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COMPARISON OF EXERGAMING VERSUS MULLIGAN MOBILIZATION WITH MOVEMENT ON PAIN, RANGE OF MOTION AND FUNCTION IN SUBJECTS WITH ADHESIVE CAPSULITIS

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ABSTRACT

Background and objective: Adhesive capsulitis is a chronic condition characterized by shoulder stiffness, pain and restricted range of motion in all planes. It can be treated using joint mobilization and by conventional therapy which consists of several phases to manage pain and to enhance range of motion. However, Exergaming differs from traditional intervention and is not frequently used in clinical settings for orthopaedic problems. The aim is to evaluate the impact of exergaming versus mulligan mobilization on subjects with adhesive capsulitis in terms of pain, range of motion and function.

Methods: Quasi Experimental Study Design. This study includes 80 subjects with a mean age of 40-60 years have clinically diagnosed with Adhesive Capsulitis were randomly allocated into 2 groups. In Group A (n=40) subjects were treated with Exergaming, where as Group B (n=40) received Mulligan Mobilization With Movement. Participants were treated thrice a week for 6 weeks. The outcome measures of this intervention were measured in terms of VAS for pain, Universal Goniometer for Shoulder Range of Motion and SPADI for Function.

Results: The independent 't' test was used to compare the mean significant difference between pre and post test scores. Paired "t" test was used to assess the statistical significance difference between pre and post test score. Statistical Analysis of the data revealed that both groups showed significant improvement in parameters when compared within groups, where as in between groups there is no significant difference between Exergaming and Mulligan mobilization with movement on pain, range of motion and function in subjects with adhesive capsulitis.

Conclusion: In six weeks of intervention, both groups were shown statistically significant improvements in pain, range of motion and function in subjects with adhesive capsulitis. Therefore, it can be concluded that Mulligan Mobilization with Movement and Exergaming are equally effective in treating patients with adhesive capsulitis and can be chosen as a method of treatment for patients with adhesive capsulitis.

Keywords: Adhesive Capsulitis, Exergaming, Mulligan Mobilization with movement, Shoulder Pain and Disability Index, Universal Goniometer and Visual Analogue Scale.

INTRODUCTION

Adhesive capsulitis is a common musculoskeletal condition called frozen shoulder is caused by the fibrosis and rigidity of the glenohumeral joint capsule, which results in discomfort, stiffness, and limited shoulder joint motion.[1] According to recent research, the glenohumeral joint's capsule stiffness and inflammation significantly limit range of motion and contribute to persistent pain. In addition, structures outside the joint capsule are affected by this illness. These tissues may consist of the subacromial bursa, the musculotendinous unit, and the corocohumeral ligament in the rotator interval. [2]

In 1872, Adhesive capsulitis was initially identified by Duplay as humeroscapular periarthritis. Neviaser coined the term "adhesive capsulitis" in 1945, based on his observations of adhesions and inflammation in the synovium and capsula after open surgery.[3] Middle-aged people are prone to adhesive capsulitis, especially women and those with diabetes. It primarily affects people in the 40–60 age range, with a higher frequency in females.[4]

In the general population, the prevalance of adhesive capsulitis is 2%–5% common, while in those with diabetes, it is 10%–20% common.[5] Between 6% and 17% of people experience problems with the other shoulder, which typically manifests five years after the first one resolves. In the year 1969, Lunberg classified the disease into following two types. They are primary or idiopathic frozen shoulder and secondary frozen shoulder. Idiopathic frozen shoulder may develop as a result of immunological, biomechanical, inflammatory, or hormonal imbalance. The secondary frozen shoulder may result from a soft tissue or fracture in the shoulder, a recent shoulder surgery, or an injury to the shoulder that prevents the shoulder from being used because of pain. [6,7]

Clinically, it can be divided into three phases based on the duration and symptoms. They are the phases of freezing, freezing, and thawing. Usually lasting between 10 and 36 weeks is the freezing or uncomfortable phase. The patient's glenohumeral capsule volume is significantly decreased, and the patient initially complained of spontaneously developing shoulder pain and stiffness. During the frozen or transitional period, which can extend from four to twelve months, the patient's range of motion is limited. Loss of abduction, internal rotation, and external rotation is a defining feature of this phase. Gradual range of motion recovery is the hallmark of the thawing or resolution phase. An average of 5 to 26 months pass during the thawing phase.[8]

After conducting a review of the literature, Grubbs N et al. (1993) described frozen shoulder as "a soft tissue capsular lesion accompanied by painful and restricted active and passive motion of glenohumeral joint motion" in all planes or overall loss of glenohumeral motion. [9] Adhesive capsulitis is defined by Donatelli, A.R. et al. as an inflexible component causing stiffness in the glenohumeral joint. Active and passive motion in the capsular pattern are painful and limited, with internal and abduction being the most limited, unless it coexists with a non-contractile lesion.[10]

Physical rehabilitation is a first-line treatment for adhesive capsulitis. Many physical therapy interventions, including wand exercises, wall and ladder exercises, active and active assisted exercises, pendular exercises, strengthening exercises for the capsular stabilizers, rotator cuff muscles, scapular alignment exercises, and shoulder joint mobilization, are commonly used in the treatment of frozen shoulder.[11]

The authors concluded that muscle relaxation achieved by superficial heating, thus indirectly causes reduction of resistance in muscles, which stretches within and around the muscle leads to increasing the shoulder range of motion.[12] In order to reduce pain and encourage a hyperthermic effect on the tissue, electrotherapy methods such short-wave diathermy, interferential therapy, transcutaneous electrical stimulation, and laser treatment are applied.[11]

The movement produced by manual therapy techniques can also reduce pain by the activation of mechanoreceptors which can inhibit nocieptive stimulus through the pain gate-control mechanism.[13] To restore the shoulder capsule's and the tight soft tissues' normal extensibility, passive stretching of the shoulder capsule and soft tissues through mobilization techniques has been advised; however, there is little evidence to support the application of these techniques. Maitland and Kaltenborn have proposed a variety of

mobilization categories, including end range mobilization (ERM) and mid-range mobilization (MRM), to increase joint mobility and lessen pain. [3]

Brain Mulligan's technique, called mobilization with movement for peripheral joints, combines restricted upper limb movement, either actively or passively by the patient, with sustained manual application of "gliding" force to a joint by the therapist in order to restore the reduced accessory glide. The end result should be a pain-free movement.[14]

Physiological movement that the patient is actively engaged in is superimposed with accessory movement in an attempt to overcome the barrier and restore proper alignment. With simultaneous joint motion (osteo-kinematics), this technique aids in the correction or realignment of bone positional errors. [15]A pain-free, passive, end-range corrective joint glide is achieved through movement in conjunction with mobilization. By creating synchronized hypoalgesic effects during and after its administration and by modifying sympathetic nervous system function, it can be used passively or actively to repair positional faults.[16]

A growing trend in physical rehabilitation is exergaming, or exercising in an interactive computer-generated environment. Benefits have been reported in the variety of therapeutic populations.[17] The terms "exercise" and "gaming" are combined to form the term "exergaming." Video games that also count as exercise are known as exergames.

Although it's new, exergaming has gained popularity in the previous few years. Exergames first appeared in the 1980s with the release of Atari 2006's foot pad controller, and they gained popularity in the 1990s with Konami's Dance Revolution product.[18] As an enjoyable, captivating, and interactive kind of physical activity that can assist in overcoming some of the conventional exercise obstacles, like a lack of desire and an unfavourable opinion of the results of exercise. [19,20]

An outline of the input devices utilized in the early days of exercise gaming is provided by Stach (2009). Accelerometers, gyroscopes, touch-sensing mats and pads, stationary bikes with controllers and balancing boards—all of these are examples of input devices. Other input devices like Kinect and PlayStation Move are used by more recent systems including the Sony PlayStation, Microsoft Xbox, and Nintendo Wii. Windows users can also use the Kinect. [21]

According to Sandlund et al. (2009)[22], the Kinect system is a wonderful approach to incorporate physical activity since it tracks free body motions in real space and uses those movements as inputs to build a combined physical/media space that is produced during play. This could provide gamers with a more physically demanding and engaging gaming experience. It can also strongly evoke a strong psychological sense of presence within the combined location. Additionally, this can help players perform better and keep their motivation and interest in the game high.

NEED FOR THE STUDY

In adhesive capsulitis, adhesions occur and the glenohumeral joint's shoulder capsule becomes inflamed and rigid. Mobilization strategies are crucial managerial actions. A novel approach to treating pain in the muscles, joints, or tendons is the mulligan concept, which focuses on readjusting abnormal movements. Numerous researchers have examined the mulligan MWM approach and have come to the conclusion that it is a more successful treatment for adhesive capsulitis.

Exergames are becoming one of the most popular and rapidly evolving types of physical activity, regardless of age. The promotion of physical activity and rehabilitation have been the main topics of exergaming research. The capacity of video games to boost motivation and cause destruction due to disinterest and tedious training and/or excruciating therapies is one of the key justifications for their use. Xbox Kinect 360 exergames can provide a powerful psychological sense of presence in the combined space while also providing subjects with a more physically demanding and engaging gaming environment.

Although, exergaming and mulligan mobilization with movements are effective in treating adhesive capsulitis, it would be interesting to determine the technique which was more effective in treating adhesive capsulitis. As there are limited studies in the literature comparing the benefits of movement, exergaming, and mulligan mobilization in subjects with adhesive capsulitis, the current study compared and determined the benefits of movement, exergaming, and mulligan mobilization on improvement of pain, range of motion, and functional disability in subjects with frozen shoulder.

Thus, the aim of the study was to assess the effectiveness of Exergaming and Mulligan Mobilization With Movement on pain, range of motion and function in subjects with adhesive capsulitis and to compare them.

MATERIALS AND METHODS

Study design: Quasi experimental Study design

Ethical Clearance and Informed Consent: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital. The purpose of the study was explained by the investigator and the information sheet was given to the subject. The participants were requested to provide their consent to participate in the study. All the participants signed the informed consent and the rights of included participants have been secured.

Study Population: Subjects who clinically diagnosed as Adhesive Capsulitis by an ORTHOPAEDICIAN.

Study Setting: The study was conducted at Outpatient Department of Physiotherapy, GSL General Hospital, Rajahmundry, Andhra Pradesh, India.

Study Duration: The study was conducted during the period of one year.

Intervention Duration: 6 weeks, 3 sessions per week, 45 minutes for each session.

Sampling Method: Convenience sampling method

Sample Size: A total of 85 subjects with adhesive capsulitis were screened for eligibility. In that 80 subjects, both men and women who were willing to participate in the study were included in this study. Recruited participants were explained about the purpose of the study and relevance of the study. The eligible participants were randomized into two groups after obtaining the informed consent.

Group A – Exergaming along with conventional physiotherapy (40 subjects)

Group B – Mulligan MWM along with conventional physiotherapy (40 subjects)

MATERIALS USED

- Data collection form
- Treatment Couch
- Visual analogue scale
- Universal Goniometer
- SPADI Questionnaire
- Mulligan belt
- Kinect X Box 360

CRITERIA FOR SAMPLE SELECTION

INCLUSION CRITERIA

- Subjects with Stage 2 adhesive capsulitis who are clinically diagnosed and referred by orthopaedician.
- 40 to 60 years of age group.
- Subjects are male and female.
- Subjects with Unilateral limb involvement.

EXCLUSION CRITERIA

- History of surgery/post traumatic stiffness.
- Recent steroid injections.
- Previous manipulation under anesthesia.
- Rotator cuff injuries, tendinitis, calcification of the tendon, rheumatoid arthritis, Osteoporosis and malignancies.
- Shoulder function issues related to neurological disorder.
- Conditions affecting the elbow, wrist or cervical spine.
- Pregnancy.
- Open wounds/Skin infections.
- Severe hypertension, cardiac failure.

STUDY TOOLS AND OUTCOME MEASURES

Mulligan mobilization belt:[23] The original mulligan mobilization belt for patient stabilization designed by Brain Mulligan. It is an 8-foot, high-quality black nylon belt used to mobilize patient during manual therapy techniques. It can be adjusted with one hand and has aside release plastic buckle.

Fig 1: Mulligan belt

Kinect Xbox 360:[18] The Kinect Xbox 360 is made up of a self-adjusting camera that functions as a sensor to identify motions of the entire body in addition to the video game console. Microsoft's motion-sensing Kinect is an input device designed for the Xbox 360 game platform. It is the first officially released game system that allows for completely unrestricted movement. It enables human motion to be used by the user to interact with the system. The Kinect is a useful tool for fast workouts because it requires no clothing on the user. Without the use of a hand controller or a balancing board, the Kinect player may move their entire body. Late in 2010, the Kinect is made available. Owing to the Xbox 360's widespread appeal.

Fig 2: Kinect X box 360

Visual Analogue Scale (VAS):[24] The VAS Scale is a valid, reliable, responsive, and dependable pain outcome measure. It is employed to gauge the intensity of pain. A 10-cm-long set of horizontal lines with anchor points marked 0 (no pain) and 10 (severe pain) make up the tool. Participants are asked to indicate their level of pain on the line by drawing a vertical mark. The VAS was used to assess the degree of adhesive capsulitis.

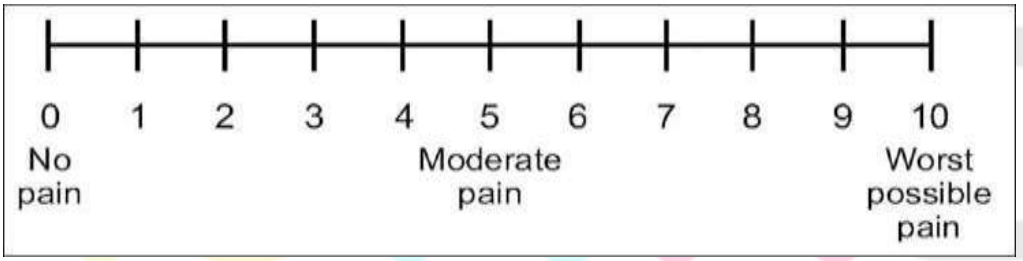


Fig 3: Visual Analogue Scale

Universal Goniometer:[25] The Universal Goniometer (UG) is a dependable, valid, and widely used tool for measuring the range of motion. It is employed to calculate the range of motion. An adaptable tool for measuring participants' ROM in peripheral joints is the full circle goniometer. The UG is a 360-degree Protractor Goniometer that allows the degree of motion to be measured in a single plane by aligning it within a joint's axis. It consists of 3 parts:

1.Axis

2. Stable Arm.

3.Movable Arm

Fig 4: Universal Goniometer

Procedure for measuring Shoulder Abduction:

Subject should be positioned in supine lying on examination couch. Axis should be placed over greater tuberosity of humerus. The movable arm is placed over midline of the lateral aspect of arm and the stable arm should be aligned straight to the movable arm. Then the subject was asked to elevate the arm during which movable arm move along with the subjects arm.

Procedure for measuring Shoulder Internal and External Rotation:

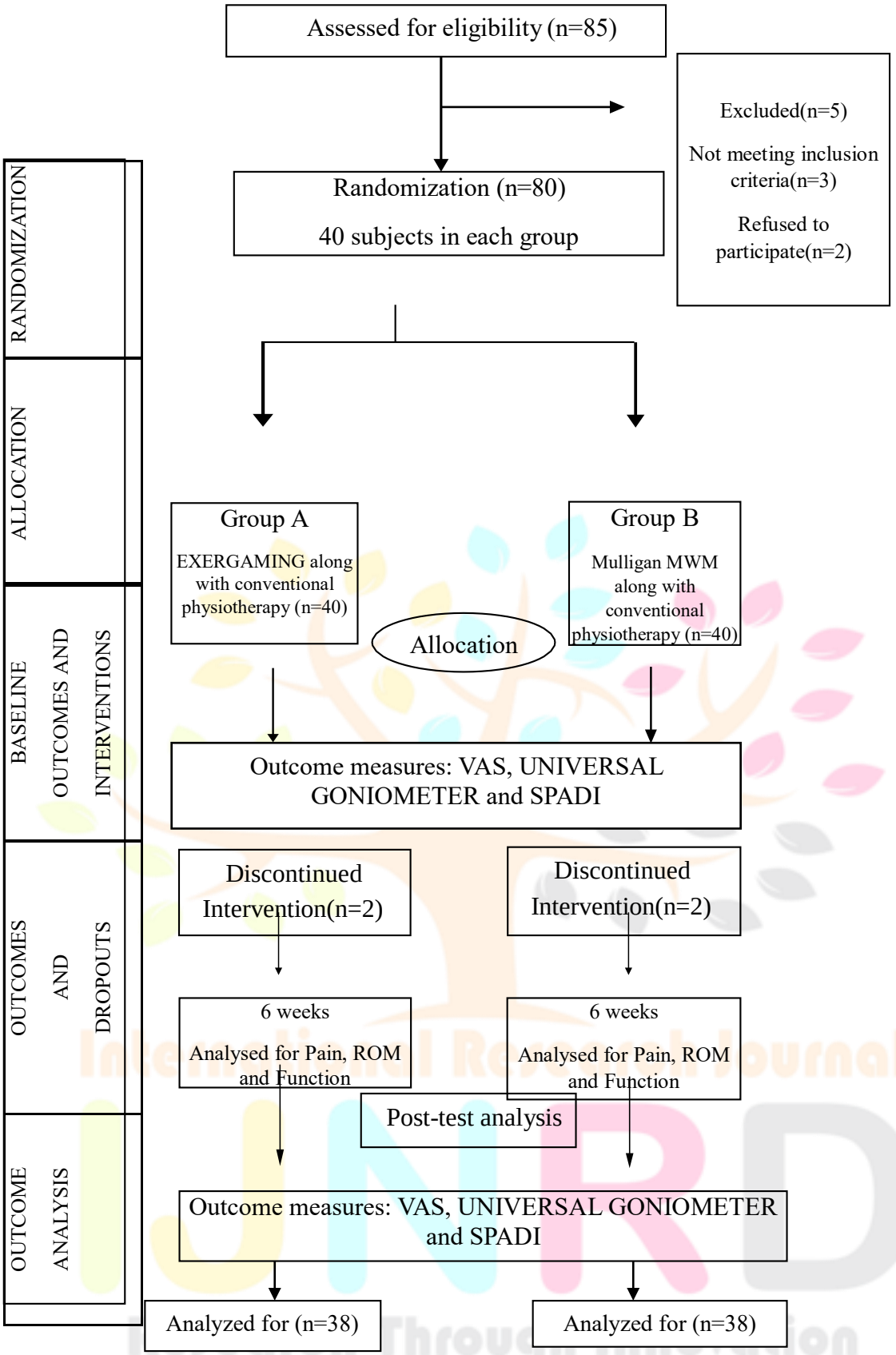
Subject should be positioned in supine lying with shoulder and elbow in 90 degrees. Axis should be fixed over olecranon process of ulna. The movable arm is placed over the midline of the medial aspect of forearm and the s table arm is placed straight line to the movable arm. Then the therapist encourage the internal and external Rotation.

Shoulder Pain and Disability Index (SPADI):[26] It is a self-report questionnaire designed to evaluate how disabled and in pain the individual felt during routine activities linked to shoulder issues. 13 items divided into two Subscales—one for Pain and the other for Functional activities—make up the Shoulder Pain and Disability Index (SPADI), a self-administered, shoulder-specific Fixed Objective Index. A person's level of pain is measured using five questions that make up the Pain dimension. The degree of difficulty an individual is having when completing upper extremity tasks is predicted by utilizing an eight-question assessment tool for functional activities. For the shoulder, the only valid and dependable region-specific measurement is the SPADI, which takes 5 to 10 minutes for the subject to respond.

Instructions for scoring

Each question should be answered by the individuals using a 10-cm visual analog scale. "No pain at all" and "worst pain imaginable" are the verbal anchors for the Pain dimensions, while "No difficulty" and "so difficult it requires help" are the verbal anchors for the Functional Activities. The overall score is calculated by averaging the scores from the dimensions.

FLOW CHART


Assessed for eligibility (n=85)
Excluded(n=5)
Not meeting inclusion criteria(n=3)
Refused to participate(n=2)
Randomization (n=80)
40 subjects in each group
RANDOMIZATION
ALLOCATION
BASELINE OUTCOMES AND INTERVENTIONS
OUTCOMES AND DROPOUTS
OUTCOME ANALYSIS
Group A
EXERGAMING along with conventional physiotherapy (n=40)
Group B
Mulligan MWM along with conventional physiotherapy (n=40)
Allocation
Outcome measures: VAS, UNIVERSAL GONIOMETER and SPADI
Discontinued Intervention(n=2)
Discontinued Intervention(n=2)
6 weeks
Analysed for Pain, ROM and Function
6 weeks
Analysed for Pain, ROM and Function
Post-test analysis
Outcome measures: VAS, UNIVERSAL GONIOMETER and SPADI
Analyzed for (n=38)
Analyzed for (n=38)

INTERVENTIONS

The Study consists of 6 weeks of intervention which includes Exergaming (Group A) and Mulligan mobilization with movement (Group B). Before the Commencement of the treatment, the study was explained individually to the subjects to minimize the learning effect during the course of the study. The Baseline measurements were taken before the treatment by using Visual Analogue Scale(VAS), Universal Goniometer(UG), Shoulder Pain and Disability Index (SPADI). After 6 weeks post treatment measures analyzed.

GROUP A:

EXERGAMING [27] along with Conventional Physiotherapy

The exergaming group undergoes exergame with an Xbox 360 Kinect (Microsoft Xbox 360). Without requiring a controller, the Kinect for Xbox 360 is a webcam-like video capture device that connects to the Xbox 360 game system and follows the user's movements to display the user's picture onto the television screen.

Standing in opposition to the Kinect sensor is the Xbox Kinect topic. The individual is free to move their entire body. To connect to video games using the Microsoft Xbox Kinect, no portable device is needed. Games from the Kinect Sports and Adventures will be played by the subjects.

Five distinct games from the Kinect Adventures series were played by the players during these X Box Kinect gaming sessions. Microsoft Kinect is a motion-sensing input device used in this game that records player motions. Players must move their arms in specific ways to complete game tasks since this game uses Microsoft Kinect, a motion-sensing input device that tracks user movements.

Activities include climbing, tennis, bowling, pin bowling, shooting with a gun, and ship steering. The therapy consisted of a variety of entertaining adventure games designed for the Xbox 360 Kinect technology. The games were shown on a projection screen. The virtual reality technology also enables therapists to keep an eye on their patients' progress in the game and track their point totals. On the first trial day, all games were played at a basic level and participants were required to play one round of each game as an introduction.

It was instructed to the players to score as many points as they could. Verbal instructions and an explanation of the game were given before the first trial round began, and scores were recorded as a baseline. During this training, upper extremity movements were covered, which are essential for success in any game. As they played activities, a therapist stood close by to keep the participant from losing his balance from shifting his body excessively.

Fig 5: Exergaming with Kinect X box 360

Dosage: Each exergame session consists of 10 min of cool down, 30 min of exergame and 10min of cool down. Thrice a week for 6 weeks.

GROUP B:

MULLIGAN MOBILIZATION WITH MOVEMENT [28] along with Conventional Physiotherapy

Procedure for Shoulder Abduction

The position of subject is sitting, belt is secured around the humerus' head, preserving the posterolateral and inferior glide. The therapist will stabilize the belt and maintain the glide with one hand. Using their other hand, the therapist applies counterpressure on the scapula. It is requested of the patient to move their shoulder slowly and actively to the limit of pain-free range (abduction). Once the body has returned to its initial position, the glide is released. It is maintained throughout the movement.

Fig 6: Mulligan MWM for shoulder abduction

Procedure for Shoulder Internal Rotation and External Rotation

The position of subject is supine lying, therapist stand lateral to the affected joint. The therapist places the belt around the patient's waist, places the patient's elbow and shoulder in a 90° flexion, and then pulls the belt laterally while gripping the distal end of the patient's humerus with both hands to stabilize the humerus and distract the joint. The patient will be taught to actively rotate both inside and outside, which is the irritating movement, and then, when the new range is reached, to passively overpress with the opposite hand.

Fig 7: Mulligan MWM for shoulder internal and external rotation

Dosage: 3 sets for 10 repetitions with 1 minute rest between sets. Thrice a week for 6 weeks.

CONVENTIONAL PHYSIOTHERAPY [29]

Conventional Physiotherapy includes the Ultrasound, Over Head Pulley, Pendular Exercises, Shoulder Wheel Exercise and Finger Ladder Exercise. Both the groups received Conventional Physiotherapy.

ULTRASOUND:[28]

For a duration of 5–10 minutes, 10–18 sessions of 3MHz ultrasound therapy with an intensity of 1.5 W/CM2 were administered.

Fig 8: Ultrasound

OVER HEAD PULLEY EXERCISE:[30]

Over Head Pulley constitutes a rope passing through the wheel and axle through whicha rope passes without friction. Subject was asked to hold the ends of rope one with each hand and pull the rope up and down, that helps for flexion, abduction movement of shoulder. Instruct the subject to perform the activity for 5-10 minutes every day.

Fig 9: Overhead pulley exercise

PENDULAR EXERCISES:[31]

Subjects was instructed to stand beside the edge of the table by slightly bending forward and get supported by placing normal hand on table. Then slowly move the hand forward to backward, side wise, in clockwise and anti-clock wise direction for 5 to 10 times.

Fig 10: Pendular exercises

FINGER LADDER EXERCISE:[29] Subject stands by facing the ladder hanging on the wall. The affected hand should be placed over the low level of ladder and slowly ascend till the Pain free range. After attaining certain range, descend the ladder.

Fig 11: Finger Ladder Exercise

SHOULDER WHEEL EXERCISE:[29] Subject stands by facing towards the wheel and holds the handle of wheel with the affected hand and makes an attempt to rotate the wheel in clockwise and Counter clockwise direction within Pain free range.

Fig 12: Shoulder Wheel Exercise

After 6 weeks of intervention, all the subjects were evaluated for their Pain, ROM and Function by VAS, Universal Goniometer and SPADI.

STATISTICAL ANALYSIS

All Statistical analysis was done by using SPSS software version 20.0 and Microsoft excel-2007. Descriptive data was presented in the form of mean +/_ standard deviation and mean difference percentages were calculated and presented.

Within the groups: Paired student "t" was performed to assess the statistical difference within the groups for Pain, Shoulder Range of Motion and Function from pre-test and post-test values.

Between the groups: Independent student "t" test was performed to assess the statistically significant difference in mean values between the groups for Visual Analogue Scale for Pain, Universal Goniometry for Shoulder Range of Motion and Shoulder Pain And Disability Index for Function.

For all statistical analysis, $p < 0.05$ was considered as statistically significant.

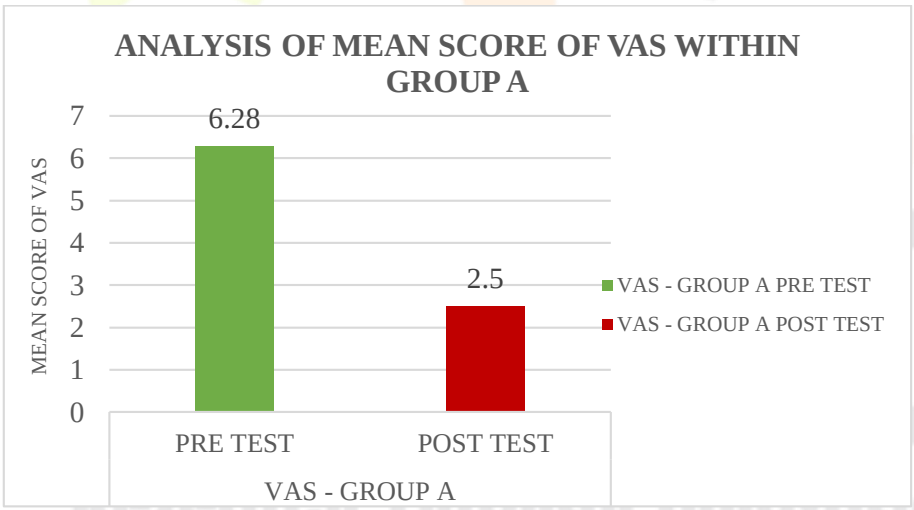
RESULTS

The results of this study were analysed in terms of reduction of pain on VAS, improved shoulder range of motion i.e., abduction, external rotation and internal rotation on Universal Goniometer and improved functional range on SPADI. The consort flow chart of the study showed the study organization in terms of subjects screening, random allocation and analysis following the intervention. A total of 85 subjects with adhesive capsulitis were screened for eligibility, amongst 80 subjects were included in the study trail. All the 80 subjects who met the inclusion criteria had undergone baseline assessment and included subjects were randomized into two equal groups consisting of 40 participants in group A and 40 participants in group B. In this study 38 participants completed training in Group A and 38 participants completed training in Group B with dropouts of 2 in each group.

Comparison was done within the groups as well as in between the groups. So as to evaluate the intra group and inter group effectiveness of Exergaming and Mulligan Mobilization With Movement which are under considerations in the present study.

ANALYSIS OF MEAN SCORE OF VAS WITHIN GROUP A

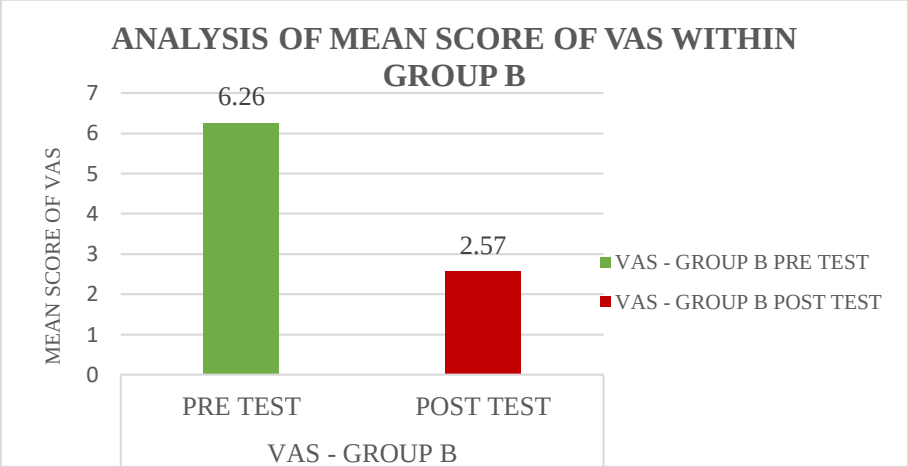
GROUP A		MEAN	SD	P VALUE	INFERENCE
VAS	PRE TEST	6.28	0.86	0.001	Highly Significant
	POST TEST	2.5	0.68		



RESULTS: The above table and graph shows that the mean score of VAS changes from pre- test to post- test values within group A were found to be statistically highly significant ($p<0.005$).

ANALYSIS OF MEAN SCORE OF VAS WITHIN GROUP B

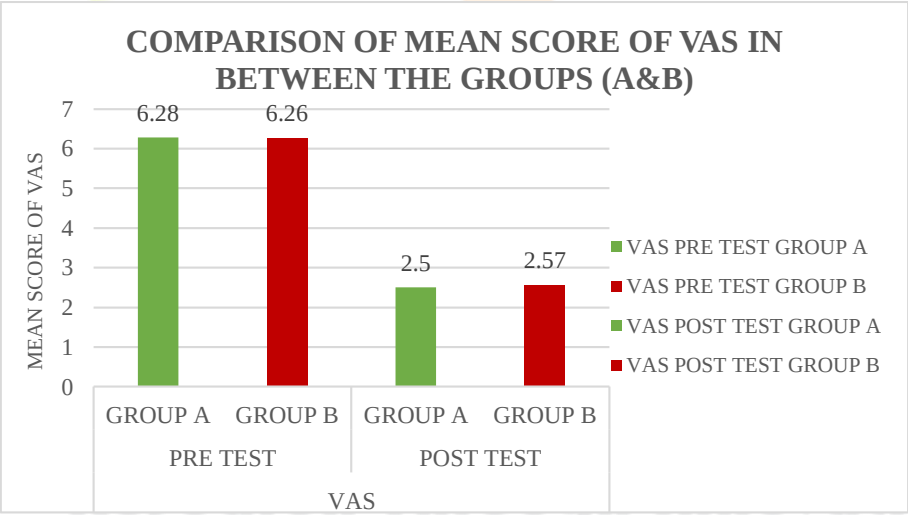
GROUP B		MEAN	SD	P VALUE	INFERENCE
VAS	PRE TEST	6.26	0.89	0.001	Highly Significant
	POST TEST	2.57	0.72		



RESULTS: The above table and graph shows that the mean score of VAS changes from pre- test to post- test values within group A were found to be statistically highly significant ($p<0.005$).

COMPARISON OF MEAN SCORE OF VAS IN BETWEEN THE GROUPS (A&B)

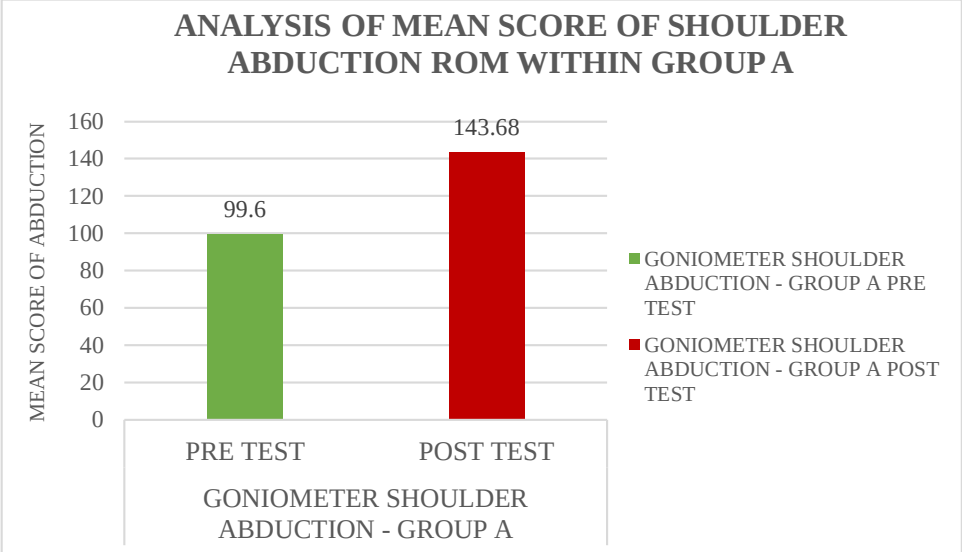
GROUPS		MEAN	SD	P VALUE	INFERENCE
VAS PRE TEST	A	6.28	0.86	0.8966	Insignificant
	B	6.26	0.89		
VAS POST TEST	A	2.5	0.68	0.6268	Insignificant
	B	2.57	0.72		



RESULTS: The above table and graph shows that the pre-test and post-test measurements of VAS in between the groups were found statistically insignificant.

ANALYSIS OF MEAN SCORE OF SHOULDER ABDUCTION ROM WITHIN GROUP A

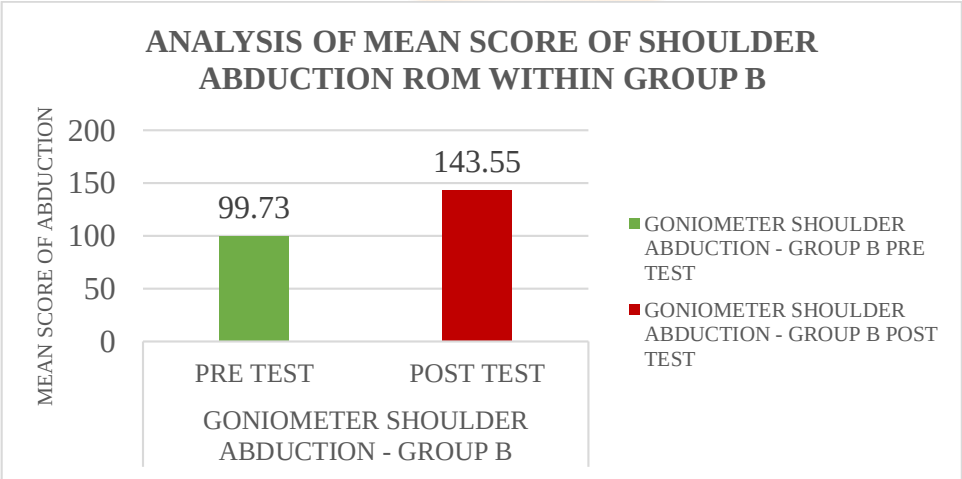
GROUP A		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER ABDUCTION ROM	PRE TEST	99.60	9.95	0.001	Highly Significant
	POST TEST	143.68	11.07		



RESULTS: The above table and graph shows that the mean score of shoulder abduction ROM changes from pre- test to post- test values within group A were found to be statistically highly significant ($p<0.005$).

ANALYSIS OF MEAN SCORE OF SHOULDER ABDUCTION ROM WITHIN GROUP B

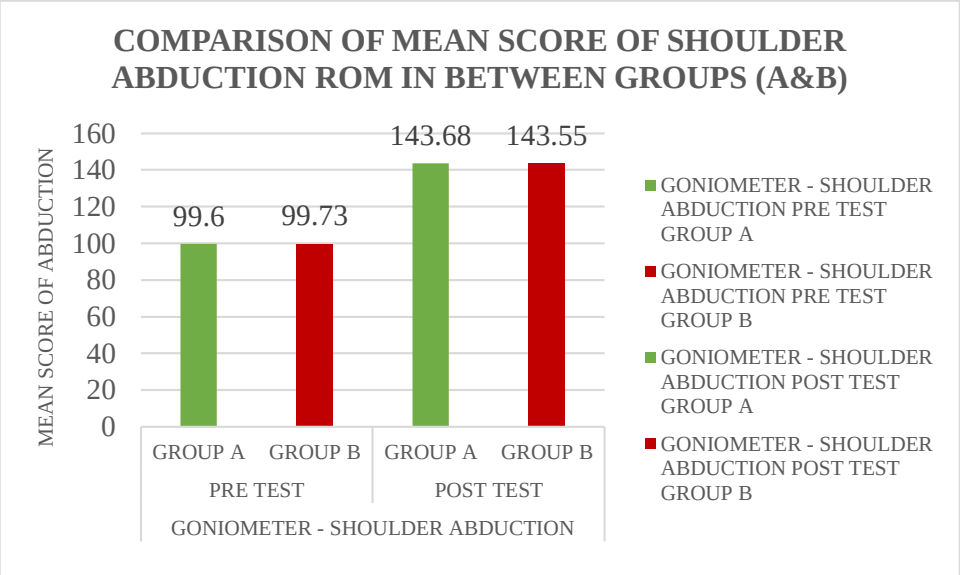
GROUP B		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER ABDUCTION ROM	PRE TEST	99.73	10.06	0.001	Highly Significant
	POST TEST	143.55	9.92		



RESULTS: The above table and graph shows that the mean score of shoulder abduction ROM changes from pre- test to post- test values within group B were found to be statistically highly significant ($p<0.005$).

COMPARISON OF MEAN SCORE OF SHOULDER ABDUCTION ROM IN BETWEEN THE GROUPS (A&B)

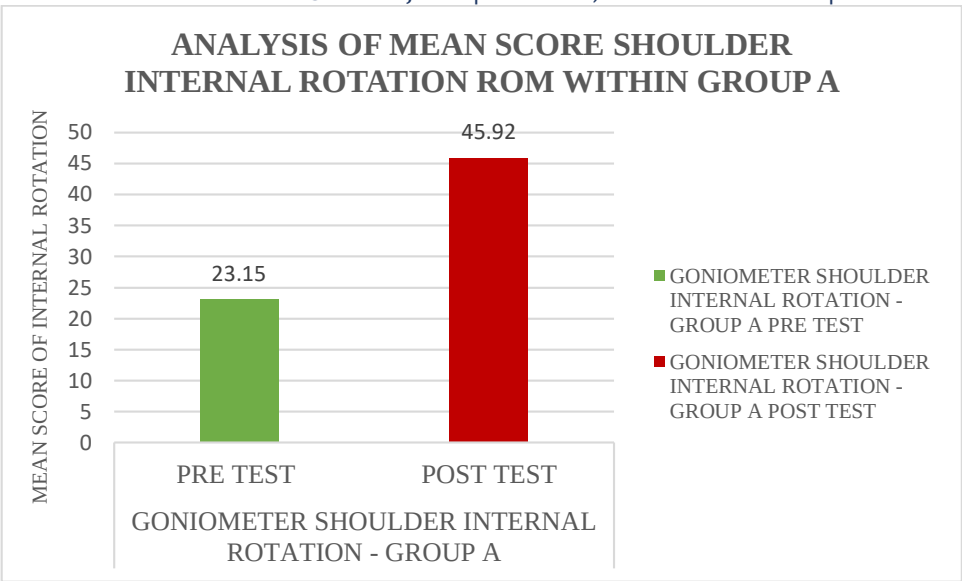
GROUPS		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER ABDUCTION PRE TEST	A	99.60	9.95	0.9545	Insignificant
	B	99.73	10.06		
GONIOMETER SHOULDER ABDUCTION POST TEST	A	143.68	11.07	0.9568	Insignificant
	B	143.55	9.92		



RESULTS: The above table and graph shows that the pre-test and post-test measurements of shoulder abduction ROM in between the groups were found statistically insignificant.

ANALYSIS OF MEAN SCORE OF SHOULDER INTERNAL ROTATION ROM WITHIN GROUP A

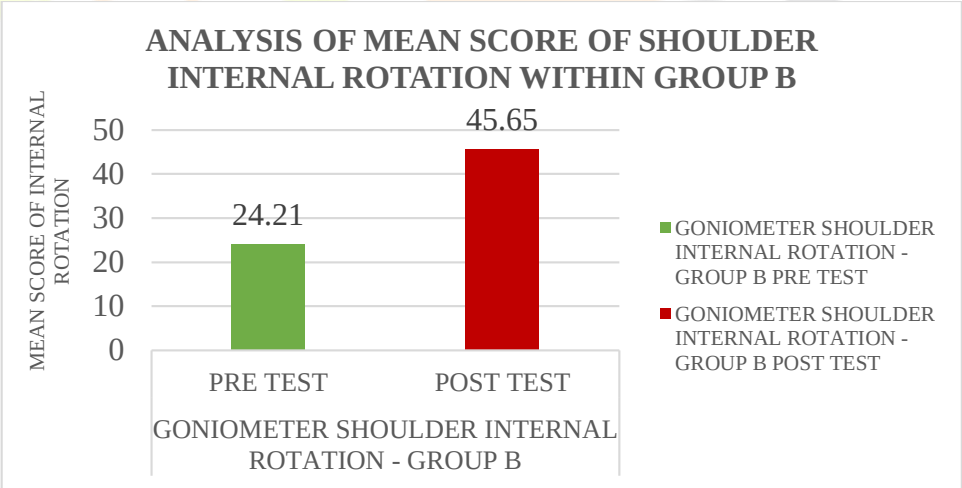
GROUP A		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER INTERNAL ROTATION	PRE TEST	23.15	6.19	0.001	Highly Significant
	POST TEST	45.92	7.69		



RESULTS: The above table and graph shows that the mean score of shoulder internal rotation ROM changes from pre- test to post-test values within group A were found to be statistically highly significant ($p<0.005$).

ANALYSIS OF MEAN SCORE OF SHOULDER INTERNAL ROTATION ROM WITHIN GROUP B

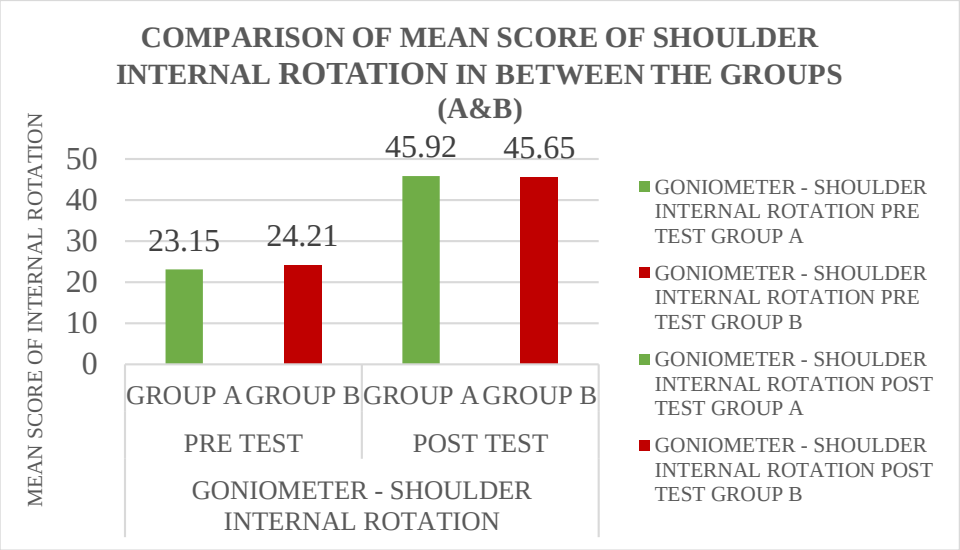
GROUP B		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER INTERNAL ROTATION	PRE TEST	24.21	6.83	0.001	Highly Significant
	POST TEST	45.65	6.99		



RESULTS: The above table and graph shows that the mean score of shoulder internal rotation ROM changes from pre- test to post-test values within group B were found to be statistically highly significant ($p<0.005$).

COMPARISON OF MEAN SCORE OF SHOULDER INTERNAL ROTATION ROM IN BETWEEN THE GROUPS (A&B)

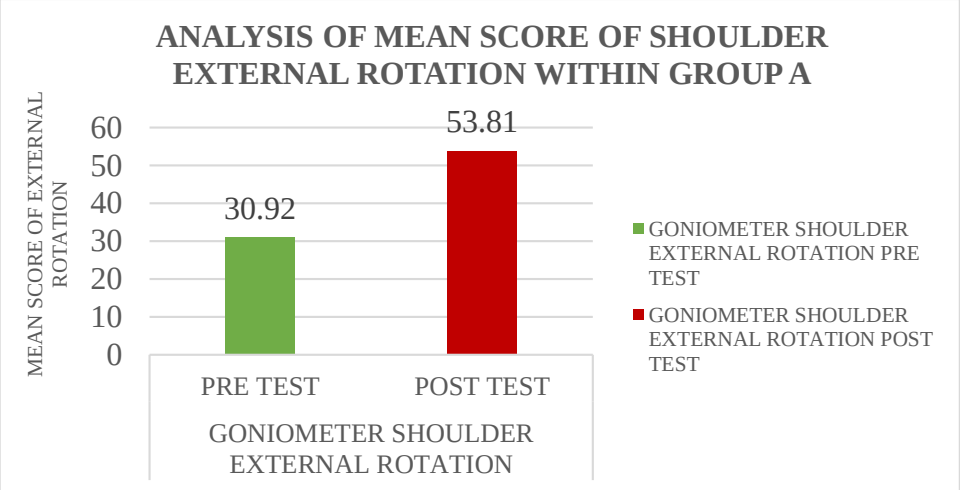
GROUPS		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER INTERNAL ROTATION PRE TEST	A	23.15	6.19	0.4839	Insignificant
	B	24.21	6.83		
GONIOMETER SHOULDER INTERNAL ROTATION POST TEST	A	45.92	7.69	0.8764	Insignificant
	B	45.65	6.99		



RESULTS: The above table and graph shows the pre test and post test measurement of shoulder internal rotation ROM in between the groups were found statistically insignificant.

ANALYSIS OF MEAN SCORE OF SHOULDER EXTERNAL ROTATION ROM WITHIN GROUP A

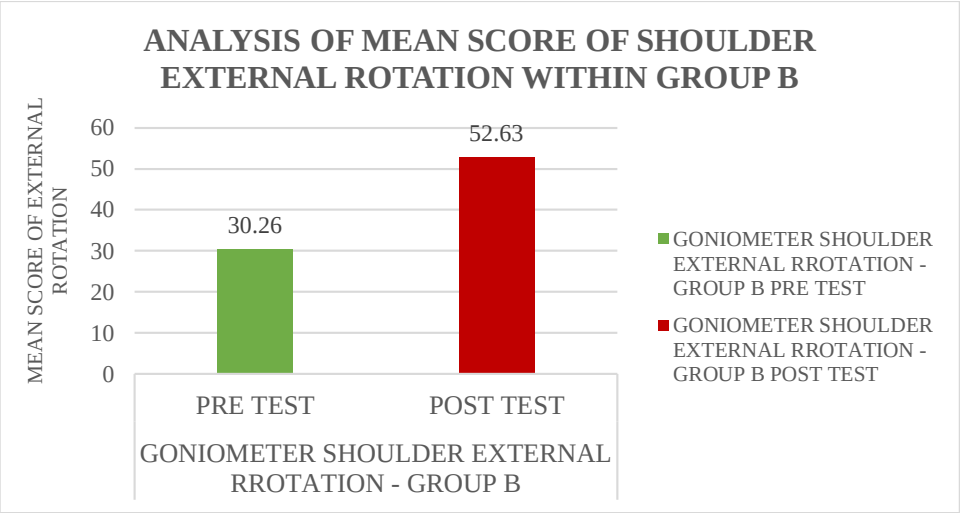
GROUP A		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER EXTERNAL ROTATION	PRE TEST	30.92	6.13	0.001	Highly Significant
	POST TEST	53.81	5.97		



RESULTS: The above table and graph shows that the mean score of shoulder external rotation ROM changes from pre- test to post-test values within group A were found to be statistically highly significant (p<0.005).

ANALYSIS OF MEAN SCORE OF SHOULDER EXTERNAL ROTATION ROM WITHIN GROUP B

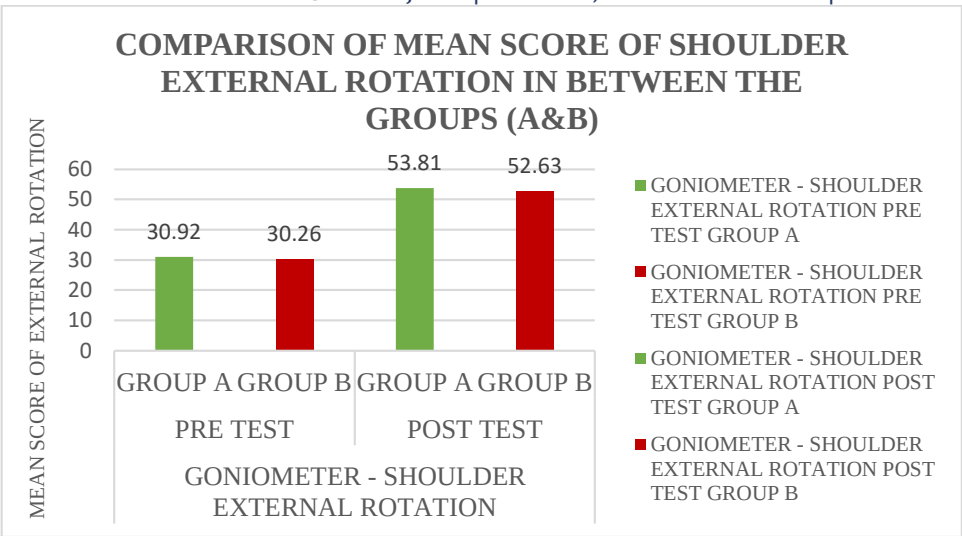
GROUP B		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER EXTERNAL ROTATION	PRE TEST	30.26	5.92	0.001	Highly Significant
	POST TEST	52.63	5.41		



RESULTS: The above table and graph shows that the mean score of shoulder external rotation ROM changes from pre- test to post-test values within group B were found to be statistically highly significant (p<0.005).

COMPARISON OF MEAN SCORE OF SHOULDER EXTERNAL ROTATION ROM IN BETWEEN THE GROUPS (A&B)

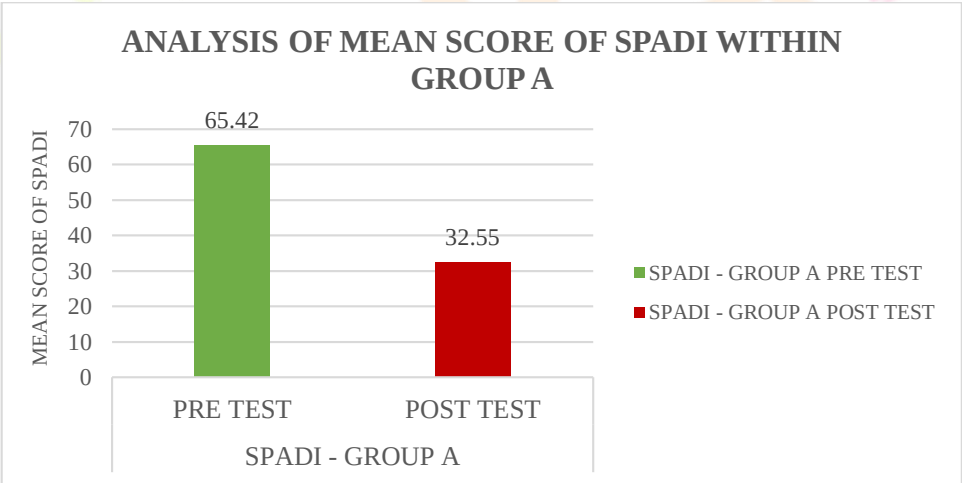
GROUPS		MEAN	SD	P VALUE	INFERENCE
GONIOMETER SHOULDER EXTERNAL ROTATION PRE TEST	A	30.92	6.13	0.6357	Insignificant
	B	30.26	5.92		
GONIOMETER SHOULDER EXTERNAL ROTATION POST TEST	A	53.81	5.97	0.3685	Insignificant
	B	52.63	5.41		



RESULTS: The above table and graph shows that the pre test and post test measurement of shoulder external rotation ROM in between the groups were found statistically insignificant.

ANALYSIS OF MEAN SCORE OF SPADI WITHIN GROUP A

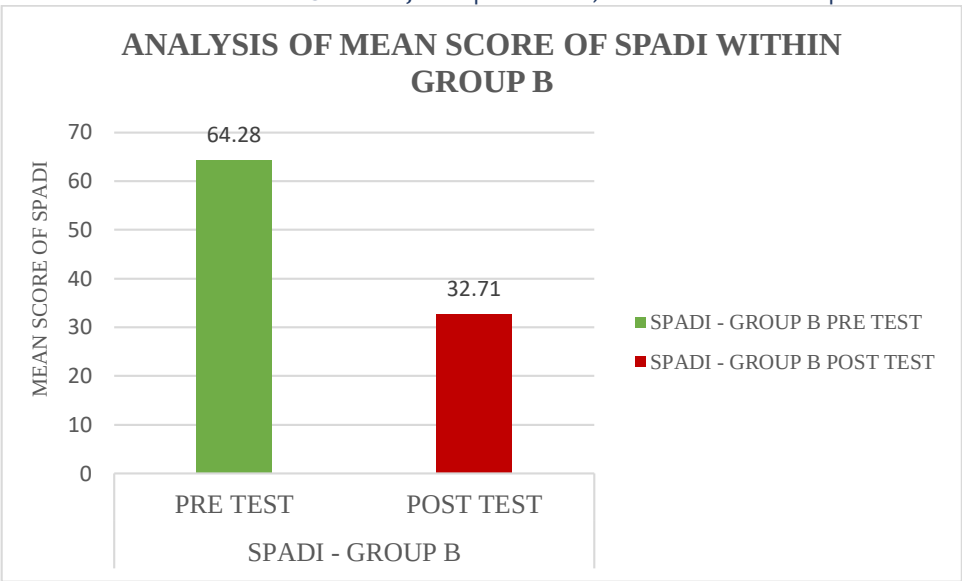
GROUP A		MEAN	SD	P VAUE	INFERENCE
SPADI	PRE TEST	65.42	8.07	0.001	Highly Significant
	POST TEST	32.55	6.704		



RESULTS: The above table and graph shows that the mean score of SPADI changes from pre- test to post- test values within group A were found to be statistically highly significant ($p<0.005$).

ANALYSIS OF MEAN SCORE OF SPADI WITHIN GROUP B

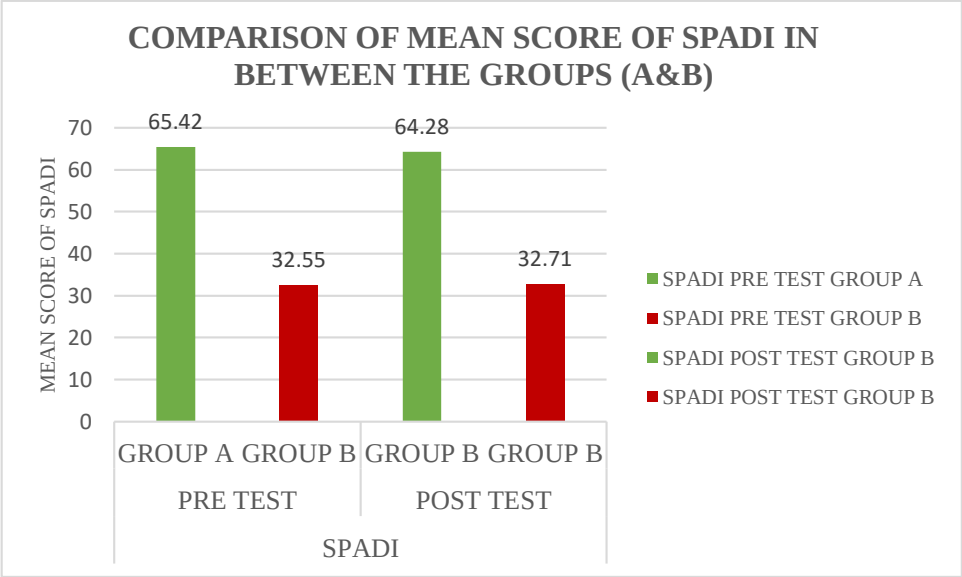
GROUP B		MEAN	SD	P VALUE	INFERENCE
SPADI	PRE TEST	64.28	8.45	0.001	Highly significant
	POST TEST	32.71	8.75		



RESULTS: The above table and graph shows that the mean score of SPADI changes from pre- test to post- test values within group B were found to be statistically highly significant ($p<0.005$).

COMPARISON OF MEAN SCORE OF SPADI IN BETWEEN THE GROUPS (A&B)

GROUPS		MEAN	SD	P VALUE	INFERENCE
SPADI PRE TEST	A	65.42	8.07	0.5526	Insignificant
	B	64.28	8.45		
SPADI POST TEST	A	32.55	6.704	0.9299	Insignificant
	B	32.71	8.75		



RESULTS: The above table and graph shows the pre test and post test measurement of SPADI in between the groups were found statistically insignificant.

DISCUSSION

The aim of the present study was to evaluate the effectiveness of exergaming and mulligan mobilization with movement on pain, range of motion and function in subjects with adhesive capsulitis of shoulder. In this study, subjects were assessed for pain, range

of motion and function. The following outcome measures are visual analogue scale (vas), universal goniometer, shoulder pain and disability index (SPADI) were used to measure the intensity of pain, ROM and function.

Subjects were assessed for pain, range of motion and function at baseline and at the end of the intervention using VAS for pain, Universal Goniometer for Shoulder Range of Motion and SPADI for Function, there were 2 drop outs in each group i.e, Group A 38 Subjects (Exergaming Group) and Group B 38 Subjects (Mulligan MWM Group) due to their own reasons.

In Group A (Exergaming along with conventional physiotherapy) there is statistically significant improvement in VAS, Universal Goniometer and SPADI ($P<0.0001$). Many of the mechanisms behind the benefits of exercise for other populations may also apply to the treatment of musculoskeletal problems, according to Sharmila.S et al. Although the exact mechanisms underlying exergaming's ability to help manage pain are unknown, they could involve graded exposure, somatosensory input modification, and distraction. This study experience suggests that even though there is a pain in the initial stage of exergaming training, motivation and involvement of the subjects in the game gave good effect on pain, ROM and function.[27]

Another study by Hoffman et al. investigated the impact of virtual reality (VR) on experimental pain using functional magnetic resonance imaging (MRI), and their findings indicated a decrease in activity in five brain regions related to pain. According to these fMRI findings, virtual reality (VR) lessens pain by influencing how the brain reacts to painful stimuli in the periphery, thereby influencing both the sensory and affective elements of pain perception.[32]

There was an earlier study by Gospodin et al concluded in his study VR showed a real benefit during joint mobilizations and during tests performed on the shoulder joint. The mechanism behind these benefits through VR that the patient had lower perception of time spent in virtual environment compered real world and decreased in pain relief during joint mobilizations. The minds of the subjects being concerned with virtual environment did not think about the problem so this leads to lower perception of time and pain.[33]

In Group B (Mulligan MWM along with conventional physiotherapy) there is a statistically significant improvement in VAS, Universal Goniometer and SPADI. The use of Mulligan MWM in conjunction with exercises and ultrasound therapy, according to B. Haveela et al., significantly improves pain ratings, shoulder range of motion, and functional abilities in patients with frozen shoulder. The golgi tendon organ is one of the proprioceptive tissues that is stimulated by the active movement in technique through tendon stretching. Correcting positional errors is the foundation of this treatment, which has also been shown to be successful through neurophysiological mechanisms. These mechanisms include producing an initial hypoalgesia by stimulating peripheral mechanoreceptors, inhibiting nociceptors, and modifying the sympathetic nervous system. It restores the normal extensibility of the shoulder capsule and tight soft tissues in frozen shoulder by gently stretching the stiffened soft tissues and capsule.[28]

According to Ujwal L. Yeole et al. study, mobilization combined with movement was found to be a more effective treatment for adhesive capsulitis of the shoulder, resulting in improved discomfort and range of motion. When particular movements are stress-tested in particular regions of the capsular tissue, the improvement resulting from the mechanical changes seen during mobilization is the breaking of adhesions, realigning the collagen, and enhancing the fiber glide. The mulligan group is responsible for the corrective glide that produces the best alignment of the articular surfaces and maintains it through the right activation of the muscles by the patient. Therefore, by causing changes in synovial fluid and increasing synovial fluid turnover, this approach tends to promote joint mobility.[3]

In order to show the advantages of exergaming in addition to traditional physiotherapy, Donny Gunawan et al. conducted a previous study titled "Association between Stretching Exercise with Virtual Reality Game and Over Head Pulley of Frozen Shoulder Patients." The research findings indicated that in patients with frozen shoulders, stretching exercises with an over-head pulley yielded similar advantages to improvement when compared to virtual reality gaming workouts.[34]

Shrutika Wankhade et al., demonstrated the effect of virtual reality aided physical therapy in adjunct to traditional therapy in frozen shoulder patients. They conclude that patients with frozen shoulder, virtual reality headset i.e., oculus assisted physical therapy is more beneficial than traditional physical therapy, according to the findings of their study.[35]

After 6 weeks of intervention, Both the exergaming group ($p < 0.001$) and the mulligan mobilization with movement ($p < 0.001$) exhibited a significant improvement in all three outcome measures, namely the VAS, the universal goniometer, and the shoulder pain and disability index (SPADI). Thus, the study's conclusions show that two methods were successful in lowering pain and

enhancing range of motion and function in the examined group. However, there was no statistically significant difference between the outcomes of exercise and Mulligan mobilization.

LIMITATIONS

- The study duration is short.
- Only done with stage 2 adhesive capsulitis.
- No follow up.
- No control group.

RECOMMENDATIONS FOR FURTHER RESEARCH

- Can be done on large sample size.
- The duration of the study can be increased by 8 weeks.
- Can be done on other stages.

CONCLUSION

The present study concluded that 6 weeks intervention of exergaming and mulligan mobilization with movement showed significant improvements in pain, range of motion and function in subjects with stage 2 adhesive capsulitis. However, exergaming and mulligan mobilization with movement were equally effective in treating adhesive capsulitis.

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