IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

To Compare The Effects Of Proprioceptive Neuromuscular Facilitation With Mulligan Versus Muscle Energy Technique With Mulligan To Improve Glenohumeral Internal Rotation Deficit In Collegiate Athletes Playing Overhead Sports- An Experimental Study

Author's Names: Jyoti Bhatt [1], Shama Praveen [2], Cooresponding Author: Niraj Kumar [3] Shiv Verma [4], Deepa Juyal[5]

Affiliation

1. Researcher, Department of Physiotherapy, School of Paramedical & Allied Health Sciences, SGRRU University, (Dehradun)
2. Assistant Professor, Department of Physiotherapy, School of Paramedical & Allied Health Sciences, SGRRU University, (Dehradun)
3. Professor, Department of Physiotherapy, School of Paramedical & Allied Health Sciences, SGRRU University, (Dehradun)
4. Associate Professor, Pt. DDU, UHS, Karnal
5. Assistant Professor, Department of Physiotherapy, School of Paramedical & Allied Health Sciences, SGRRU University, (Dehradun)

ABSTRACT

Introduction: Glenohumeral Internal Rotation Deficit (GIRD) is a common issue among collegiate athletes engaged in overhead sports, characterized by a significant reduction in internal rotation of the throwing shoulder compared to the contra lateral shoulder. This study aims to compare the efficacy of two therapeutic approaches—Proprioceptive Neuromuscular Facilitation (PNF) combined with Mulligan versus Muscle Energy Technique (MET) combined with Mulligan in improving GIRD in collegiate athletes involved in overhead sports.

Need of the study: Although many studies have been done on improving GIRD but none has been done to compare the effects of Proprioceptive Neuromuscular Facilitation with Mulligan Versus Muscle energy Technique with Mulligan to improve Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

Methods: A total of 30 collegiate athletes with diagnosed GIRD will be recruited from Shri Guru Ram Rai University, Patel Nagar, Dehradun. Participants will be randomly assigned to one of two experimental groups: Group 1 will receive PNF with Mulligan, and Group 2 will receive MET with Mulligan. Pre-treatment, Mid Treatment and post-treatment evaluations will be conducted using the Hand behind Back Test and the Tyler Test to measure changes in internal rotation. Treatment protocols will be administered over a specified duration, and the data will be analyzed using SPSS 21.0.

Conclusion: The study's findings indicate that while both therapeutic approaches—Proprioceptive Neuromuscular Facilitation (PNF) combined with Mulligan and Muscle Energy Technique (MET) combined with Mulligan—showed no significant difference in effectiveness when comparing outcomes between the two groups, Group A (PNF with Mulligan) demonstrated a significantly greater improvement within the group itself. These results suggest that PNF may be the more effective approach for addressing Glenohumeral Internal Rotation Deficit (GIRD) in collegiate athletes participating in overhead sports. Further research is recommended to explore the long-term effects and potential mechanisms behind these outcomes.

Keywords: Glenohumeral Internal Rotation Deficit (GIRD), Proprioceptive Neuromuscular Facilitation (PNF), Muscle Energy Technique (MET), Mulligan Technique, Overhead Sports, Collegiate Athletes.

INTRODUCTION

College players play sports that are similar to those of elite athletes, but they vary in terms of training, practice, and participation levels. The difference in the damage patterns of these two groups could be attributed in large part to this differentiation. It has been suggested that these constant pressures cause athletes to undergo persistent degenerative changes. Shoulder injuries have increased among non-professional collegiate athletes who engage in overhead throwing activities. Glenohumeral internal rotation deficit (GIRD), which causes a decrease in the throwing shoulder's internal rotation in comparison to the contra lateral shoulder, is one such common issue that impacts athletes who throw overhead. [1]

A process of adaptation known as Glenohumeral internal rotation deficit (GIRD) causes the throwing shoulder to internal rotation (IR) is lost. A loss of more than 20 degrees of internal rotation with respect to the contra lateral shoulder currently characterizes GIRD.[2] The term GIRD has been used to describe an internal rotation measurement and one of the most important factors influencing injury risk in the arm of overhead athletes, such as baseball pitchers, tennis players, hammer throwers, shot putters, among others.[3,4,5,6,7,8]

Muscle energy technique. It is a non-invasive treatment that can be used to extend or stretch stiff muscles and fascia. MET primarily targets soft tissues, but it also significantly contributes to joint mobilization, which enhances extensibility of muscle and increases range of motion of joints through a mechanism known as enhancing tolerance to stretch [9]

To be able to throw at fast speeds, athletes' shoulders must shift. Usually, neither the non-dominant side of throwers' shoulders nor the shoulders of non-throwers exhibit these modifications. One of these adaptations is the shift in motion experienced by athletes who use the overhead throwing action. [9]

Because of adaptive alterations to soft tissue and bone that are assumed to result from repeated throwing actions, GIRD is more common in overhead athletes. Loss of Glenohumeral internal rotation could result from an osseous adaptation of the humerus and increased retroversion of the proximal humerus. This would increase external rotation at the price of internal rotation. Furthermore, a decrease in glenohumeral internal rotation greater than an increase in external rotation has been associated with posterior capsule soft tissue constriction. Throwing involves repetitive motion, and throwing athletes are susceptible to GIRD. As a result, there is a high risk of impingement due to shoulder instability, or a loss of control over the humeral head movement. [11, 12, 13]

The synchronization of strong forces from the lower to the upper extremities during overhead sports activities creates the necessary velocities for throwing actions. Because of the torque and distraction involved in throwing repetitively, athletes' glenohumeral and elbow joints are subjected to significant mechanical stress. [1]

A lot of popular competitive and leisure sports involve the overhead throwing motion. This motion causes the human body to experience its fastest joint velocities, and each throw or movement places the body under tremendous stress. [9]

During the throwing motion, the glenohumeral joint (GHJ) achieves extraordinary ranges of motion (ROMs), velocities, and forces. The GHJ internal rotation can reach peak angular velocities of around 7000°/s, and it can decelerate at 500 000°/s during the follow-through. This generates a significant force that the posterior shoulder must fight while the humerus continues to internally spin and adduct horizontally. It is hypothesized that in throwing athletes, altered GHJ range of motion and posterior shoulder stiffness are the outcome of these significant speeds and forces at the posterior shoulder. When comparing the GHJ external rotation range of motion of the dominant arm to that of the non-dominant arm at 90° of abduction, overhead athletes frequently display noticeably higher ROM. [13, 14, 15, 16]

One of the functions of glenohumeral joint arthrokinematics is to facilitate optimal glenohumeral rotation, which combines both. If internal and external rotations are appropriately balanced, the humeral head can remain centered in the glenoid fossa. Many research investigations have shown that in most throwing athletes, the dominant arm's glenohumeral external rotation magnitude is higher and its glenohumeral internal rotation magnitude is lower than in the non-dominant arm. GIRD is caused in athletes that throw above by the repetitive throwing motion that creates adaptive changes in soft tissue and bone. GIRD is one of the most important factors influencing the risk of arm injuries. [17]

Brian Mulligan's concept of Mobilization with Movement (MWM) is a natural continuance of the progression in the development of manual therapy from active stretching exercise to therapist applied passive physiological movement to passive accessory mobilization technique. MWM is the concurrent application of a sustained accessory mobilization applied by the therapist and an active physiological movement to end range applied by the patient. Passive end of range over pressure or stretching is then able to be delivered without pain as a barrier. (18)

The significance of GIRD extends beyond mere mechanical changes; it is associated with a higher incidence of shoulder injuries and functional impairments. This study seeks to examine the prevalence and implications of GIRD among collegiate athletes, aiming to provide a comprehensive understanding of how this condition affects shoulder biomechanics and performance. By exploring the mechanisms underlying GIRD and its impact on injury risk, the study aims to contribute valuable insights into effective prevention and rehabilitation strategies for overhead athletes. Understanding these dynamics is crucial for mitigating the adverse effects of GIRD and enhancing the long-term health and performance of athletes

AIMS AND OBJECTIVES

AIM

The aim of the study is to see the effects of Proprioceptive Neuromuscular Fascilitation with Mulligan Versus Muscle Energy Technique with Mulligan to improve Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

OBJECTIVE

To determine which treatment—Proprioceptive Neuromuscular Facilitation with Mulligan, Energy Techniques with Mulligan —most rapidly improves Glenohumeral Internal Rotation Deficit in collegiate athletes who play overhead sports.

NEED OF THE STUDY

Although many studies have been done on improving GIRD but none has been done to compare the effects of Proprioceptive Neuromuscular Facilitation with Mulligan Versus Muscle energy Technique with Mulligan to improve Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

PURPOSE OF THE STUDY

Overhead activity is used very much in everyday lifestyle. Its importance is tremendously more in sports. The purpose of the study is to find out which treatment protocol- Proprioceptive Neuromuscular Facilitation with Mulligan Versus Muscle energy Technique with Mulligan is fast resulting for improving Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

HYPOTHESIS

Alternate Hypothesis (H_1): There may be significant difference between the effects of Proprioceptive Neuromuscular Facilitation with Mulligan Versus Muscle energy Technique with Mulligan to improve Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

Null Hypothesis (H_0): There may not be significant difference between the effects of Proprioceptive Neuromuscular Facilitation with Mulligan Versus Muscle energy Technique with Mulligan to improve Glenohumeral Internal Rotation Deficit in Collegiate Athletes playing Overhead Sports.

METHODOLOGY: A total of 30 collegiate athletes with diagnosed Glenohumeral Internal Rotation Deficit (GIRD) were recruited from Shri Guru Ram Rai University, Patel Nagar, Dehradun. Participants were randomly assigned to one of two experimental groups: Group 1 received Proprioceptive Neuromuscular Facilitation (PNF) with Mulligan, while Group 2 received Muscle Energy Technique (MET) with Mulligan. Evaluations were conducted before treatment, during treatment, and after treatment using the Hand behind Back Test and the Tyler Test to assess changes in internal rotation. Inclusion criteria included athletes aged 18-30 involved in sports such as cricket, basketball, and tennis, with posterior capsular tightness confirmed by the Tyler Test. Exclusion criteria included a history of shoulder or neck surgery, significant upper extremity numbness, or other related pathologies.

OUTCOME MEASURES: Hand behind back Test and Tyler Test

PROCEDURE: Subjects who met the inclusion and exclusion criteria were randomly assigned to two groups, A and B. These individuals were assessed at baseline, mid-treatment, and post-intervention using outcome measures such as the Hand Behind Back Test and the Tyler Test.

Group A (Mulligan with Proprioceptive Neuromuscular Facilitation)

Subjects underwent three proprioceptive neuromuscular facilitation (PNF) stretches: the sleeper, cross-body, and genie stretches. Each stretch involved passive stretching to the endpoint for 7 seconds with the scapula stabilized, followed by a 3-second contraction against resistance, and then a passive stretch to a new endpoint using the contract-relax PNF technique. This sequence was repeated three times per session. The subjects' contractions were graded 4/5 on the manual muscle test, indicating sufficient strength to resist external forces but not to push out of the stretch position. Over four weeks, subjects performed these stretches six times a week, with each stretch held for 30 seconds and rated at an intensity of 2 on a scale from 1 (stretching sensation) to 3 (intense discomfort).

Additionally, the Mulligan technique was applied similarly to Group A, involving a supine position with a mobilizing belt for lateral distraction while the shoulder was internally rotated. The program consisted of five sessions a week for four weeks, with range of motion reassessed post-treatment (Fig:-1).

Figure 1: Mulligan Technique(supine position with mobilizing belt for lateral distraction and shoulder internally rotated.)

Figure 2: Cross Body Stretch (Supine Position, Elbow Flexed, Arm in horizontal Adduction)

Figure 3: Genie Stretch (Supine Position, Elbow Extended, Arm in horizontal Adduction)

Figure 4: Sleeper Stretch (Side Lying Position, Elbow and Shoulder in 90-degree Flexion, Passive shoulder internal rotation)

GROUP B (MULLIGAN WITH MUSCLE ENERGY TECHNIQUE)

Before therapy, subjects were encouraged to perform stretches for internal rotation and were provided with hot packs for relaxation. For the Muscle Energy Technique, each subject was positioned supine with their elbow and shoulder in 90-degree abduction and flexion. Internal rotation was applied to the humerus until the first resistance was felt, followed by a 5-second isometric contraction against a counterforce in the direction of external rotation at approximately 25% of peak effort. This was followed by a 30-second active assisted stretch for the external rotators, with subjects being encouraged to relax and adjust to a new movement barrier. The Mulligan Technique was administered in the same manner as Group A, involving lateral distraction and internal rotation of the shoulder with the mobilizing belt (Fig;-5).

Figure 5: Muscle Energy Technique (Supine position, elbow and shoulder in 90-degree abduction and flexion, Shoulder passively internally rotated until resistance is felt.)

DATA ANALYSIS

The data were analyzed using statistical software SPSS 21 version. To analyze the difference between Hand behind Back test and Tyler test within the Groups through Paired t test on Baseline and second week and between baseline and fourth week. The groups showing extremely significant when compared within the groups by paired t test but the group A is more effective as compared to group B.

To analyze the difference of the Hand behind Back test and Tyler test between Group A and Group B independent t test was used. The groups showing insignificant at p values.

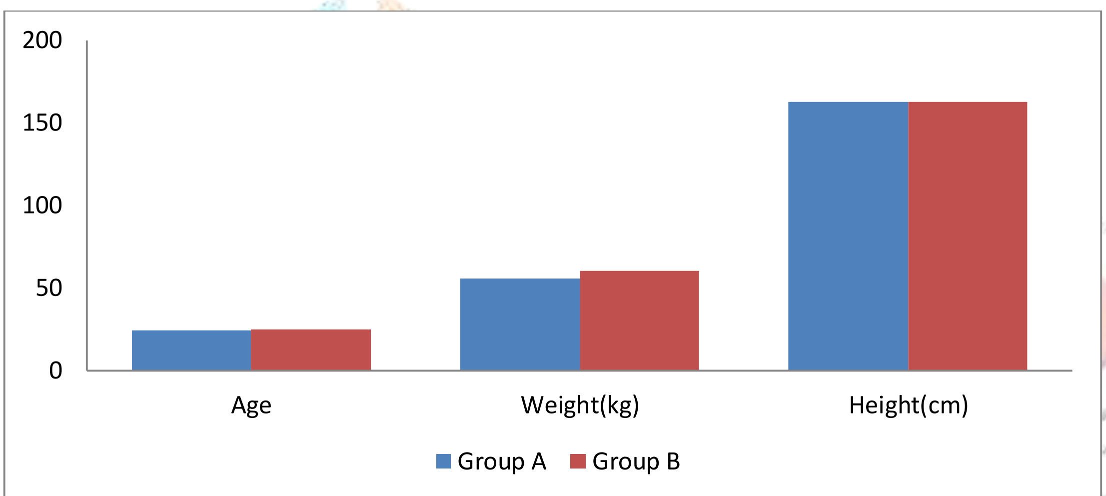
Level of significance was set at p=0.05

Demographic Baseline Characteristics

1. The table represents the demographic characteristics of subjects in both the groups. Mean age of group A and B was 24.27 and 24.93 respectively. Mean Weight of Group A and B was 56.11 and 60.32 respectively. Mean Height of Group A and B was 163.05 and 162.52 respectively. The results were non significant at $p < 0.05$.

Table 1- Independent Sample t-test for Baseline characteristic

Variables	Mean ± SD		t-value	p-value
	Group A	Group B		
Age	24.27±1.83	24.93±1.33	-1.140	0.264
Weight(kg)	56.11±7.79	60.32±9.80	-1.301	0.204
Height(cm)	163.05±9.96	162.52±9.27	0.150	0.882

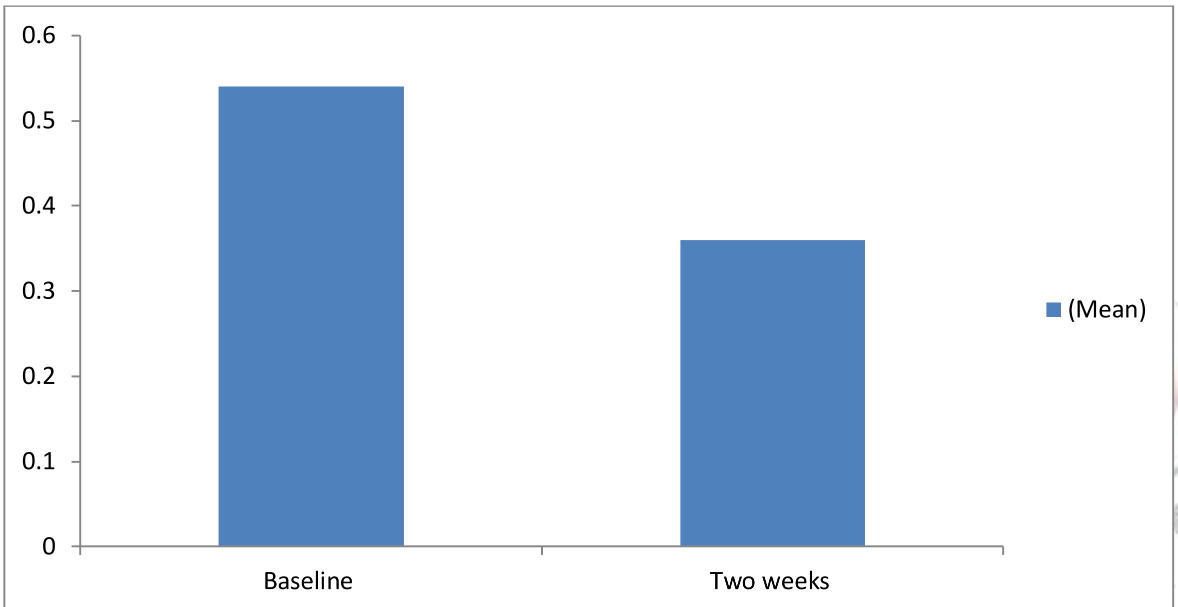


Graph 1

2. To analyze the difference in the Hand behind Back Test of baseline and two week measurement paired t-test was used. Table- 1 and Graph 1 shows the average score of Hand behind Back Test scores of baseline and two week for the group subjected to the experiment was initially recorded as 0.54, with a standard deviation (SD) of 0.05 of baseline while for the two week the average of 0.36 , accompanied by a standard deviation of 0.10. It was found that P value was less than 0.05 which implies statistical significant difference in Hand behind Back Test of baseline and two week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 2 - Paired t-test Results showing within group of Hand behind Back Test of Group A

Outcome Measures		**Hand behind Back Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	0.54±0.05	9.95	0.001	Significant
	Two weeks measurement	0.36±0.10			

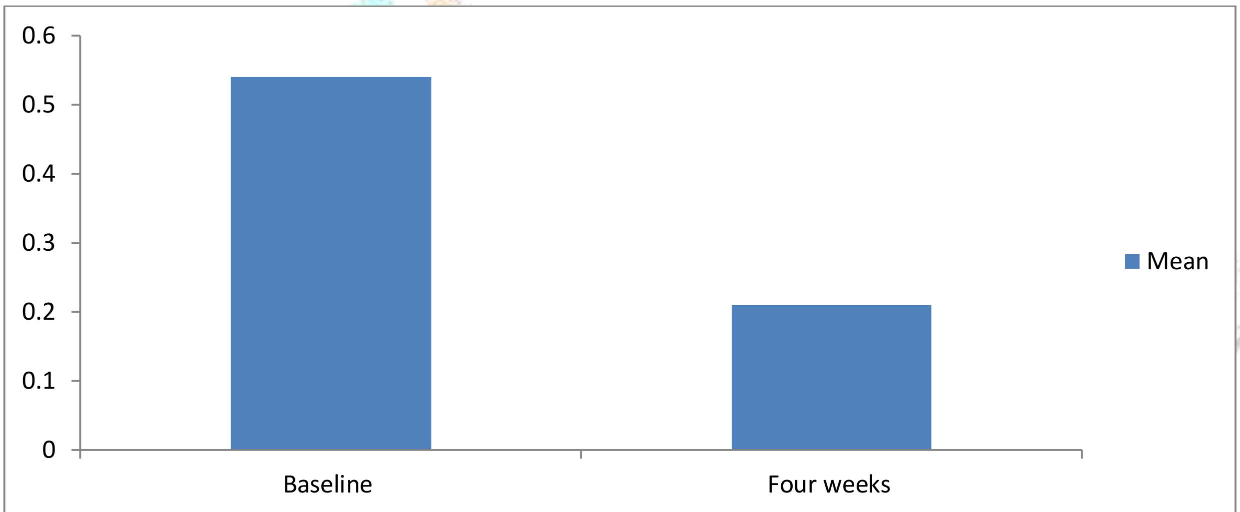


Graph 2

3. To analyze the difference in the Hand behind Back Test of baseline and Four week measurement paired t-test was used. Table- 2 and Graph 2 shows the average score of Hand behind Back Test scores of baseline and two week for the group subjected to the experiment was initially recorded as 0.54, with a standard deviation (SD) of 0.05 of baseline while for the four week the average of 0.21 , accompanied by a standard deviation of 0.14. It was found that P value was less than 0.05 which implies statistical insignificant difference in Hand behind Back Test of baseline and four week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 3 - Paired t-test Results showing within group of Hand behind Back Test of Group A

Outcome Measures		**Hand behind Back Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	0.54±0.05	10.92	0.001	Significant
	Four weeks measurement	0.21±0.14			

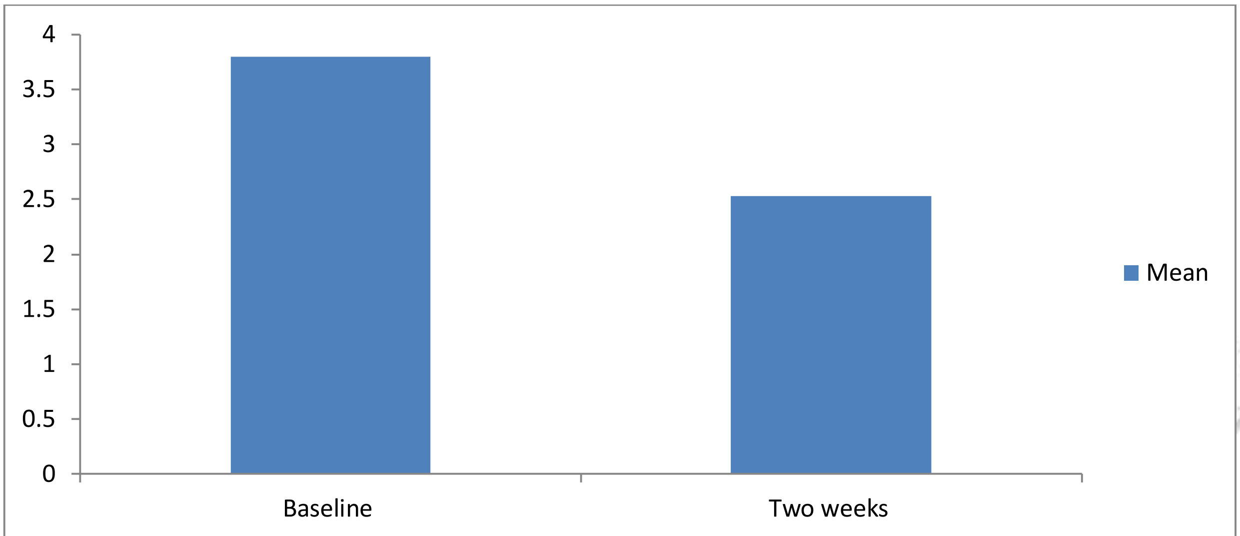


Graph 3

4. To analyze the difference in the Tyler Test of baseline and Two week measurement paired t-test was used. Table- 3 and Graph 3 shows the average score of Tyler Test scores of baseline and two week for the group subjected to the experiment was initially recorded as 3.80, with a standard deviation (SD) of 0.88 of baseline while for the two week the average of 2.53, accompanied by a standard deviation of 0.91. It was found that P value was less than 0.05 which implies statistical significant difference in Tyler Test of baseline and two week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 4 - Paired t-test Results showing within group of Tyler Test of Group A

Outcome Measures		Tyler Test			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	3.80±0.88	8.264	0.001	Significant
	Two weeks measurement	2.53±0.91			

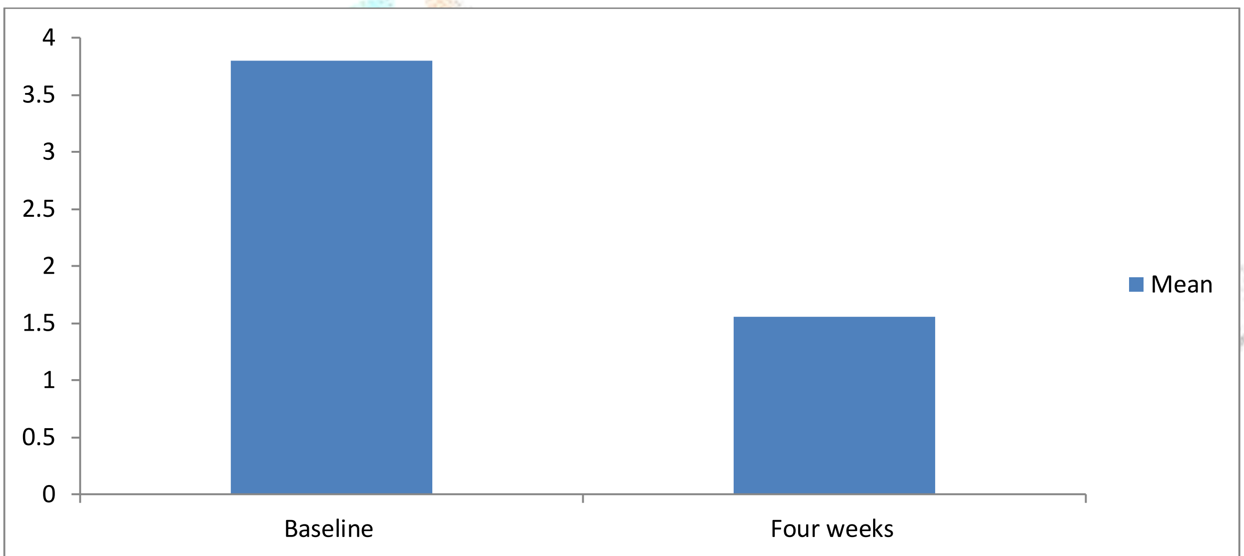


Graph 4

5. To analyze the difference in the Tyler Test of baseline and four week measurement paired t-test was used. Table- 4 and graph 4 shows the average score of Tyler Test scores of baseline and four week for the group subjected to the experiment was initially recorded as 3.80, with a standard deviation (SD) of 0.88 of baseline while for the four week the average of 1.56, accompanied by a standard deviation of 1.09. It was found that P value was less than 0.05 which implies statistical significant difference in Tyler Test of baseline and four week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 5 - Paired t-test Results showing within group of Tyler Test of Group A

Outcome Measures		**Tyler Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	3.80±0.88	9.369	0.001	Significant
	Four weeks measurement	1.56±1.09			

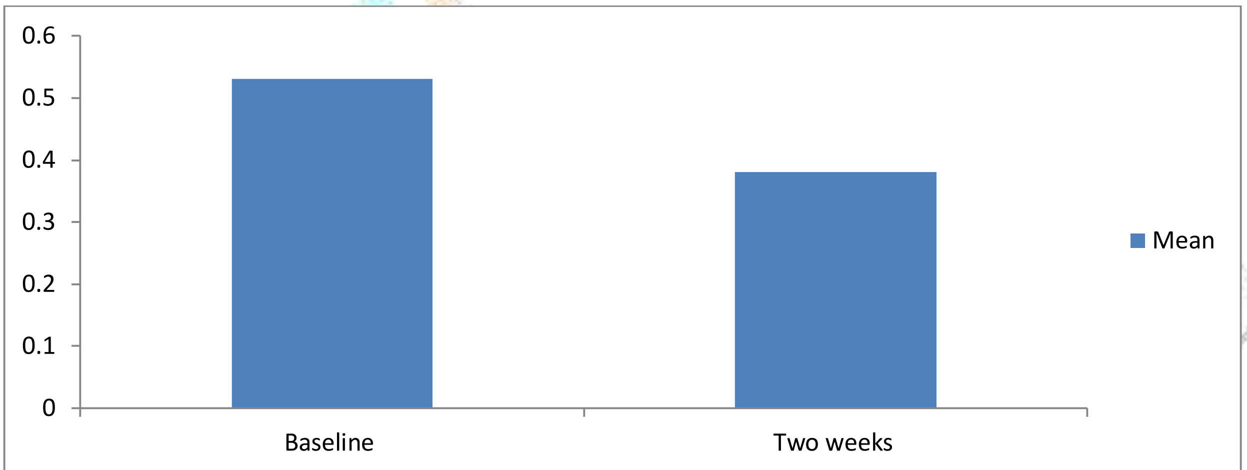


Graph 5

6. To analyze the difference in the Hand behind Back Test of baseline and two week measurement paired t-test was used. Table- 5 and Graph 5 shows the average score of Hand behind Back Test scores of baseline and two week for the group subjected to the experiment was initially recorded as 0.53, with a standard deviation (SD) of 0.07 of baseline while for the two week the average of 0.38 , accompanied by a standard deviation of 0.09. It was found that P value was less than 0.05 which implies statistical significant difference in Hand behind Back Test of baseline and two week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 6- Paired t-test Results showing within group of Hand behind Back Test of Group B

Outcome Measures		Hand behind Back Test			
		(Mean ±SD)	t- Value	P value	Result
	Baseline Measurement	0.53±0.07	4.70	0.001	Significant
	Two weeks measurement	0.38±0.09			

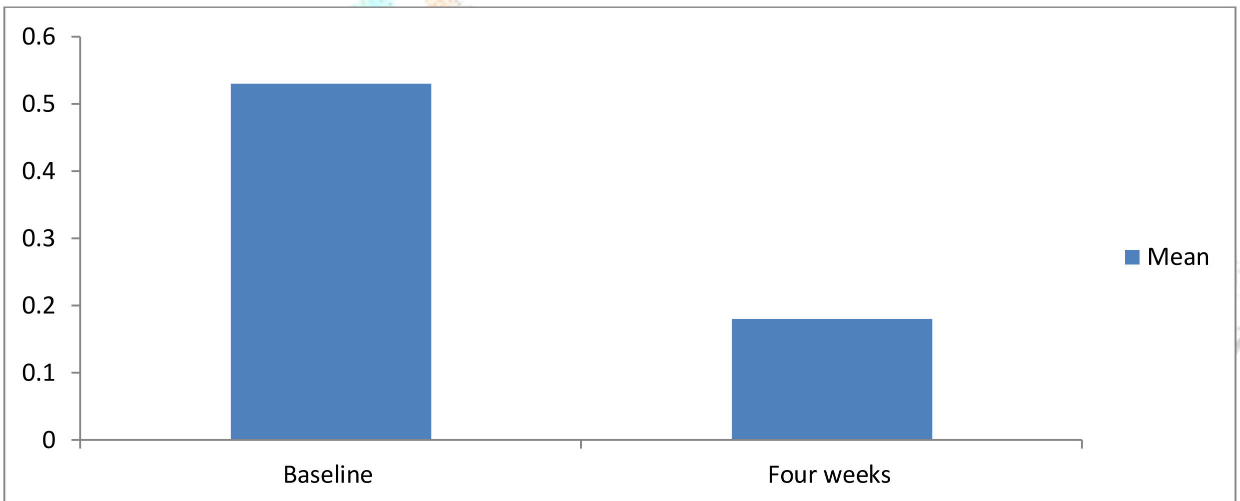


Graph 6

7. To analyze the difference in the Hand behind Back Test of baseline and four week measurement paired t-test was used. Table- 6 and graph 6 shows the average score of Hand behind Back Test scores of baseline and four week for the group subjected to the experiment was initially recorded as 0.53, with a standard deviation (SD) of 0.07 of baseline while for the four week the average of 0.18, accompanied by a standard deviation of 0.10. It was found that P value was less than 0.05 which implies statistical significant difference in Hand behind Back Test of baseline and four week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 7- Paired t-test Results showing within group of Hand behind Back Test of Group B

Outcome Measures		**Hand behind Back Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	0.53±0.07	9.62	0.001	Significant
	Four weeks measurement	0.18±0.10			

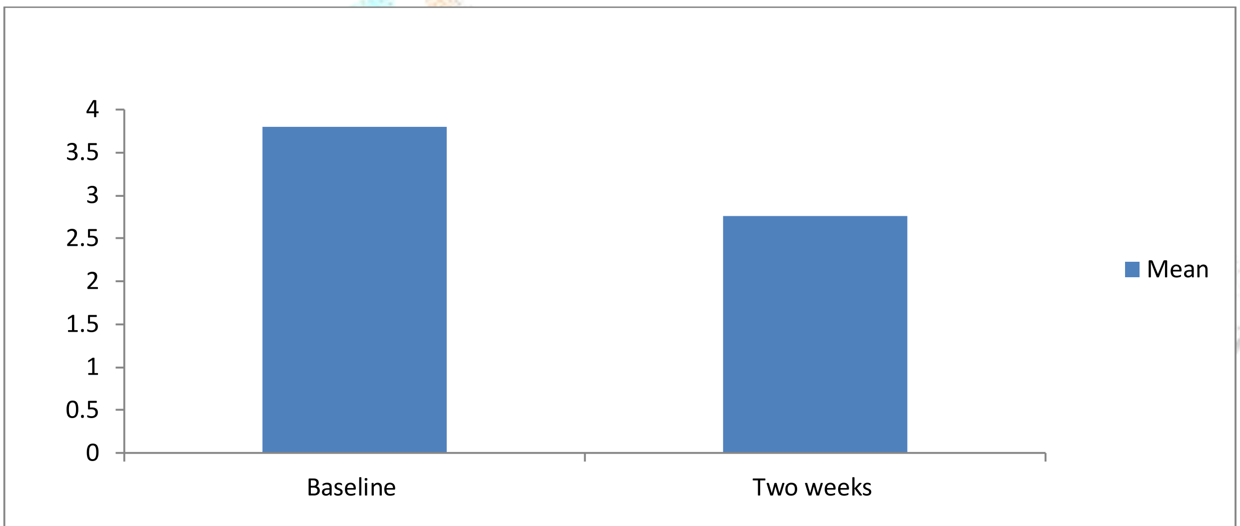


Graph 7

8. To analyze the difference in the Tyler Test of baseline and Two week measurement paired t-test was used. Table- 7 and graph 7 shows the average score of Tyler Test scores of baseline and two week for the group subjected to the experiment was initially recorded as 3.80, with a standard deviation (SD) of 0.90 of baseline while for the two week the average of 2.76 , accompanied by a standard deviation of 0.90. It was found that P value was less than 0.05 which implies statistical significant difference in Tyler Test of baseline and two week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 8 - Paired t-test Results showing within group of Tyler Test of Group B

Outcome Measures		Tyler Test			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	3.80±0.90	5.771	0.001	Significant
	Two weeks measurement	2.76±0.90			

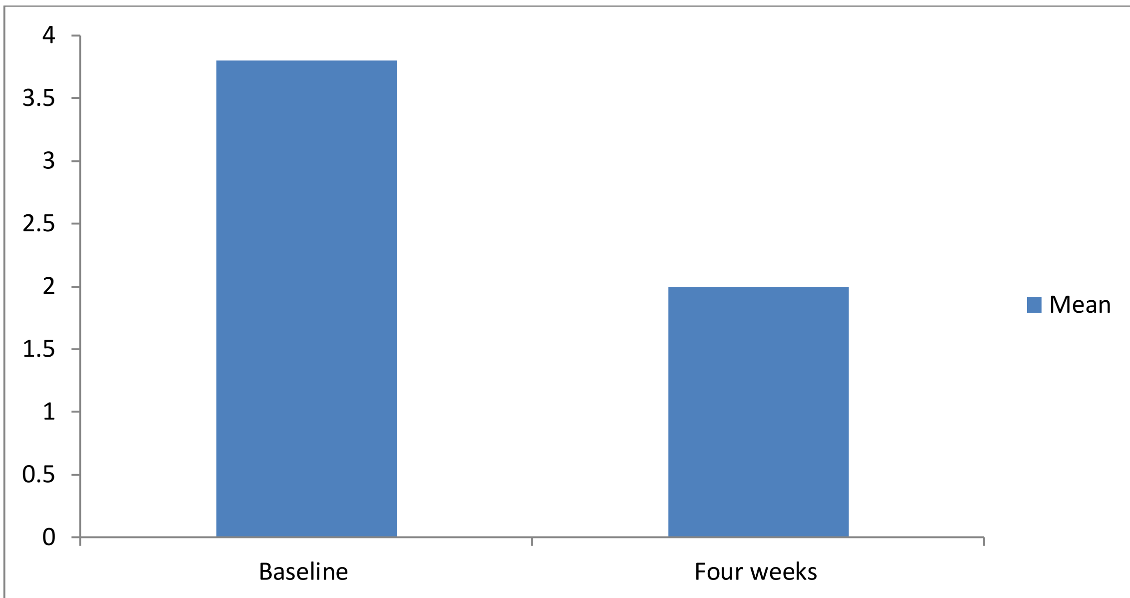


Graph 8

9. To analyze the difference in the Tyler Test of baseline and Four week measurement paired t-test was used. Table- 8 and graph 8 shows the average score of Tyler Test scores of baseline and Four week for the group subjected to the experiment was initially recorded as 3.80, with a standard deviation (SD) of 0.90 of baseline while for the Four week the average of 2.00, accompanied by a standard deviation of 1.18. It was found that P value was less than 0.05 which implies statistical significant difference in Tyler Test of baseline and four week i.e. rejecting the null hypothesis (H_0) and accepting alternative hypothesis (H_1)

Table 9 - Paired t-test Results showing within group of Tyler Test of Group B

Outcome Measures		**Tyler Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Baseline Measurement	3.80±0.90	6.165	0.001	Significant
	Four weeks measurement	2.00±1.18			



Graph 9

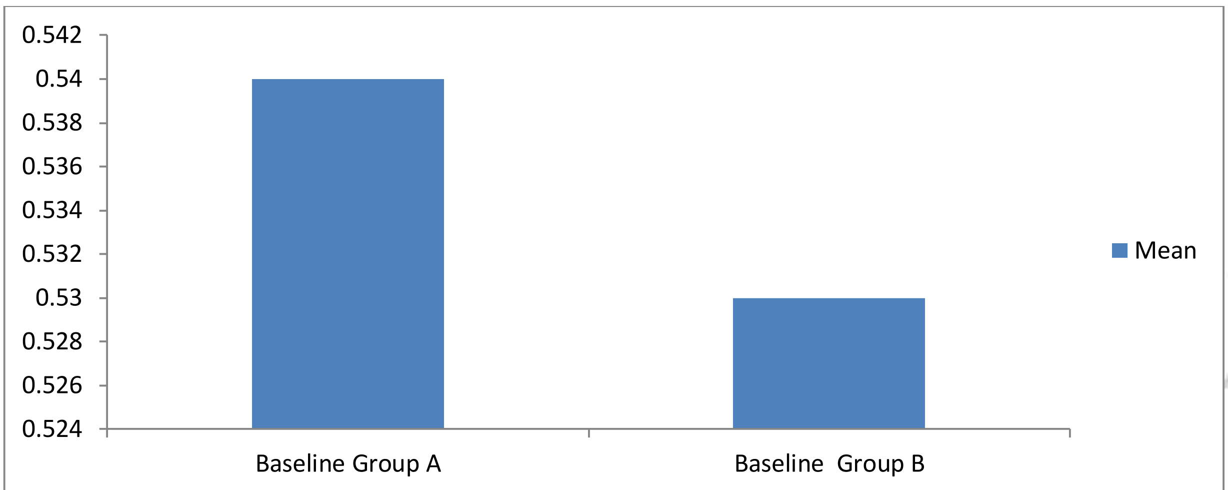
Between Group Analysis

To analyze the difference in the Hand behind Back Test and Tyler Test between two groups (A and B, Independent t test was used. The groups showing insignificant at p values.

10. To analyze the difference in the Hand behind Back Test of baseline measurement Independent t-test was used .In table 9 It was found that P value was greater than 0.05 which implies statistical insignificant difference in Hand behind Back Test of baseline between Groups A and B. I.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 10 – Independent t-test Results showing between group of Hand behind Back Test of Group A and Group B

Outcome Measures		Hand behind Back Test			
		(Mean ±SD)	t- Value	P value	Result
	Baseline Group A	0.54±0.05	0.717	0.480	Insignificant
	Baseline Group B	0.53±0.07			

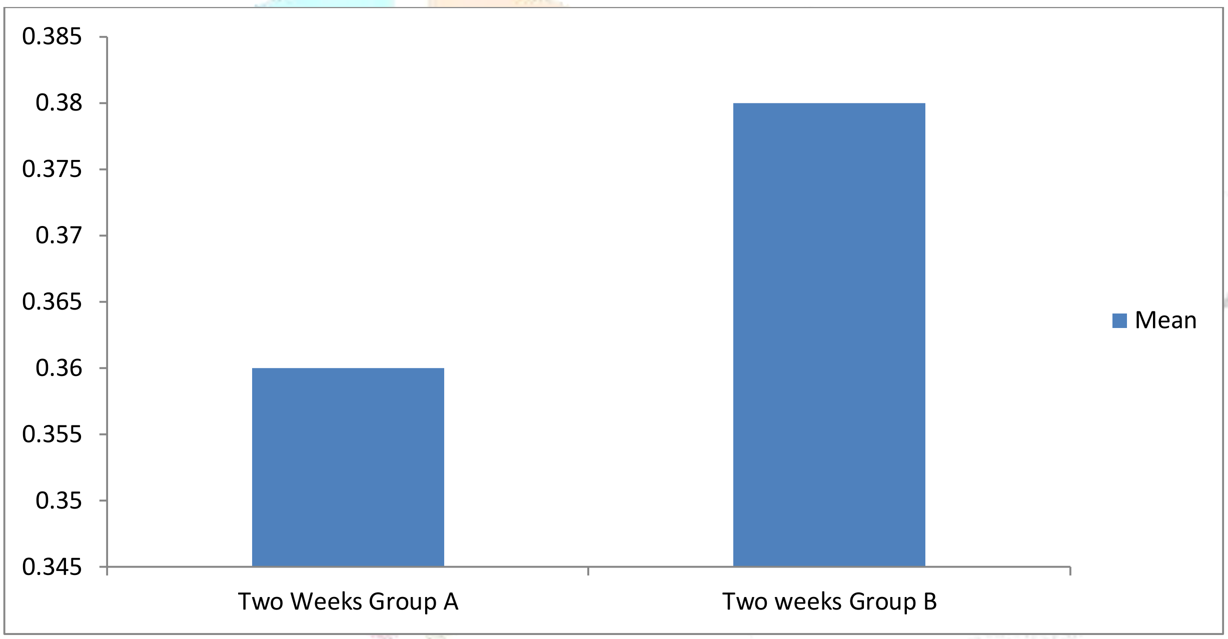


Graph 10

11. To analyze the difference in the Hand behind Back Test of two week measurement Independent t-test was used in table 10. It was found that P value was greater than 0.05 which implies statistical insignificant difference in Hand behind Back Test of two week between Groups A and B. i.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 11 - Independent t-test Results showing between group of Hand behind Back Test of Group A and Group B

Outcome Measures		**Hand behind Back Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Two Weeks Group A	0.36±0.10	0.503	0.619	Insignificant
	Two weeks Group B	0.38±0.09			

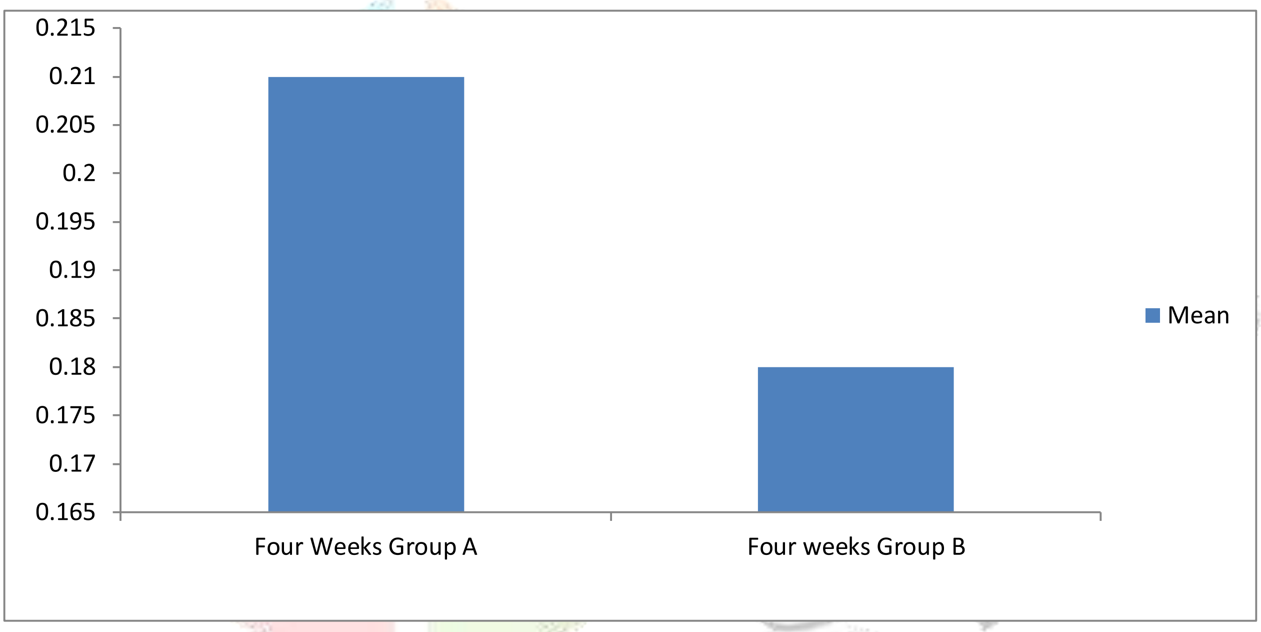


Graph 11

12. To analyze the difference in the Hand behind Back Test of Four week measurement Independent t-test was used in table 11. It was found that P value was greater than 0.05 which implies statistical insignificant difference in Hand behind Back Test of Four week between Groups A and B I.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 12 - Independent t-test Results showing between group of Hand behind Back Test of Group A and Group B

Outcome Measures		**Hand behind Back Test**			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Four Weeks Group A	0.21±0.14	0.661	0.514	Insignificant
	Four weeks Group B	0.18±0.10			

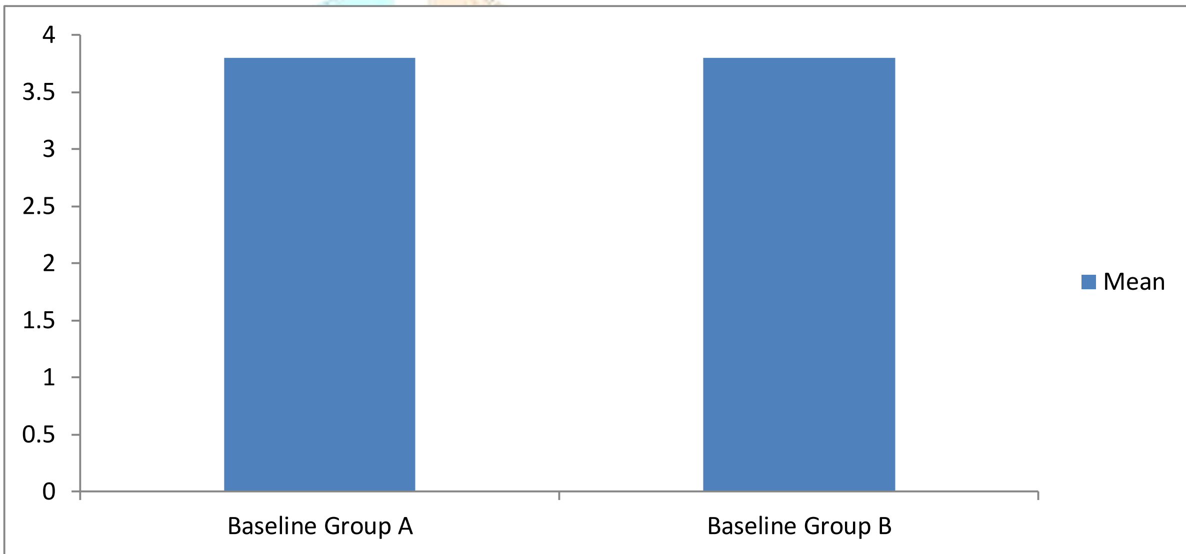


Graph 12

13. To analyze the difference in the Tyler Test of baseline measurement Independent t-test was used in table 12. It was found that P value was greater than 0.05 which implies statistical insignificant difference in Curl up baseline between Groups A and B. i.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 13 - Independent t-test Results showing between group of Tyler Test of Group A and Group B

Outcome Measures		Tyler Test			
		(Mean ±SD)	t- Value	P value	Result
	Baseline Group A	3.80±0.88	0.000	1.000	Insignificant
	Baseline Group B	3.80±0.90			

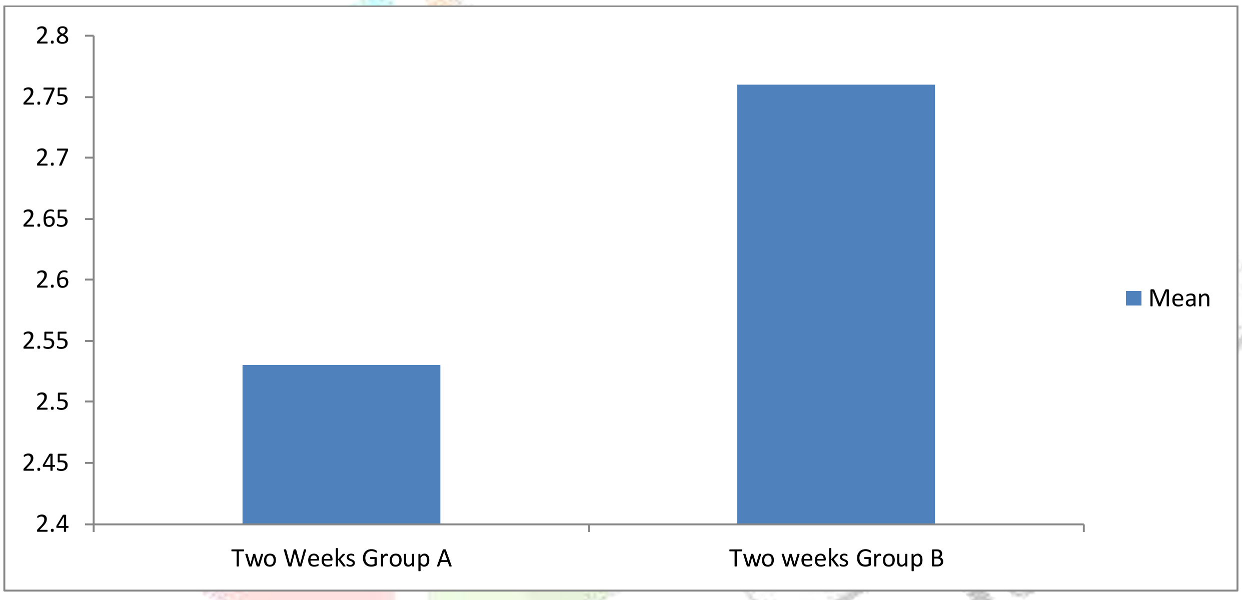


Graph 13

14. To analyze the difference in the Tyler Test of two week measurement Independent t-test was used in table 13 It was found that P value was greater than 0.05 which implies statistical insignificant difference in Tyler Test of two week between Groups A and B. i.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 14- Independent t-test Results showing between group of Tyler Test of Group A and Group B

Outcome Measures		Tyler Test			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Two Weeks Group A	2.53±0.91	0.703	0.488	Insignificant
	Two weeks Group B	2.76±0.90			

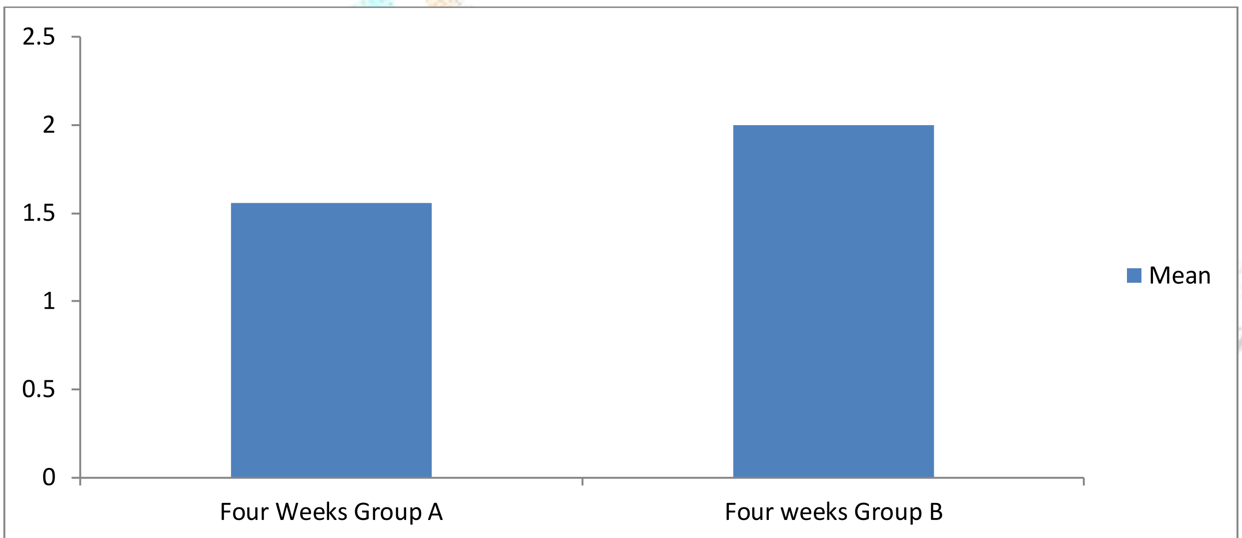


Graph 14

15. To analyze the difference in the Tyler Test of Four week measurement Independent t-test was used in table 14. It was found that P value was greater than 0.05 which implies statistical insignificant difference in Tyler Test of Four week between Groups A and B i.e. accepting the null hypothesis (H_0) and rejecting alternative hypothesis (H_1)

Table 15 - Independent t-test Results showing between group of Tyler Test of Group A and Group B

Outcome Measures		Tyler Test			
		(Mean ±SD)	**t- Value**	**P value**	**Result**
	Four Weeks Group A	1.56±1.09	-1.040	0.307	Insignificant
	Four weeks Group B	2.00±1.18			



Graph 15

DISCUSSION: The present study aimed to "Compare the effects of proprioceptive neuromuscular facilitation with mulligan versus muscle energy technique with mulligan to improve glenohumeral internal rotation deficit in collegiate athletes playing overhead sports"

GIRD is a common condition among collegiate athletes that can impair their performance and raise their risk of shoulder injury. Improving sports performance and averting long-term problems depend on addressing this shortfall. Although PNF and MET with Mulligan are two independent treatment techniques that target joint mobility and muscle flexibility, their processes and effects may differ. The results show that the shoulder's internal rotation range of motion can be effectively improved by both therapies. The relative effectiveness of these techniques, however, raises the possibility that athletes may profit from individualized rehabilitation plans depending on their unique requirements and therapeutic reactions. Collegiate athletes who participate in overhead sports may benefit from improved shoulder health overall, decreased chance of injury, and increased athletic performance when GIRD is managed using these therapeutic methods.

The study conducted by **Prateek Srivastav et al. (2018)** looked at participants who were between the ages of 17 and 30, with a mean age of 21.75 years, to find out how common Glenohumeral Internal Rotation Deficit (GIRD) was among collegiate athletes who played overhead sports. Due to their high levels of agility, resilience, and fitness, this age group—especially those between the ages of 18 and 25—makes them ideal subjects for studies on sports performance and injury prevention.

The results showed that 29.1% of the athletes had GIRD, and there was no discernible relationship between GIRD and scapular dyskinesia or the rotator cuff strength ratio. The study was enhanced by the participation of collegiate athletes in this age group, as their zeal and dedication probably made the procedure of gathering data easier. Training and support programs can be specifically designed for these athletes by taking into account their transitional experiences, such as moving from university to professional sports. Furthermore, this age group is more likely to use cutting-edge training techniques and technology, giving researchers the chance to evaluate how well such strategies improve performance and recuperation.

Participants in the study showed a deep comprehension of appropriate body mechanics, which are essential for preventing injuries and achieving peak performance. Their spirit of competition created a lively atmosphere that improved focus and involvement. Studying these athletes' physiological, psychological, and technical characteristics can provide important insights on tactics for reaching peak performance, as these athletes frequently represent the pinnacle of physical ability. This approach helps with both injury prevention and understanding the variables influencing their competitive drive.

I think this study's age range of 17 to 30 years old is especially enlightening. This range encompasses an important stage in the development of athletes, particularly those between the ages of 18 and 25, when they typically attain their optimum physical state and undergo major professional shifts. Through research, this group can be better understood in terms of training modifications, injury risks, and special challenges. This age group is also a good candidate to test novel approaches to injury prevention and performance enhancement because they are generally more open to new training methods. In general, studying collegiate players in this age range can yield insightful information that will help them improve both now and in the future.

The study by **Masahiro Mitsukane et al**. focused on healthy people between the ages of 20 and 59 and investigated the validity of a modified hand-behind-back (HBB) method for detecting shoulder internal rotation. Due to their frequent participation in a variety of physical activities that may impair shoulder mobility, this age group was chosen for its significance in studying adult shoulder function.

The results showed that the modified HBB technique had intraclass correlation coefficients ranging from 0.73 to 0.89, indicating good to moderate dependability. This implies that the technique is a useful tool for physicians to evaluate the internal rotation of the shoulder in patients with varying body types, including adults and possibly toddlers. The study emphasizes how critical it is to normalize measurements to take into consideration variations in body size, as these might have a big influence on how shoulder mobility is evaluated.

Additionally, this meticulous approach makes it possible to comprehend shoulder function better and makes it easier to create rehabilitation and training regimens that are specifically targeted at the shoulder. The research provides important insights for maximizing performance and reducing injuries in both recreational and professional athletes by concentrating on the subtleties of shoulder mechanics in this age range. In general, the results highlight the necessity of trustworthy evaluation instruments in medical environments, especially for those participating in activities requiring elevated shoulder range of motion.

Assessing shoulder internal rotation practically can be done with the hand-behind-back (HBB) test. The test subject touches the shoulder blade on the other side by reaching behind their back. This motion, which mainly uses internal rotation, sheds light on the shoulder joint's flexibility and functionality. HBB test has the advantage of being easy to use and not requiring any specialized equipment, which makes it suitable for use in training and clinical environments. Clinicians can determine any restrictions or imbalances in shoulder mobility by measuring an individual's reach, which is essential for spotting possible problems that could result in injuries. All things considered, it's a useful technique for assessing shoulder health, particularly for athletes whose sports depend on their shoulders functioning at their best.

Timothy F. Tyler et al. (1999) looked at the validity and reliability of a novel technique for measuring posterior shoulder tension in nonimpaired individuals and collegiate baseball pitchers. The age range of the participants was 11–59 years old, with a mean age of 30 years. This wide age range facilitates a thorough grasp of shoulder mechanics in various life phases, especially for athletes whose repetitive overhead movements frequently result in shoulder discomfort. The results showed good intertester reliability (K = 0.80) and high intratester reliability (K = 0.92 for the dominant arm), demonstrating the consistency and dependability of the new measurement method. Furthermore, compared to nonimpaired patients, pitchers showed noticeably more posterior shoulder tension, underscoring the influence of their sport on shoulder mechanics. This link highlights the importance of providing athletes who play overhead sports with focused evaluations and interventions. It is essential to comprehend shoulder tightness in this setting in order to create training and rehabilitation regimens that work. The study's findings imply that the novel approach can help medical professionals recognize and treat possible restrictions on shoulder mobility, thereby fostering injury avoidance and peak performance.In conclusion, the study's age distribution adds richness to the results, providing perspectives on how different developmental phases of athletes may be impacted by shoulder tightness. Clinicians can more effectively customize their techniques to improve recovery and performance—especially in sports where shoulder function is crucial—by concentrating on a strong and trustworthy measuring tool. This study opens the door for more investigation into the shoulder mechanics of athletes, which will enhance training regimens and approaches to injury prevention.

This test offers an accurate and dependable way to detect posterior shoulder structural stiffness, which can greatly affect shoulder function and range of motion, especially in athletes who engage in repetitive overhead sports. Clinicians can better understand an athlete's shoulder mechanics and adjust training or rehabilitation regimens by assessing posterior capsular tightness. This may result in enhanced performance and a lower chance of injury. All things considered, the Tyler test is a useful tool for medical professionals who work with athletes, as it may assist address the consequences of shoulder stiffness and maximize healing techniques.

The goal of **Kimaya Vinod Kini et al**.'s study was to determine how well district-level cricket bowlers' Glenohumeral Internal Rotation Deficit (GIRD) could be improved by using Muscle Energy Technique (MET) as opposed to Mulligan mobilization. All of the participants were male bowlers under the age of 19, and they were chosen based on the fact that they regularly trained in cricket and had GIRD, which is a condition that many sportsmen who perform overhead have.

Over a four-week period, the data showed that both approaches significantly improved GIRD. The study indicated that both groups had an increase in mean range of motion, with p-values indicating strong significance ($p < 0.0001$). Due to the unique physical demands of their sport, district-level cricket bowlers' participation offered important insights into successful treatment strategies for GIRD.

This study emphasizes the value of customized rehabilitation plans that take into account the special requirements of young athletes making the move to more competitive levels of play. Researchers can better understand the unique training adaptations and injury risks associated with cricket bowlers by focusing on this demographic. The results imply that using Mulligan or MET approaches can be advantageous, giving practitioners the freedom to select the approach that best suits the needs and preferences of their patients. For young athletes to maximize their recuperation and performance, this adaptability is essential. The study's result highlights the importance of efficient injury prevention and treatment plans for district-level cricket bowlers, since these players are at a crucial stage of their athletic careers. Investigating cutting-edge rehabilitation methods benefits athletes' long-term athletic growth in addition to helping with their immediate recovery. As a result, this study provides a solid basis for future research into the best practices for improving youth overhead athletes' performance and lowering their risk of injury. The Glenohumeral Internal Rotation Deficit (GIRD), a significant problem faced by young cricket bowlers, is clarified by this study by Kimaya Vinod Kini et al.

It's amazing to observe how, in just four weeks, Mulligan mobilization and Muscle Energy Technique (MET) may both significantly improve this condition. Knowing how to treat GIRD can have a big impact on bowlers' performance and injury prevention because they are at a critical point in their sporting careers. Notably, the study's emphasis on athletes competing at the district level is pertinent. Despite the fact that this group is frequently disregarded, they have unique physical needs that need for specialized rehabilitation techniques. The results emphasize how crucial it is to modify treatment strategies to meet the particular requirements of young athletes, particularly as they advance to more competitive levels of competition. It allows for more research into cutting-edge rehabilitation methods, which may eventually improve performance and lower the likelihood of injury for young athletes who perform overhead.

Dr. Vaishali Kale et al.'s study from 2024 examined the effects of Muscle Energy Techniques (MET) and Proprioceptive Neuromuscular Facilitation (PNF) on range of motion (ROM) and the Shoulder Pain and Disability Index (SPADI) in individuals with unilateral peri-arthritis shoulder. There were 40 participants in the study, most of them were in the 40–65 age range, which is a demographic frequently impacted by shoulder issues. This age group is especially important since they frequently go from an active working life to retirement, which may have an impact on their degree of physical activity and requirement for rehabilitation.

In terms of enhancing both ROM and SPADI scores, the results showed that PNF considerably outperformed MET; this suggests that PNF's dynamic, multidirectional movements are especially helpful for treating the complexity of shoulder deficits. Targeted intervention tactics that improve recovery and preserve function can result from an understanding of the needs of this population. Furthermore, individuals in this age range are frequently receptive to novel therapy modalities, which makes them excellent candidates for testing out novel ways in rehabilitation procedures. They also emphasize the significance of customized rehabilitation plans that take into account the particular physical and psychological requirements of older adults.

The study's emphasis on Proprioceptive Neuromuscular Facilitation (PNF) as a superior method for enhancing range of motion (ROM) over Muscle Energy Technique (MET) strikes me as especially insightful. It emphasizes how crucial it is to select the best course of treatment for those with peri-arthritis shoulder. The notable increases in range of motion (ROM) that have been noted with PNF imply that this method not only promotes increased flexibility but also more fully activates the neuromuscular system. Older folks may benefit the most from this as they may have more difficulty maintaining joint mobility.

By demonstrating that PNF can lead to quicker and more substantial gains in ROM compared to MET, the study provides valuable guidance for clinicians in developing targeted treatment plans. This finding could encourage physiotherapists to prioritize PNF in their practice, ultimately enhancing patient outcomes and improving overall quality of life for those dealing with shoulder pain. Overall, the study's findings support the notion that customized therapies, such as PNF, can have a major impact on rehabilitation, and I think this emphasis will enable clinicians to assist patients in recovering from shoulder problems more effectively.

When comparing the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) with Mulligan techniques versus Muscle Energy Technique (MET) with Mulligan, it can be concluded that PNF is superior at addressing the glenohumeral internal rotation deficit in collegiate athletes who play overhead sports. Athletes can improve their shoulder function overall, as well as their flexibility and motor control, by including PNF into their rehabilitation routines. By lowering the chance of injury and improving performance, this strategy enables athletes to train more efficiently and compete at greater levels. Stressing PNF can result in notable improvements in shoulder mobility, which will ultimately enhance athletic performance.

CLINICAL RELEVANCE

The aim of this experimental research was to compare the effects of proprioceptive neuromuscular facilitation (PNF) with Mulligan versus muscle energy technique (MET) with Mulligan on improving glenohumeral internal rotation deficits in collegiate athletes playing overhead sports. The results showed significant improvements, with PNF demonstrating more effective and faster results compared to MET. Both techniques can be integrated into the training programs of collegiate athletes to enhance shoulder mobility and performance. As these athletes often face challenges related to range of motion due to repetitive overhead activities, incorporating these techniques periodically can help them maintain optimal shoulder function, thereby improving overall athletic performance and reducing the risk of injury.

LIMITATIONS OF THE STUDY

1. The study is limited to a specific age group of collegiate athletes, which may not reflect the effects in other populations, such as younger or older athletes.
2. This study is limited to the use of PNF and MET techniques with Mulligan, potentially excluding other effective modalities that could influence glenohumeral internal rotation.

3. This study is limited by a small sample size, which may restrict the generalizability of the findings to a broader athletic population.
4. The duration of the intervention may have been insufficient to assess long-term effects on shoulder mobility and performance.
5. This study is limited by the absence of a control group, making it challenging to isolate the effects of the techniques from other external factors.

FUTURE SCOPE OF THE STUDY

1. The effects of proprioceptive neuromuscular facilitation (PNF) with Mulligan can be compared against other techniques, such as dynamic stretching or joint mobilizations, to identify the most effective interventions for glenohumeral internal rotation deficits.
2. The study can be conducted with a broader age range of collegiate athletes to determine the effectiveness of PNF and muscle energy techniques across different developmental stages.
3. Future research can involve a larger sample size to enhance the statistical power of the findings, allowing for more precise conclusions and insights into the techniques' effectiveness.
4. Longitudinal studies can be implemented to assess the long-term effects of these interventions on shoulder mobility and athletic performance, providing insights into sustainability and rehabilitation.

CONCLUSION: In this research, the conclusion draws that proprioceptive neuromuscular facilitation (PNF) with Mulligan and muscle energy technique (MET) with Mulligan are equally effective techniques to improve glenohumeral internal rotation deficits in collegiate athletes playing overhead sports. Although the results show no significant difference between PNF and MET, PNF has proven to be quite effective when compared to MET. Thus, we accept the null hypothesis (H0) and reject the alternative hypothesis (H1). In order to achieve faster results, the treatment strategy including PNF can be performed.

REFERECES

1. Prateek Srivastav[1] , Ganesh Balthillaya[2] , Siddharth Bagrecha[3];Prevalence of Glenohumeral Internal Rotation Deficit and its Association with Scapular Dyskinesia and Rotator Cuff Strength Ratio in Collegiate Athletes Playing Overhead Sports; Journal of Clinical and Diagnostic Research. 2018 Dec, Vol-12(12): YC01-YC04; DOI: 10.7860/JCDR/2018/37819.12377[JCDR]
2. Kimaya Vinod Kini1 , Deepali Rathod2 , Ajay Kumar3;Comparison of Muscle Energy Technique vs Mulligan to Improve Gird in District Level Cricket Bowlers; International Journal of Health Sciences and Research;DOI: https://doi.org/10.52403/ijhsr.20210513 [ResearchGate]

3. Rose MB, Noonan T. Glenohumeral internal rotation deficit in throwing athletes: current perspectives. Open Access J Sports Med. 2018;9:69–78; DOI: 10.2147/OAJSM.S138975[PubMed]
4. Hibberd EE, Shutt CE, Oyama S, et al. Physical contributors to glenohumeral internal rotation deficit in high school baseball players. J Sport Health Sci. 2015;4:299–306; DOI:10.1016/j.jshs.2014.04.008[ResearchGate]
5. Wilk KE, Macrina LC, Fleisig GS, et al. Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball pitchers. Am J Sports Med. 2011;39:329–35;DOI: 10.1177/0363546510384223[PubMed]
6. Kalo K, Vogt L, Sieland J, et al. Injury and training history are associated with glenohumeral internal rotation deficit in youth tennis athletes. BMC Musculoskelet Disord. 2020;21:553.; DOI: 10.1186/s12891-020-03571-0[PubMed]
7. Lubis AMT, Wisnubaroto RP, Ilyas EI, et al. Glenohumeral internal rotation deficit in non-pitcher overhead athletic athletes: case series analysis of ten athletes. Ann Med Surg. 2020;58:138–42; DOI: 10.1016/j.amsu.2020.08.050[PubMed]
8. Almeida GPL, Silveira PF, Rosseto NP, et al. Glenohumeral range of motion in handball players with and without throwing-related shoulder pain. J Shoulder Elbow Surg. 2013;22:602–7;DOI: 10.1016/j.jse.2012.08.027[PubMed]
9. Niraj Kumar, Navneet Badoni, Sharda Sharma, et al./Effectiveness of Muscle Energy Technique on Pain, Range of Motion,Proprioception, Muscle strength & QOL in Diabetic Frozen Shoulder Conditions/Physiotherapy and Occupational TherapyJournal. 2023;16(3): 139-152
10. Sreenivasu Kotagiri1*, Anup Kumar Songa2 , Mayuri Vijay Gad3 , Jaideep Lad; International Archives of Integrated Medicine, Vol. 5, Issue 5, May, 2018. [IAIM]
11. Moore SD, Laudner KG, McLoda TA, Shaffer MA. The immediate effects of muscle energy technique on posterior shoulder tightness: a randomized controlled trial. J Orthop Sports Phys Ther. 2011 Jun;41(6):400-7. doi: 10.2519/jospt.2011.3292. Epub 2011 Apr 6. PMID: 21471651.[PubMed]
12. Ellenbecker TS, Roetert EP, Bailie DS, Davies GJ, Brown SW. Glenohumeral joint total rotation range of motion in elite tennis players and baseball pitchers. Med Sci Sports Exerc. 2002;34:2052-2056. http://dx.doi. org/10.1249/01.MSS.0000039301.69917.0C[PubMed]
13. Bigliani LU, Codd TP, Connor PM, Levine WN, Littlefield MA, Hershon SJ. Shoulder motion and laxity in the professional baseball player. Am J Sports Med. 1997 Sep-Oct;25(5):609-13. doi: 10.1177/036354659702500504. PMID: 9302464.[PubMed]
14. Dillman CJ, Fleisig GS, Andrews JR. Biomechanics of pitching with emphasis upon shoulder kinematics. J Orthop Sports Phys Ther. 1993 Aug;18(2):402-8. doi: 10.2519/jospt.1993.18.2.402. PMID: 8364594.[PubMed]

15. Pappas AM, Zawacki RM, Sullivan TJ. Biomechanics of baseball pitching. A preliminary report. Am J Sports Med. 1985 Jul-Aug;13(4):216-22. doi: 10.1177/036354658501300402. PMID: 4025673.[PubMed
16. Wilk KE, Reinold MM, Dugas JR, Arrigo CA, Moser MW, Andrews JR. Current concepts in the recognition and treatment of superior labral (SLAP) lesions. J Orthop Sports Phys Ther. 2005 May;35(5):273-91. doi: 10.2519/jospt.2005.35.5.273. PMID: 15966539.[PubMed
17. Lintner D, Mayol M, Uzodinma O, Jones R, Labossiere D. Glenohumeral internal rotation deficits in professional pitchers enrolled in an internal rotation stretching program. Am J Sports Med. 2007 Apr;35(4):617-21. doi: 10.1177/0363546506296736. Epub 2007 Feb 9. PMID: 17293473.[PubMed]
18. Kumar, N., Sen, S., Badoni, N., Patra, A., & Garg, S. (2022). Effectiveness of movement with mobilization (MWM) on pain, proprioception and muscle strength in diabetic frozen shoulder conditions. International Journal of Health Sciences, 6(S1), 2630–2645, https://doi.org/10.53730/ijhs.v6nS1.5338