [8]:

Knee push-up exercise

The initial posture involves kneeling prone, with the weight evenly distributed across the hands and knee, the shoulder at a 90-degree flexion, and the elbow completely extended. The thorax nearly touches the floor when the elbows are flexed. Repeat it for 5 times

Knee prone bridging plus exercise

The patient lies prone with their elbows beneath their shoulders. They are then instructed to raise their body off the ground, distribute their weight equally between their arms and knees, maintain their straight body for ten seconds, and then return to the starting position for five repetitions.

Pull- up exercise

Lying on their backs beneath the parallel bar is the patient's position. Reach up, take hold of the parallel bar with both hands, and instruct the patient to maintain a straight body while pulling up towards the bar and attempting to touch it with their chest. Then, instruct the patient to return to the starting position and repeat the exercise five times.

Interferential therapy (IFT) for group A and B

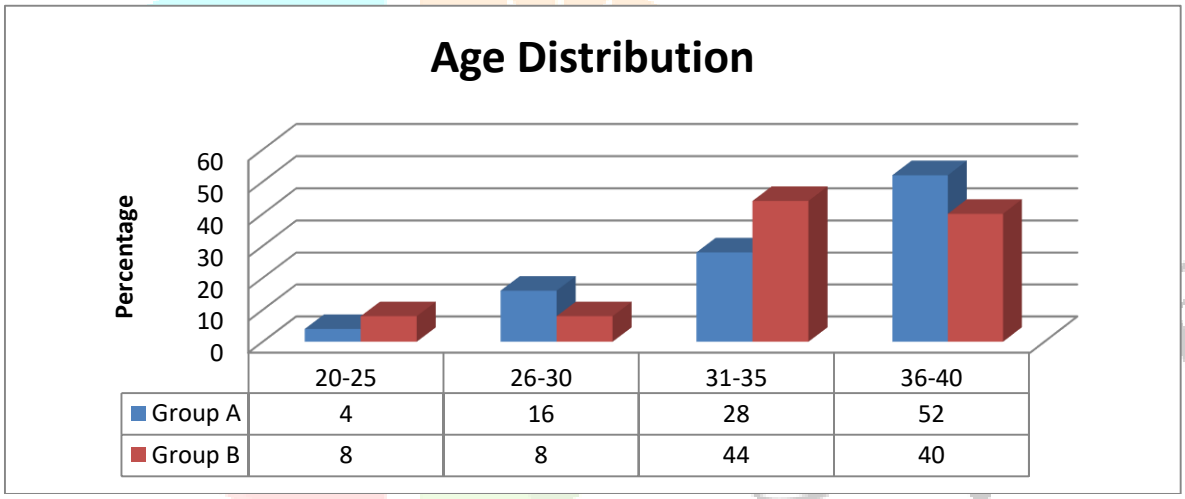
The neck region in the quadripolar approach, 90–120 Hz (rhythmic), as per the patient's tolerance, Triangle/Trapezoid/Rectangular for 20 minutes 4 days per week for 2 weeks

DATA ANALYSIS:

Table 1: Analysis of Groups A and B's age distribution

Age	Group A		Group B	
	Numbers	Percentage	Number	Percentage
20-25	1	4	2	8
26-30	4	16	2	8
31-35	7	28	11	44
36-40	13	52	10	40
TOTAL	25	100	25	100

In the age range of 20 to 25 years, Group A has 4% and Group B has 8% of the population; in the age range of 26 to 30 years, Group A has 16% and Group B has 8%; in the age range of 31 to 35 years, Group A has 28% and Group B has 44% of the population; and in the age range of 36 to 40 years, Group A has 52% and Group B has 40% of the population.

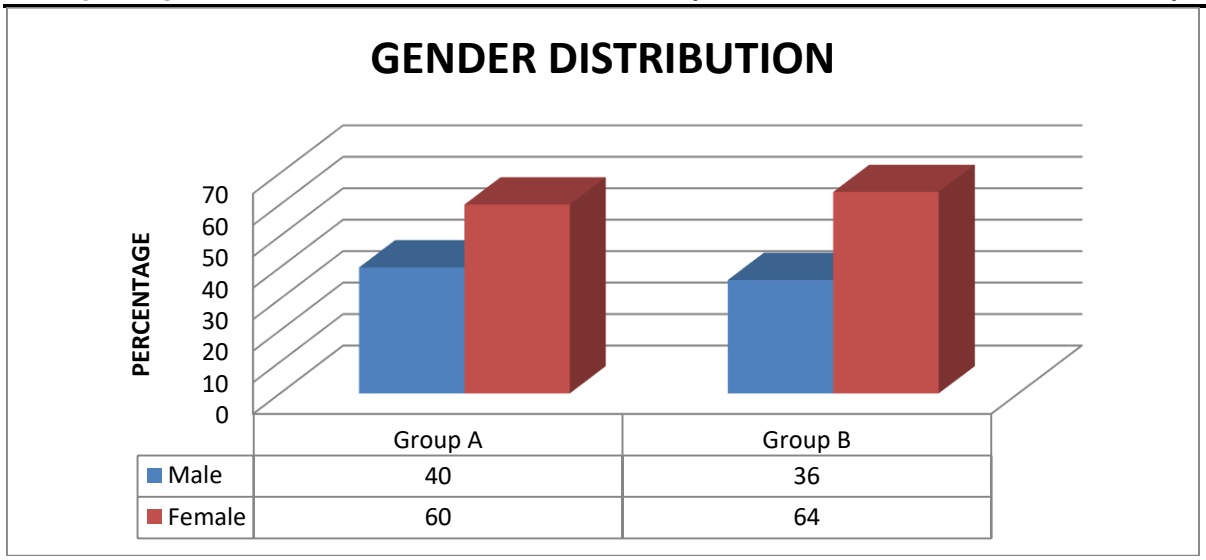


Graph 1: Age distribution representation among groups

Table 2: Analysis of Groups A and B's gender distribution

Gender	Group A		Group B	
	Numbers	Percentage	Number	Percentage
Male	10	40	9	36
Female	15	60	16	64
Total	25	100	25	100

Group B included 36% men and 64% women, while Group A had 40% men and 60% women.

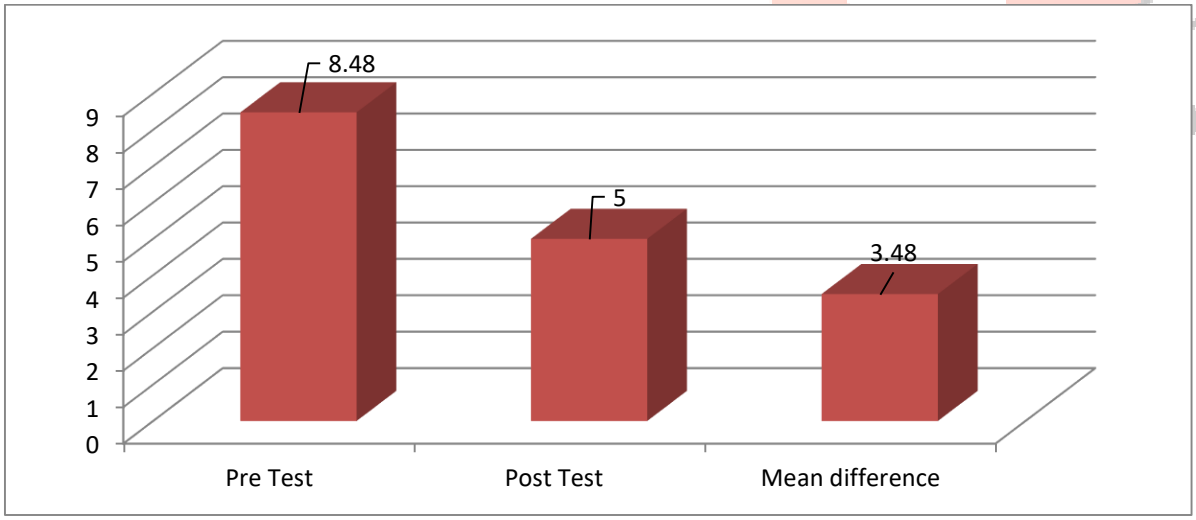


Graph 2: Gender distribution representation among groups

Table 3: The table displays group A's test results on the Numeric Pain Rating Scale.

Measurement	Mean	Mean Difference	Standard deviation	Paired 't' value
Pre-Test	8.48	3.48	0.65	16.0407
Post Test	5.00		1.32	

The paired "t" value for pain in Group A is 16.0407. The figure 3 indicates a noteworthy distinction in open kinematic chain workouts and interferential therapy for persistent cervical pain.

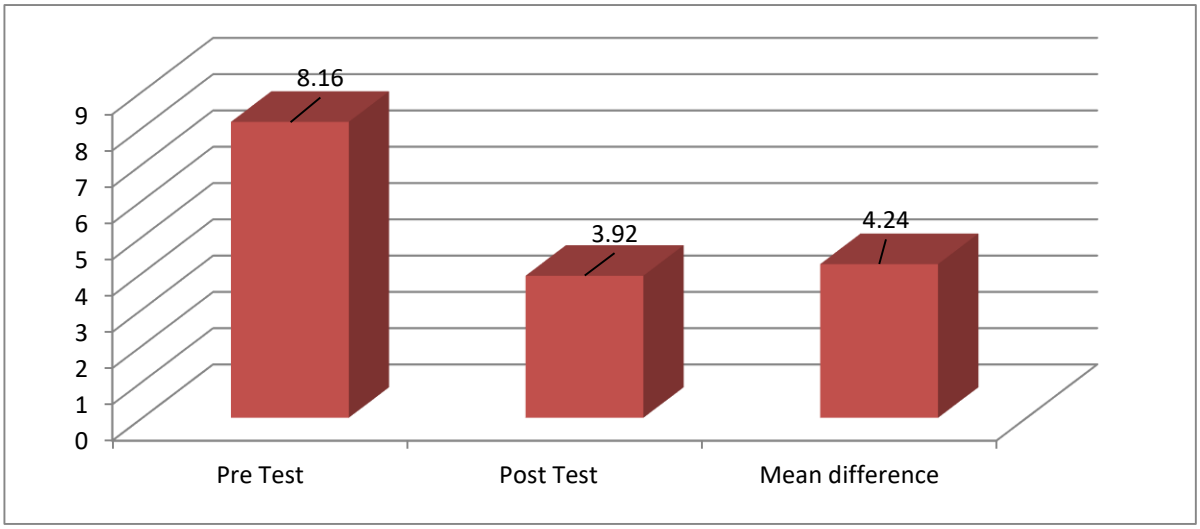


Graph 3: Displays the group A pre- and post-test mean value of the Numeric Pain Rating Scale (NPRS) is graphically shown.

Table 4: The table displays Group B's pre- and post-test results on the Numeric Pain Rating Scale.

Measurement	Mean	Mean Difference	Standard deviation	Paired 't' value
Pre test	8.16	4.24	1.07	15.9199
Post test	3.92		1.15	

The paired "t" value for pain in Group B is 15.9199. The figure 4 demonstrates a noteworthy difference in interferential therapy and closed kinematic chain exercises for persistent neck pain.

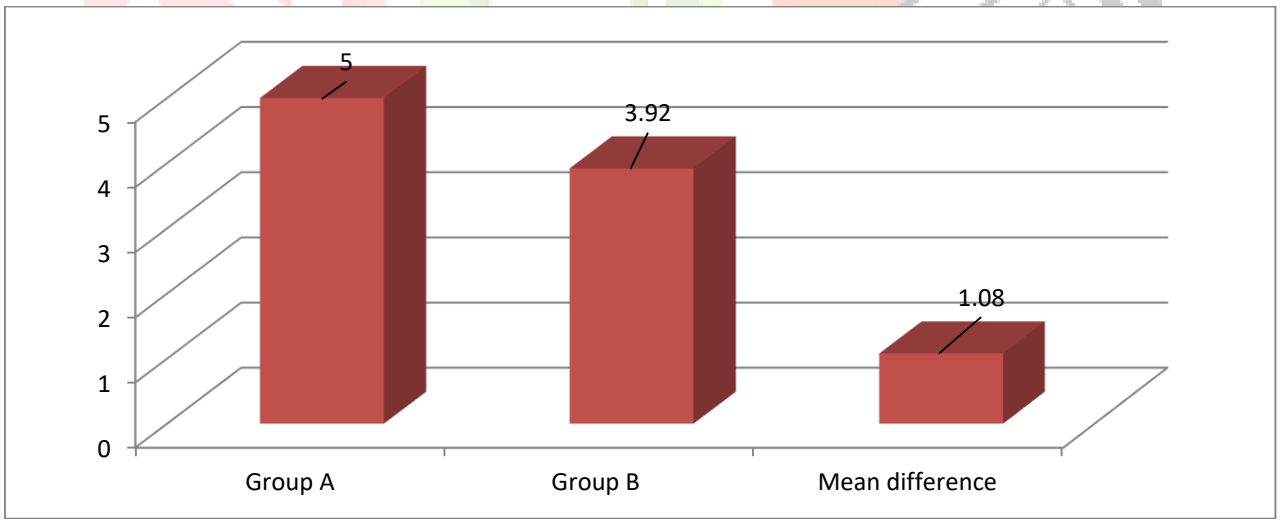


Graph 4: Displays the mean values of the pre- and post-test in a graphical format. Group B's numerical pain rating scale

Table 5: The table displays Group A and Group B's post-test results on the Numeric Pain Rating Scale.

Group	Mean	Mean Difference	Standard Deviation	Unpaired 't' test
A	5.00	1.08	1.32	3.0786
B	3.92		1.15	

The estimated unpaired "t" value for pain in Groups A and B is 3.0786. The figure 5 demonstrates that, when combined with interferential therapy, there is a considerable difference between closed and open kinematic chain exercises for chronic neck pain.

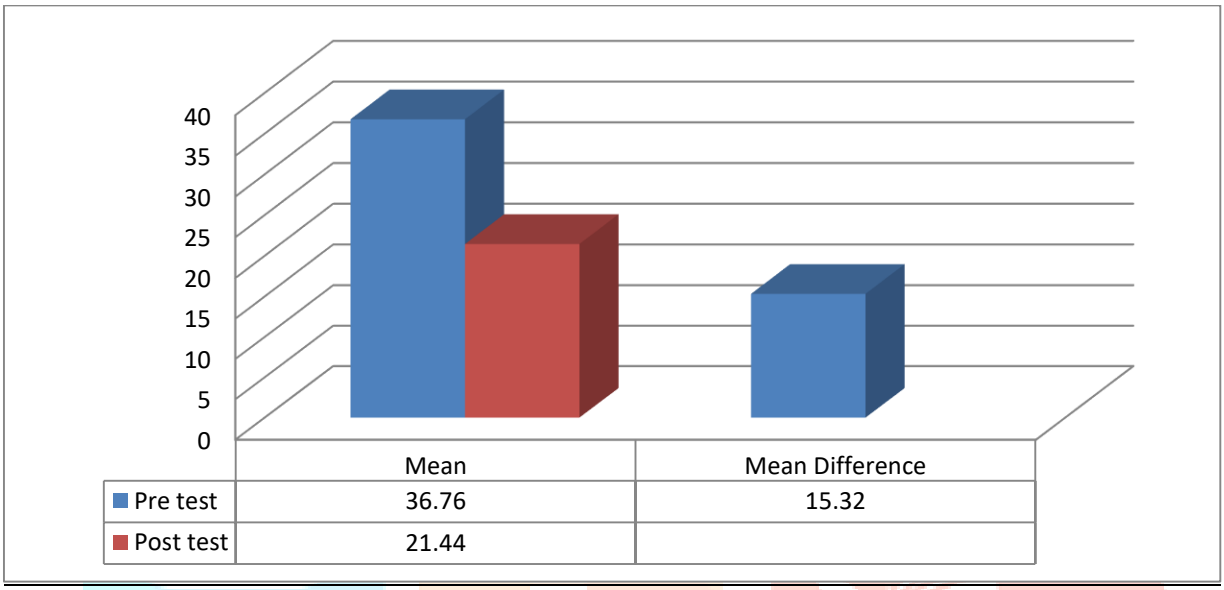


Graph 5: Displays the post-test mean values for groups A and B on the Numeric Pain Rating Scale (NPRS) in a graphical format.

Table 6: Displays group A's neck disability index pre- and post-test results.

Measurement	Mean	Mean Difference	Standard deviation	Paired 't' value
Pre test	36.76	15.32	5.95	19.2142
Post test	21.44		6.44	

The paired "t" value for functional disability in Group A is 19.2142. The figure 6 indicates a noteworthy distinction in open kinematic chain workouts and interferential therapy for persistent cervical pain.

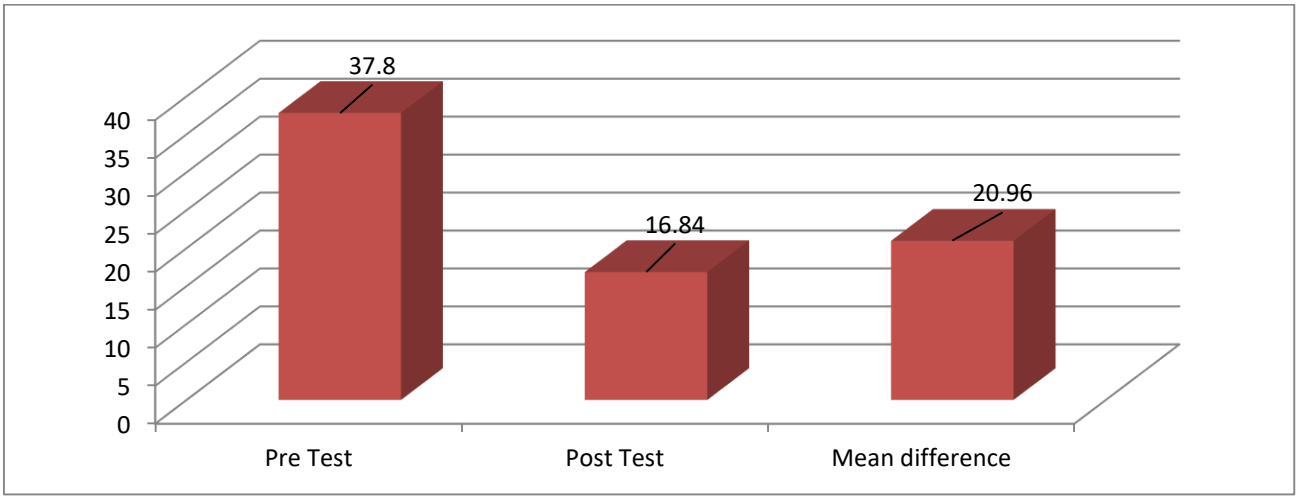


Graph 6: Displays a graphical depiction of group A's Neck Disability Index (NDI) mean values before and after the test.

Table 7: The table shows Group B's Neck Disability Index pre- and post-test findings.

Measurement	Mean	Mean Difference	Standard deviation	Paired 't' value
Pre test	37.80	20.96	3.95	26.5849
Post test	16.84		4.12	

The functional disability paired "t" table value in Group B is 26.5849. The figure 7 demonstrates that, when combined with interferential therapy, closed kinematic chain exercises significantly reduce chronic neck discomfort.

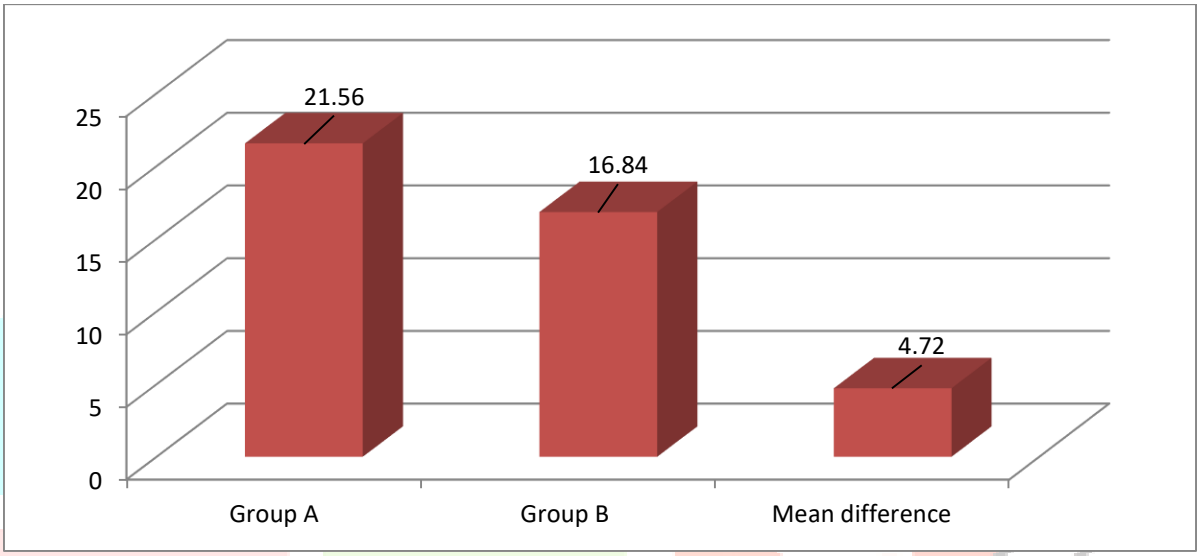


Graph 7: Displays the Neck Disability Index mean values for group B before and after the test.

Table 8: The Neck Disability Index post-test results for Groups A and B are displayed in the table.

Group	Mean	Mean Difference	Standard Deviation	Unpaired t test
A	21.56	4.72	6.53	3.0558
B	16.84		4.12	

When comparing open versus closed kinematic chain exercises with interferential therapy for persistent neck pain, the unpaired "t" value for functional impairment in Groups A and B is 3.0558 there is a considerable difference between groups.



Graph 8: Displays the post-test mean values of the Neck Disability Index for groups A and B in a graphical format.

RESULTS:

The study's findings showed that closed kinematic chain exercises with interferential therapy significantly improved performance compared to open kinematic chain workouts with interferential therapy.

DISCUSSION:

The current study aims to investigate the effects of interferential therapy in conjunction with open and closed kinematic chain exercises on pain and functional impairment in patients with chronic neck pain. In total, fifty individuals with persistent neck pain were enrolled in the study and were split into two groups, Group A and Group B. For a duration of four days per week for two weeks, Group A underwent open kinematic chain exercises and interferential therapy, while Group B underwent closed kinematic chain exercises and interferential therapy. Following the intervention, closed kinematic chain exercises are more successful than OKC in reducing pain and enhancing functional capacity.

An aberrant scapular posture that compromises cervical motion and stability by causing improper compressive and shear stresses in the cervical spine. Additionally, it can result in a break in the functional kinematic chain, increasing the danger of damage to other structures. The goal of the kinematic workouts was to increase scapular upward and downward rotation activation. The rhomboid minor, rhomboid major, trapezius, and serratus anterior may all contribute to scapular rotation. The imbalance between the upper and downward rotators is reduced by the OKC and CKC exercises. A patient with persistent neck pain may have downward pulling tension in their scapula, which could result in a persistent compressive force on their facets or posterior neck spine. These exercises serve to restore normal scapula motion, lessen stress on the cervical region, and minimize the downward tension in the scapula.

Kinematics describes a segment's displacement, change in position over time, or motion without taking into account the forces causing that movement. An exercise or movement pattern known as an "open kinematic chain" occurs when the distal end of an extremity ends freely in space and is not fixed to anything. Furthermore, OKCE exercises are usually non-weight-bearing.

Because there is an innately small degree of muscular co-contraction, OKCE and movement patterns also permit more isolated muscle activation. The distal part of the extremities is fixed to an object that is either moving or stationary in the Closed Kinematic Chain workout or movement pattern. These workouts usually include many joints and weight bearing. The CKC exercises will limit the ability of muscles and joints' proprioceptors to react to sensory information. Proprioceptor joint stability is enhanced by CKC, and enhanced coactivation facilitates greater use and more functional movement patterns.

Roopa Rajendra Desai et al., [9] conducted a study comparing the effects of facilitation techniques and Closed Kinematic Chain (CKC) exercises on patients with chronic neck pain and scapular dyskinesia. The study found that the CKC exercises improved the patient pain intensity, which is consistent with my current findings that the CKC exercises reduce pain.

My current study, which found that closed kinematic chain exercises were used to correct the scapulothoracic muscles' weakness and improve functional ability, is supported by another study by Damla Karabay et al., [10] that demonstrated how CKC exercise training programmes highly activate the scapulothoracic muscles and improve functional ability.

Mitul Patel [11] conducted a study to compare the effect of open kinetic chain exercise and close kinetic chain exercise on pain and function in patients with low back pain concluded that CKC exercises are more effective than OKC exercises for low back pain and function. Elif Turgut et al., [12] conducted a study on three-dimensional scapular kinematics during open and closed kinetic chain movements in asymptomatic and symptomatic subjects the findings of the study indicated that 3-d scapular kinematics during OKC shoulder elevation differed from those during CKC movements. as a result, the current study demonstrates that both groups' improvements are statistically significant, and closed kinematic chain exercises significantly improve pain and functional impairment than OKC.

CONCLUSION:

According to the study, closed kinematic chain exercises and interferential therapy were helpful in reducing pain and improving functional abilities in those with chronic neck discomfort.

LIMITATIONS AND SUGGESTIONS:

- Future research with larger populations is necessary to increase the validity of the findings.
- More research is required to determine whether they have scapula dyskinesia.
- Samples relating to specific occupations can add value to additional research.

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