EFFECTS OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION TECHNIQUE IN CHILDREN WITH POST FRACTURE ELBOW STIFFNESS

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ABSTRACT: Daily living are an vital part of a child's development. Range of motion exerciese, strengthening ,stretching exercise and mobilizations play important role in elbow stiffness treatment. Proprioceptive Neuromuscular Facilitation is a method of stretching that has been demonstrated to enhance active and passive ROM. PNF is applied in medical contexts by therapists to support individuals who have had invasive surgery soft tissue destruction regain their functional ROM and strength.This study aimed to determine the effects of proprioceptive neuromuscular facilitation (PNF) techniques on children with post-fracture elbow stiffness. Conducted as a randomized controlled trial at DHQ Pakpattan, 26 patients were unsystematically assigned to either Group A (experimental group receiving PNF technique and baseline treatment) or Group B (control group receiving exercise therapy with baseline treatment including a heating pad). Both groups underwent 30-minute sessions, five times a week for four weeks. The study was ethically approved, and data were analyzed using the latest version of SPSS. The results demonstrated a statistically significant difference between the two groups, with p-values less than 0.05. Post-treatment, the mean±SD for elbow flexion was 150.15±2.303 in Group A and 142.53±1.450 in Group B. For elbow extension, the post-treatment mean±SD was 1.30±1.493 in Group A and 3.69±0.8548 in Group B. The DASH score post-treatment mean±SD was 28.69±2.626 in Group A and 56.62±4.942 in Group B. The study concluded that while both treatment techniques were effective, PNF techniques were more effective than exercise therapy in improving range of motion and reducing disability in children with post-fracture elbow stiffness.

Keywords: Children, Elbow contracture,Functional Recovery, Goniometry, PNF techniques, Post-traumatic stiffness, Post-fracture elbow stiffness, Stretchings.

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1 INTRODUCTION

The elbow joint, a restricted synovial hinge joint, is particularly prone to rigidity and degeneration and is highly intolerant of trauma. It is formed by the articulation of the radial head with the capitellum and trochlea of the humerus and the notch of the ulna. The joint's soft tissue margin is defined by the articular capsule, which includes distinct medial and lateral ligament complexes but is weakest anteriorly and posteriorly(1, 2). This joint's stiffness can be attributed to its highly congruent bone structure, relatively small joint space, a tightly knit collateral ligament complex, and the interaction of surrounding muscles that act as additional stabilizers. Stiffness can result from surgery, trauma, post-traumatic arthritis, the development of heterotopic ossification, and age-related degeneration. It may also arise from soft tissue contracture, deformity, osseous impingement, or a combination of these factors(3, 4).

Elbow and forearm fractures account for 8%–10% of adult fractures, commonly resulting from falls onto an outstretched arm that lead to impact injuries. Early diagnosis and treatment typically result in functional improvement and reduced patient morbidity. The pathophysiology of common elbow injuries is varied but often involves microtrauma. This microtrauma leads to gradual cellular and tissue deterioration, making individuals, particularly athletes, more susceptible to significant injuries as their bodies adapt to the demands of their sports. This injury process is similar to patterns observed in the shoulder, knee, and foot. Assessment frameworks can be used to identify clinical changes and evaluate all factors contributing to these injuries.(5, 6)

The elbow plays a crucial role in positioning the hand in space. For daily activities, the elbow's functional range of motion should include 100° for pronation-supination (50° in each direction) and 100° for flexion-extension (from 30° to 130°). Functional limitations may be less noticeable with minor motion loss, but an elbow is considered stiff if it has lost more than 30° of extension and can flex less than 120°. (7, 8)

The elbow is one of the most frequently injured joints in sports, particularly affecting pitchers, golfers, tennis players, and weightlifters. Valgus extension overload syndrome often explains injuries in sports involving overhead throwing. Accurate radiologic diagnosis necessitates an understanding of the elbow's specific anatomy, biomechanics, and symptoms(9). Sporting activities can cause unique injury patterns due to increased varus or valgus stresses and overload in extension or flexion, leading to tensile, compressive, and shear stresses. Acute symptoms typically arise from the chronic degradation of ligaments and tendons due to recurrent microtrauma associated with overuse(10).

Elbow stiffness often results from trauma, progressing through four stages: granulation, edema, fibrosis, and hemorrhage. Proper load transmission to the forearm relies on the integrity of the ligamentous structures in the forearm and wrist. There is ongoing uncertainty and debate regarding the distribution of loads on the bones in different forearm positions and how alterations in forearm anatomy affect these loads. Early biomechanical studies suggest that the ulna transmits 40% of the axial force applied to the hand(11, 12).

Childhood elbow injuries are common, accounting for 2% to 3% of emergency room visits, with many involving fractures. Fractures of the proximal radius and ulna, as well as apophyseal elbow injuries, are less frequent. Diagnosing fractures in children can be challenging due to the elbow's multiple ossification centers, which ossify and close at different ages.(13) Accurate diagnosis requires a thorough history to facilitate a safe, effective physical examination. As elbow range of motion decreases with age, setting realistic goals should consider the patient's age. After trauma, defining the mechanism of injury as precisely as possible can reveal patterns involving specific elbow structures and help therapists identify safe zones of motion(14, 15).

Elbow injuries in children and adolescents can be classified into three main categories: those resulting from lateral compression, posterior shear, and medial tension. Prompt and accurate diagnosis is crucial for both nonoperative and surgical treatments to yield favorable outcomes (16). Traumatic elbow injuries carry the risk of joint contracture; among our study participants, 12% experienced restricted elbow movement, necessitating surgical intervention for joint contracture in 12% of cases. Over the course of a year post-injury, there is typically improvement in range of motion; however, if improvement stalls after three months, it may indicate impending elbow joint contracture (17, 18).

Proprioceptive Neuromuscular Facilitation (PNF) therapy, often coupled with physical therapy and splinting, plays a pivotal role in managing stiffness following elbow surgery. While postoperative rehabilitation aims to maintain achieved range of motion, conservative treatments strive to enhance it. Commencing conservative therapy within six months post-injury yields optimal results, particularly for soft tissue contractures causing symptomatic stiffness. Surgical intervention becomes necessary if conservative measures fail to improve range of motion after three to six months, especially in cases where osseous anatomy disturbance is the primary cause (19, 20).

Regular stretching is essential for maintaining muscle length and preventing a reduction in range of motion (ROM) that can hinder daily activities. Various stretching techniques, including Proprioceptive Neuromuscular Facilitation (PNF), have been documented to preserve or regain muscle flexibility effectively. PNF targets tense muscles through mechanisms like the gate control hypothesis, autogenic inhibition, reciprocal inhibition, and stress relaxation, aiding in both passive and active flexibility enhancement (21, 22).

PNF, developed over 70 years ago, remains a potent therapeutic tool for individuals seeking to regain voluntary control over their body movements. A comprehensive understanding of anatomy, neurophysiology, and kinesiology is crucial for therapists to administer effective PNF programs tailored to patients' needs. By incorporating PNF into rehabilitation regimens, patients with neurological disorders, physical trauma, or orthopedic issues can achieve maximum independence and function, ultimately enhancing their quality of life (23, 24).

Children who suffer from elbow fracture, stiffness after elbow fracture impact their everyday life. Therefore, it is important to determine potential interventions to decrease the stiffness as a result of elbow fracture technique and exercise therapy have been evident to increase joint mobility. Therefore, the aim of this study is to determine the effects of proprioceptive neuromuscular facilitation techniques in children with Post Fracture Elbow Stiffness.

4.1Null Hypothesis:

There were no effects of exercise therapy and PNF techniques on elbow stiffness in children with post traumatic elbow stiffness.

4.2Alternate Hypothesis:

There were effects of exercise therapy and PNF techniques on elbow stiffness in children with post traumatic elbow stiffness.

2 STUDY DESIGN AND METHODOLOGY

This study was designed as a randomized controlled trial (trial registry not 06198088). The sample size was calculated using Epitool, factoring in a 10% attrition rate, resulting in a final sample size of 26 participants (15). Each group in the study comprised 13 participants, totaling 26 (13 in CG and 13 in EG). The sampling technique employed was non-probability convenient sampling to recruit patients.

Following approval, the study was conducted at the Department of DHQ Teaching Hospital Pakpattan, spanning from July 15 to December 20, 2023. The inclusion criteria targeted children aged 3 to 7 years, encompassing both male and female patients. Participants included were those with contractures occurring 4 to 8 weeks post-traumatic injuries, as well as post-operative patients (25, 26). Exclusion criteria ruled out children with burn contractures, contractures due to neurological conditions, Dupuytren's contracture, Volkmann's contracture, and those with contractures lasting more than 8 weeks(27).

Data collection tools included a goniometer and the Modified DASH outcome measure questionnaire to assess and quantify the outcomes of the intervention.

Intervention

Both groups received a heating pad as part of the intervention.

Group A (Experimental Group): PNF Technique + Heating Pad (Baseline)

Group B (Control Group): Exercise Therapy + Heating Pad (Baseline)

Experimental Group (Group A)

Participants in the experimental group underwent Proprioceptive Neuromuscular Facilitation (PNF) techniques, specifically the hold-relax method, alongside baseline treatment for post-traumatic elbow stiffness. Patients were positioned comfortably in a supine posture, with their elbow moved to the limit of its passive range of motion in the direction of its limitation. A stretching force was applied for thirty seconds, followed by a ten-second relaxation period. This sequence was repeated five times per session, five days a week for four weeks.

For elbow flexion, the patient's arm was positioned in the center of the plinth with the therapist standing on the affected side, slightly beyond the elbow's flexion point. The therapist's same-side hand grasped the patient's medial boundary, while the opposite hand stabilized the shoulder joint. A heating pad was applied for fifteen minutes before each treatment session. During the PNF technique, the restricted muscle was stretched and then contracted isometrically. After the designated time, the muscle was passively moved to a greater stretch position. In the Hold-Relax Agonist method, patients performed an isometric contraction of the agonist muscle for approximately six seconds before further advancing the range. Verbal cues such as "Hold. Hold. Don't move" were given. The patient then isometrically contracted the antagonist muscle to overcome resistance, followed by concentric contraction of the agonist muscle to enhance the range of motion.(28)

Control Group (Group B)

Stretching for Flexion and Extension:

Patients were placed in a supine position with the tested arm moved into flexion or extension. The stretch was maintained for 10 to 30 seconds, with a 15-second rest period between each stretch, repeated five times per session. The angle of elbow flexion was not exceeded if pain persisted.(29)

Strengthening Exercises:

Active Assisted Elbow Flexion and Extension:

Patients were instructed to grasp their involved arm at the wrist and gently bend the elbow as far as possible, holding for 30 seconds before straightening the arm back out as far as possible. This exercise was repeated to enhance strength and range of motion.

Data Analysis Procedure:

Data analyzed by using SPSS latest version. The significance level was accepted as $P<.05$ Numeric variables defined with mean ± standard deviation. The hypothesis normality had been tested by using the Shapiro- Wilk test. The Values of the Shapiro-Wilk Test was < 0.05, the data were significantly deviated from a normal distribution hence the parametric test was used.

3 RESULTS

In current study participants, Age falls between 3 to 7 years. The mean age was 5.81±1.939 (Figure1). The current study included 11 females (42%) and 15(58%) males. The normality of the data was tested by the Shapiro-Wilk statistic was used. The Findings of result showed the p-value for variables like Elbow males and DASH-Questionnaire was significant, p > 0.05, which indicates that data was normally distributed. We applied parametric tests for between and within group comparison.

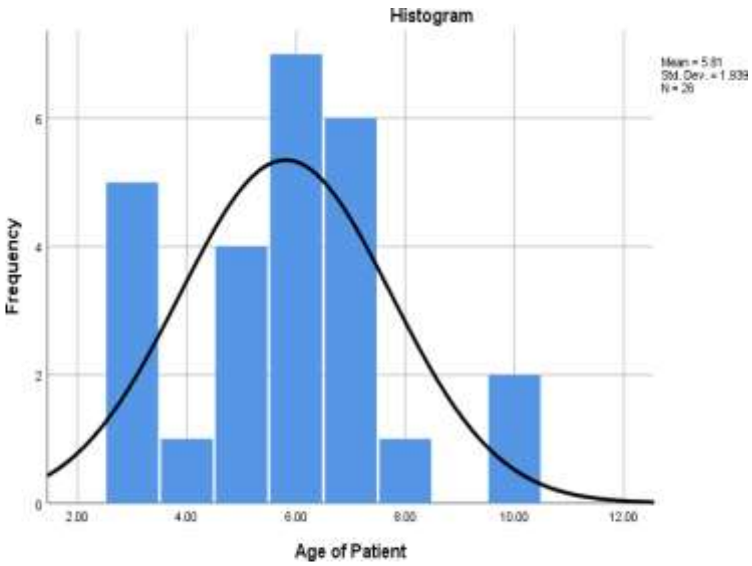

Fig. 3.1: Histogram of age

The independent t test used to compare pre-treatment means of group A and B. Both groups were similar in Elbow ROM and DASH score at baseline values with p- value greater then 0.05 and Pre-treatment Mean±SD of Elbow Flexion in Group A was 135.15 ±4.058 while in Group B 134.23±3.218 (p-value 0.527). Pre-treatment Mean±SD of Elbow Extension in Group A was 8.76±1.690 while in Group B 8.23±1.780 (p-value 0.438). Pre-treatment Mean±SD of supination in Group A was 80.53 ±2.875while in Group B was 80.92±3.094 (p-value 0.919). Pre-treatment Mean±SD of Pronation in Group A is 74.61 ±3.990 while in Group B 73.76 ±3.632 (p-value 0.181). Pre-treatment Mean±SD of DASH-Score in Group A was 83.08±7.610 while in Group B 85.31±9.673 (p-value 0.520).

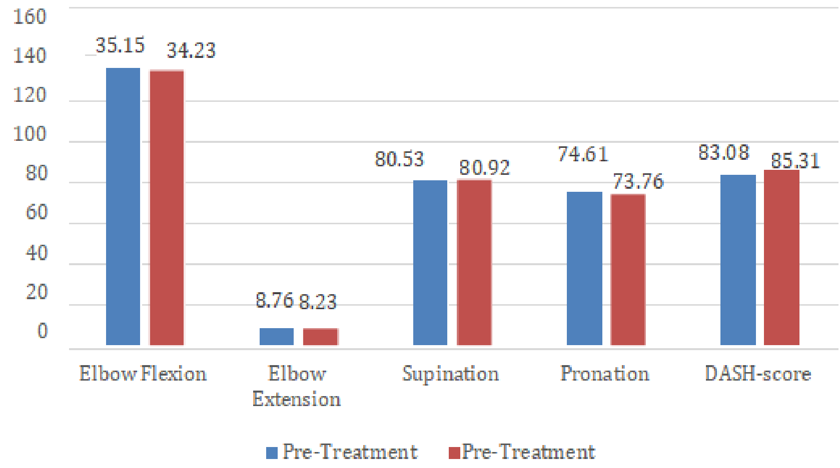

Fig. 3.2: Between-Group Comparison of Pre-Treatment Mean

The independent t test used for comparsion the post treatment means of group A and B. Both groups were similar in Elbow 632. and DASH score at baseline treatment with p- values>0.05. Post treatment Mean±SD of Elbow Flexion in Group A was 150.15±2.303 while in Group B 142.53±1.450 (p-value 0.004). Post treatment Mean±SD of Elbow Extension in Group A was 1.30±1.493 while in Group B 3.69±.8548 (p-value 0.001). Post-treatment Mean±SD of Supination in Group A was 86.53±2.875 while in Group B 84.92±3.094 (p-value 0.002). Post treatment Mean±SD of Pronation in Group A was 85.07±1.187 while in Group B 78.53±.660 (p-value 0.002). Post-treatment Mean±SD of DASH-Score in Group A was 28.69±2.626 while in Group B 56.62±4.942 (p-value 0.003).

The results demonstrated a statistically significant difference between the two groups ($p < 0.05$), leading to the rejection of the null hypothesis. Group A, which received the PNF technique plus heating pad, showed significantly better outcomes in terms of elbow flexion, extension, supination, pronation, and DASH scores compared to Group B, which received exercise therapy plus heating pad.

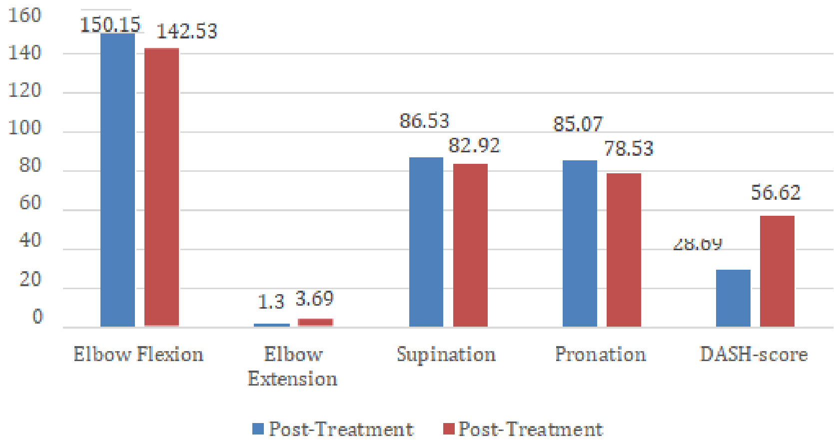

Fig. 3.3: Between-Group Comparison of Post-Treatment Mean

A paired t-test was conducted to compare the mean differences within each treatment group. The findings from the graph below revealed significant improvements in control group with a mean difference of **Elbow Flexion:** 15±1.755 (p-value 0.001), **Elbow**

Extension : 7.37±0.197 (p-value 0.002), **Supination:** 6±0.005 (p-value 0.002), **Pronation:** 10.46±2.203 (p-value 0.003) and **DASH Score:** 54.39±4.984 (p-value 0.003).

The results demonstrated a statistically significant mean difference ($p < 0.05$) between the pre-treatment and post-treatment measurements, indicating that PNF techniques are effective in improving range of motion (ROM) and reducing disability in children with post-fracture elbow stiffness .

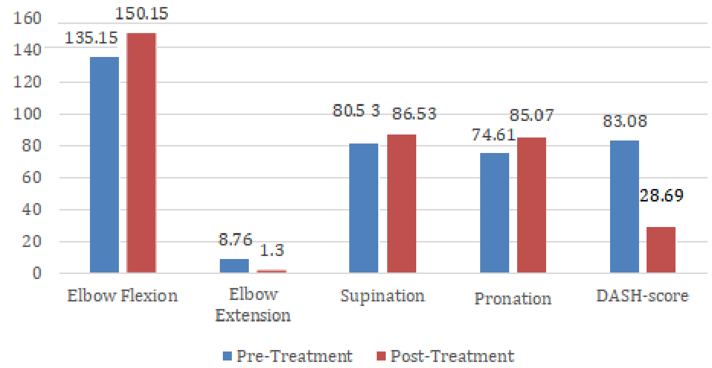

Fig. 3.4: Within group comparison for control group

The findings from the graph below revealed significant improvements in Experimental group with a mean difference of **Elbow Flexion:** 8.3±1.768 (p-value 0.001), **Elbow Extension :** 4.54±0.926 (p-value 0.001), **Supination:** 2±0.005 (p-value 0.003), **Pronation:** 4.77±2.972 (p-value 0.001) and **DASH Score:** 28.69±4.731 (p-value 0.004).

The results indicated a statistically significant mean difference ($p < 0.001$) between the pre-treatment and post-treatment measurements. This signifies that exercise therapy is effective in improving range of motion (ROM) and reducing disability in children with post-fracture elbow stiffness.

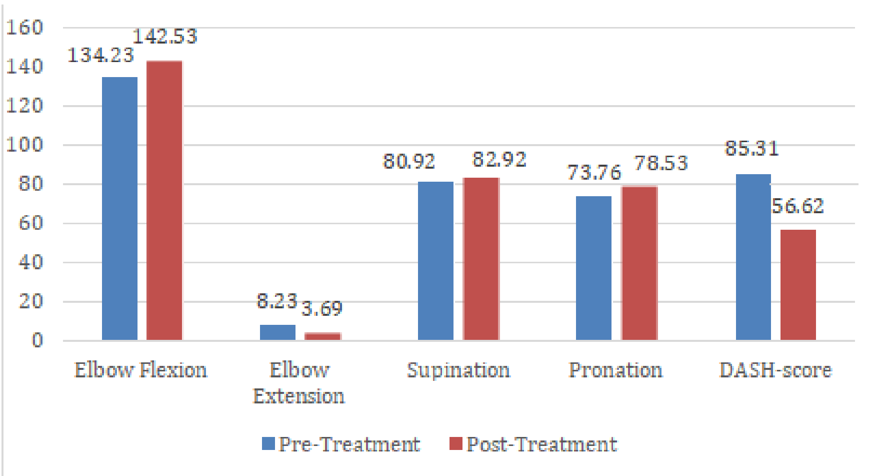

Fig. 5: Within group comparison for Experimental group

4 DISCUSSION

Hamid, Javed carried out a study in 2023 to assess and contrast the life quality and patient satisfaction levels in those with elbow stiffness who get passive stretching with those who receive Proprioceptive Neuromuscular Facilitation (PNF) stretching. The PNF group mean 82.34 ± 6.63 had substantially better questionnaire scores ($p < 0.000$) than mean 63.98 ± 14.42 of the Passive Stretching group. Compare to the group receiving passive stretching, patients receiving PNF stretching expressed more enjoyment and a higher quality of life. These reseults showed between the two groups that there was a statistically significant difference (30). In current study participants, Age falls between 3 to 7 years. Both groups were similar in Elbow Flexion, Elbow Extension and DASH_score at baseline treatment values with p-value less than 0.05.Post treatment Mean±SD of Elbow Flexion in Group A was150.15±2.303 while in Group B 142.53±1.450. Post-treatment Mean±SD of Elbow Extension in Group A was1.30±1.493 while in Group B 3.69±.8548.According to these results, there is a statistically significant difference between the two groups.

In present research there was a statistically significant mean difference p=<.001 between pre-treatment mean and post-treatment mean which indicated that the PNF Techniques was effective in improving range of motion and disability in children with post_fracture elbow stiffness. Research on post-immobilization shoulder stiffness was conducted by Sarangan, Ezhumalai in 2023. The abduction improves shows that the mean difference in Group B (Active release approach) was 101.5 with a P of 0.0001, whereas the mean difference in Group A (Hold relax technique) was 87.5 with a P of 0.0001. The external rotation improve shows that the mean difference in Group B was 62 and the P of 0.0001, whereas the mean difference in Group A (Hold relax approach) was 53.8 and the P of 0.0001(31).

2019 research by Razak Ozdincler and Birinci. The study found that the static stretching group's mean DASH score was 19.25 ± 10.30, with a p value less than 0.05, whereas the PNF stretching group's improved somewhat (8.66 ± 6.15). For elbow flexion (AROM) mean change for PNF group and static group; 41.10 and 34.42, p = 0.04, VAS-activity (-3.47,-3.78, , p = 0.01), and VAS-rest (-1.31, -1.08, p = 0.03), so there was a significant group-by-time interaction in favor of the PNF stretching group (28).

According to our results the hold-relax technique was more effective in the case of elbow stiffness in reducing pain and improving range of motion showed that there is statistically significant mean difference p=<.001 between pretreatment mean and posttreatment mean of group A and group B which indicated that the PNF Techniques is effective.

In present study posttreatment Mean±SD of Elbow Flexion in Group A was 150.15±2.303 while in Group B 142.53±1.450. Posttreatment Mean±SD of Elbow Extension in Group A was 1.30±1.493 while in Group B 3.69±.8548. Results shows that there is statistically significant mean difference p=<.001 between pre-treatment mean and post-treatment mean of group A and group B which indicated that the PNF Techniques is effective. In 2023, Latouf and Halouani carried out research. The long- term effects of PNF stretching on hamstring strength and neuromuscular activity were the focus of this study. Between pre- and post-training, there was a significant difference in the neuromuscular activity of the medial and lateral hamstring muscles for the apex and region of the muscle (P < 0.01). In the contract and relax postures, there was also a significant difference in hamstring muscle strength (medial and lateral) between pre- and post-training (P < 0.001). The hamstring muscles can be made more neuromuscular active and stronger with eight weeks of CR-PNF stretching(23).

Mean DASH score is 28.69±4.731 slightly better with the PNF stretching group (28.69±2.626) then with the static stretching group Posttreatment Mean±SD of Supination in Group A is 86.53±2.875 while in Group B 84.92±3.094. Posttreatment Mean±SD of Pronation in Group A is 85.07±1.187 while in Group B 78.53±.660. Posttreatment

Mean±SD of DASH-Score in Group A is 28.69±2.626 while in Group B 56.62±4.942.

Previous research carried out in 2023 by Ahamad Zaidi. The effects of static stretching methods and PNF-contract-relax on knee range of motion, hamstring flexibility, and knee flexor muscle electromyographic activity in older adults have not been compared in any research. The goal of this study is to compare the same. Throughout the four weeks, twelve sessions were offered. After four weeks of intervention, there was a statistically significant difference ($p = 0.01$) in the maximal voluntary isometric contraction (MVIC) of the biceps femoris between the PNF and the control groups. The PNF group's knee range of motion and hamstring flexibility significantly improved both immediately following the test ($p = 0.01$) and following four weeks of training ($p = 0.07$ and $p = 0.001$)(32).This study demonstrated that the PNF stretching more useful in treating individuals with posttraumatic elbow stiffness in terms of enhancing elbow flexion range of motion.

5 CONCLUSION:

The study concluded that both treatment techniques are effective in improving the symptoms however PNF Techniques was more effective than exercises therapy on range of motion and disability in children with post-fracture elbow stiffness.

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