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Neurocognitive Training Versus Kinetic Motor Control Exercises on Patellofemoral Pain Syndrome- Randomised Controlled Trial

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ABSTRACT

Objectives: To compare the effects of Neurocognitive training Versus Kinetic motor control exercise to improve the Q-angle, kinesiophobia, proprioceptive and motor problem in PFPS.

Methods: Comparative study, 30 subjects were allocated randomly into 2 groups. Group A (15 patients) & each was treated with Neuro-cognitive exercises with Short Wave Diathermy. Group B (15 patients) & each was treated with Kinetic Motor control exercise with Short Wave Diathermy. 10 weeks of intervention were provided. Both groups were assessed by using outcome measures like AKPS, TAMPA scale, IQP and Q-Angle measurement.

Results: Statistical Analysis was done by unpaired't' test and paired't' test for the between group and within the group respectively. The mean and SD for AKPS in Group A is 6.20 ± 42.40 and Group B 9.00 ± 154.00. The mean and SD of Tampa scale in Group A is 17.87 ± 299.73 and Group B 14.07 ± 224.93. The mean and SD for Isometric Quadriceps Pressure in Group A is 9.20 ± 198.40 and Group B 12.93± 158.93. The mean and SD for ' Q '-Angle in Group A is 7.27 ± 94.93 and Group B 5.40 ± 61.60 respectively.

Conclusion: This study concludes that Kinetic Motor Control Exercises (Group B) shows more significant effect than neurocognitive exercises (Group A) in improving the Q-angle, Kinesiophobia, proprioceptive and motor problem in PFPS.

Keywords: *Anterior knee pain rating scale, Patellofemoral pain syndrome, Isometric Quadriceps pressure, Q-Angle measurement & Kinesiophobia.*

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1. INTRODUCTION

Patellofemoral pain syndrome is a most common musculoskeletal condition affecting the knee joint [1]. It included patients who had discomfort in the anterior knee, patella, or knee cap [2]. Retropatellar and peripatellar pain are common symptoms, which are exacerbated when the patellofemoral joint is stressed during activities such as running, jumping, squatting, kneeling, prolong sitting, ascending and descending stairs [3]. Annual prevalence of Patello-femoral pain in the general population was reported as 22.7%and adolescent as 28.9% in which females are more affected when compared to males [4]. Patients with PFPS have been reported to have greater patella-femoral joint stress, leading to increased cartilage and sub- chondral bone stress which causes injury and pain over time [5].It usually happens between the ages of 15 and 30yrs. Local factors such as VMO weakness cause lateral movement and tracking of the patella during the last 30 degrees of knee extension, thereby reducing the contact area of the patella-femoral joint and increasing PF joint stress [6]. Proprioceptive deficit is present in PFP due to abnormal force acting on the surrounding soft tissue which can disrupt normal motor control and joint position sensation [7]. Proximal factor such as reduced strength of hip abductors and external rotators can lead to lower extremity mal-alignment (femoral adduction and medial rotation) which may place additional stress to patella-femoral joint & leading to a predisposition to lateral patella tracking as the femur medially rotates underneath the patella [8].As the patellar lateral traction force increases, there is more pressure exert on the lateral facet of patella which results in a larger dynamic Q-angle [9]. When the Quadriceps angle (Q angle) exceeds 20 degrees, it is considered excessive& potentiating results in patella-femoral disorder [10]. Individuals with PFPS may acquire pain-related fears such as avoidance, catastrophizing thoughts, and low self-efficacy, all of which influence not only their function but also impair their quality of life [11]. This kinesiophobia and catastrophizing thinking are particularly relevant for impairment and pain chronification in patients with anterior knee pain [12]. Therefore long term prognosis is poor in PFP [13]. Short wave diathermy works on the principle of electromagnetic radiation and it helps to provide pain relief and improvement in functional activity in individual with PFPS [14]. As patellofemoral pain lasts for 2 to 6 years (3.46 ± 1.9 years) [15], in addition to the local &proximal musculoskeletal changes there are some alterations takes place in CNS which is not known in the community. In persistent PFP Brain changes are evident due to loss of normal intramuscular coordination, which leads to the adoption of a more "simplified movement pattern," resulting in impaired motor control [16]. In evaluation of quadriceps muscle by using EMG& Transcranial magnetic stimulation they found that there is decreased corticomotor excitability or reduction in the cortical territory of neural networks that project to the quadriceps muscle and increased intracortical inhibition which leads to altered primary motor cortex organisation in persistent PFPS [17]. Neurocognitive rehabilitation exercises focus on both proprioceptive and motor problems that patients must address using higher brain functions like attention, awareness, memory learning, and processing physcomotor speed activity. During neurocognitive exercise motor imaginary is heavily considered. Decety, define motor imaginary as a dynamic state during which a person simulates a given action [18, 19]. By performing neurocognitive exercises the patient regain control over the dimensions of functional movement: spatiality, timing, and intensity. Kinetic motor control identifies the location and direction of uncontrolled movement, and exercises are given to retrain motor control. Movement control retraining system has 3 key processes which involve in managing the uncontrolled movement: Retrain control of the site and direction of the uncontrolled movement. Control the translation that goes along with the uncontrolled movement via repetition. Correct muscle recruitment and length imbalance that associated with the uncontrolled movement [20].Therefore, this current study examines the effect of neurocognitive training versus kinetic motor control exercise training in individual with patellofemoral pain syndrome.

2. MATERIALS AND METHODOLOGY

This study was Comparative & followed by factorial randomised design. Research was conducted in a Tertiary Care Hospital at Puducherry. Patients with unilateral PFPS were selected based on inclusion criteria as follows: Both gender & age group 18-35 years were selected. People with non- traumatic anterior & retro patella pain presenting more than 2 years. Patient complains of pain during prolong sitting, ascending & descending stairs. Q-angle greater than 20 degree in women and 10 degree in men. Physical examination: Clarke's test positive. Self -reported disability less than 85/100 on anterior knee pain scale. Exclusion criteria includes H/O of patella Fracture or dislocation. Previous H/O knee surgery. Knee joint effusion. Patient with patella tendon pathology. Previous history of Ankle & hip injury. Patient with lesion diagnosed on physical examination. Patient diagnosed with knee joint ligament & meniscal injury. Based on the power analysis done in the previous study 30 Patients were allocated randomly into two groups (Group A& Group B) with 15 patients each. Treatment Duration was carried for 10 weeks and the study duration was 12 months. Subjective outcome measure includes Kujala scale and Tampa scale. Objective outcome Measure includes Q-angle and Quadriceps isometric test.

Procedure

Here Short Wave Diathermy was used as a conventional therapy for both groups. Group A consists of 15 patients and each was treated with Neuro- cognitive exercises along with Short Wave Diathermy. Group B consists of 15 patients and each was treated with Kinetic Motor control exercises along with Short Wave Diathermy.

3. GROUP A: NEUROCOGNITIVE REHABILITATION EXERCISES:

Phase 1: Neurocognitive Exercises with Absence of Load (4 Weeks).

1. **Recognition of Knee Joint Range Position Exercise**: Patient is positioned in supine lying and patient is asked to recognition the position in flexion / extension of the affected knee between 0° and 90°.(Fig: 1)
2. **Recognition of Position with Check Board Exercise:** Supine with unaffected leg is flexed and affected leg in extended position and Recognition of different position in space with check board and execution of circular path with heel maintaining the affected leg with knee extended.(Fig: 2)
3. **Recognition of Position in Curvilinear Trajectories**: Patient was positioned in supine with unaffected leg is flexed and affected foot supported on an inclined plane. Recognition of position in flexion / extension of knee between 0° and

90˚ with the heel resting on the sliding curvilinear trajectories.(Fig: 3)

(All the above exercises in Phase 1 must be provided initially in first degree for 4 weeks by varying the angle of plane as a function of knee joint motion.)

Fig: 1 Recognition of Knee Joint Range in Supine

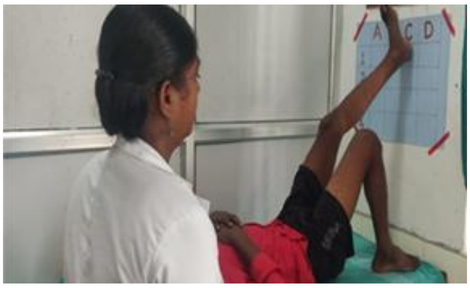


Fig: 2 Recognition of Position with Check Board Exercise

Fig: 3 Recognition of Position in Curvilinear Trajectories

First degree-eyes closed with the help of therapist (verbal or manual) support.

Phase 2: Neurocognitive Exercise with Transfer of Load in Affected Leg on Weighing Scale (3 weeks).

1. **Transfer of Load in Affected Leg by Using One Scale:** Patient was positioned in upright position with the affected leg on a scale and unaffected leg on an inclined plane with curvilinear trajectories. Patient was asked to perform different trajectories with the heel of unaffected leg in both uphill and downhill direction.(Fig : 4)
2. **Transfer of load in affected leg by using 2 scales:** Patient was positioned in upright with unaffected leg is placed on one scale and affected leg is placed on 2 scales. (i.e) one for forefoot & other for the heel. Patient must transfer the load in affected leg from back to front on to the forefoot & front to back on to the heel.(Fig:5)

Fig: 4 Transfer of Load in Affected Leg by Using One Scale.

Fig: 5 Transfer of load in Affected Leg by Using Two Scales.

(All the above exercises in Phase 2 must be performed in second degree for 3 weeks.) Second degree: open eyes with the help of therapist.

Phase 3: Neurocognitive Exercises with Transfer of Load in Affected Leg without Using Weighing Scale (3 Weeks).

1. **Transfer of Load in Varying Distance, Direction and Height: Patient was positioned in** Upright position with affected leg on various heights. Patient must transfer the load in affected leg to carry out programmed steps with unaffected leg in various distance and direction.(Fig: 6)
2. **Transfer of Load in Affected Leg by Performing Knee Circles:** The Affected leg is placed on various heights. Patient must perform various circles in unaffected leg. (Fig:7)

Fig: 6 Transfer of Load in Varying Distance, Direction and Height

Fig: 7 Transfer the Load in Affected Leg by Performing Knee Circles

(All the above exercises in Phase 3 must be performed in third degree for 3 weeks.) Third degree-Patients are executed independently under the supervision of therapist. 5mins of session. 3sessions per week. Each session lasting for one hour. Progress every 3 week & Total duration -10 weeks.

4. GROUP B: KINETIC MOTOR CONTROL EXERCISES: (HIP LATERAL ROTATION & ABDUCTION CONTROL REHABILITATION EXERCISES)

The protocol for kinetic motor control exercise as follows: 10 repetition were done for each set of exercises. 3 sets per session and 3 sessions per week .Total treatment duration was carried for 10 weeks. Both group (A & B) were treated with SWD .This was applied for 10 minutes during each session. The treatment was carried out in 3 sessions per week, for a period of 2 weeks.

Single Leg & High Knee Lift Exercise: Patient stand with back against the wall and the feet 10-15 cm apart and heel should be 5-10 cm from the wall. Pelvis & trunk should be upright. Patient is instructed to shift the weight onto one foot and keeping the pelvis and shoulder at level, slowly lift the foot off the ground. The hip can lift into flexion 90 degrees only as far as the lateral rotation, abduction and pelvic position can be controlled. (Monitored with feedback) (Fig: 8)

Fig: 8 Single Leg & High Knee Lift Exercise.

One Leg Knee Bend with Trunk Rotation Exercise: Patient stands facing the frame of the doorway or corner section of wall or doorframe. They should stand on one leg with inside border of the foot perpendicular to the wall with toes approximately 5cm from the wall. Patient first performs a Small knee bend to position the thigh & trunk against the wall / doorframe. Patient is instructed to turn the trunk & pelvis towards the stance leg. The patient should control hip& knee movement with the feedback. (Fig: 9)

Fig: 9 One Leg Knee Bend with Trunk Rotation Exercise.

Bent Knee Hip Extension Exercise: Patient position themselves in 4 point kneeling & shift weight onto one knee. Instruct the patient to perform hip extension but allow the knee to straighten so that it is only flexed to about 20 or 30 degree. The leg should stay in sagittal plane & not abduct out to side. Hip can lift into extension as for as lateral rotation abduction & pelvic rotation can be controlled. (Fig: 10)

Fig: 10 Bent Knee Hip Extension Exercise.

Single Leg Lift Exercise: Patient should be in crook lying with feet & knees together. Instruct the patient to lift the pelvis 5cm off the floor while maintaining the neutral alignment. Later instruct the patient to transfer the weight to one foot & only lift the other foot a few centi- meter from the floor. The person should lift the unweighted leg as far as hip lateral rotation and abduction can be controlled. Progression= Fully extend the unweighted leg. (Fig: 11)

Fig: 11 Single Leg Lift Exercise.

5. HIP FLEXION MOTOR CONTROL EXERCISE:

Vertical Trunk Single Leg ¼ Squat Exercise: Patient stand with back against a wall & feet with apart (heel 10-15 cm) apart with feet parallel. Heel should be 5-10cm from the wall. It is instructed to shift their weight to one leg and perform single leg KB to squat position. Slide down until trunk stay on the wall and not in increased hip flexion. Progression: Perform above exercise unsupported against the wall**. (**Fig: 12)

Fig:12 Vertical trunk single leg ¼ squat exercise

Single Foot Lift Exercise: Patient stand with back against a wall & feet with apart (heel 10-15 cm) apart with feet parallel. Heel should be 5-10cm from the wall. Patient should perform SKB by sliding the trunk against the wall to ¼ squat position with weight balanced equally on both feet. Then shift full weight onto one leg, allowing the pelvis &shoulder to keep the body weight centred over the weight bearing foot. Then lift the foot 15-20 cm off the floor. There should be no increase hip flexion over the stance leg. Progression: Perform above exercise unsupported against the wall. (Fig: 13)

Fig: 13 Single Foot Lift Exercise.

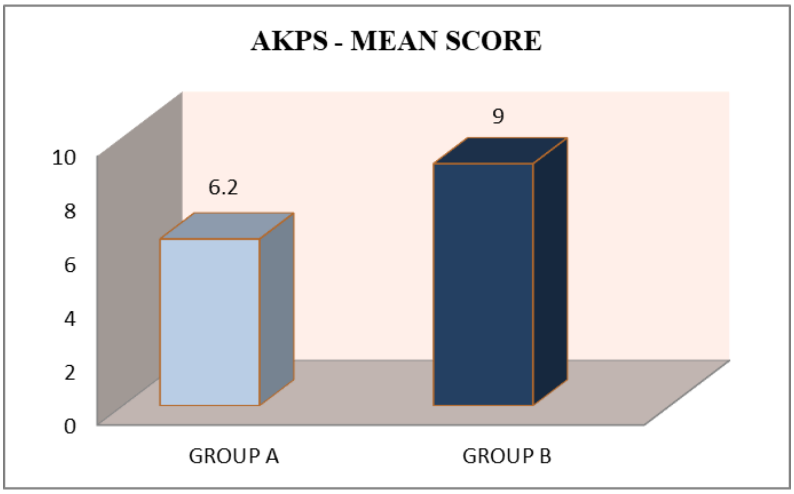
Spinal Roll down Exercise: Patient trunk support against the wall with feet apart & knee slightly flexed (hip flexor unloaded & wide base of support) heel 30-40 cm front of the wall. Instruct the patient to flexing the thoracic spine while rolling the pelvis backward to flatten the back onto the wall. Patient should monitor that they can feel the sacrum flattened against the wall only roll the spine down off the wall through partial flexion range. Ensure sacrum & upper pelvis can stay in contact with the wall and not roll forward into increased hip flexion. (Fig: 14)

Fig: 14 Spinal Roll down Exercise.

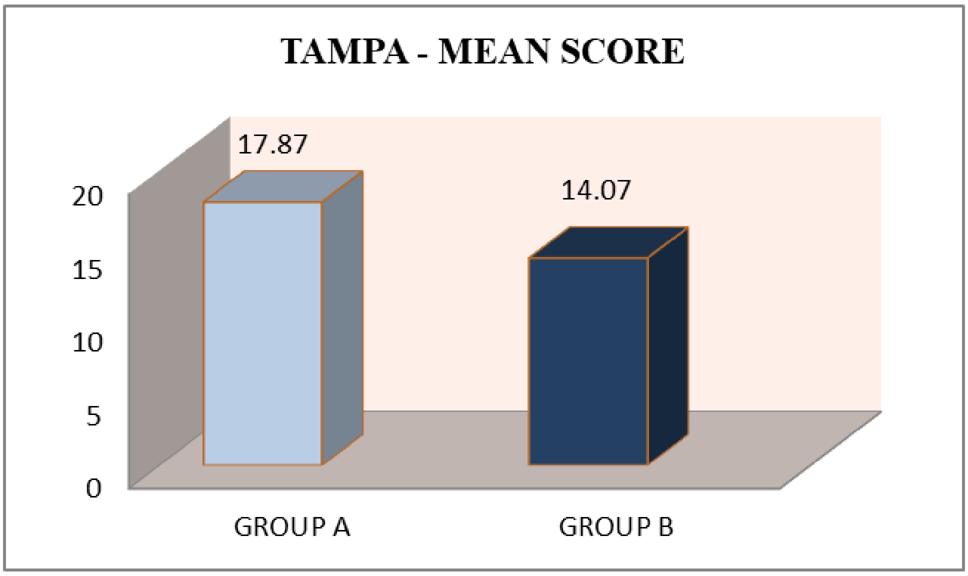
6. RESULTS

The online program link www.socscistatistics.com is used to perform the statistical analysis of this study. According to the statistical analysis of Groups A and B, the AKPS mean and SD are 6.20 ± 42.40 and 9.00 ± 154.00, respectively, and the "t" value is -2.895 (see Table 1 & Graphical Representation1). Group A's Tampa scale mean and standard deviation are 17.87 ± 299.73 and Group B's are 14.07 ± 224.93, with a "t" value of 2.404 (refer to Table 2 & Graphical Representation 2). Group A's isometric quadriceps pressure mean and standard deviation are 9.20 ± 198.40 and Group B's are 12.93 ± 158.93, with a "t" value of -4.162 (refer to Table 3 and Graphical Representation 3).Group A's ˊQ ˋ-Angle mean and SD are 7.27 ± 94.93, while Group B's is 5.40 ± 61.60, with a "t" value of 2.1620 (refer to Table 4 & Graphical Representation 4).The statistical analysis was done with unpaired t test between the Group A and Group B analysis shows significance ($p< 0.05$)

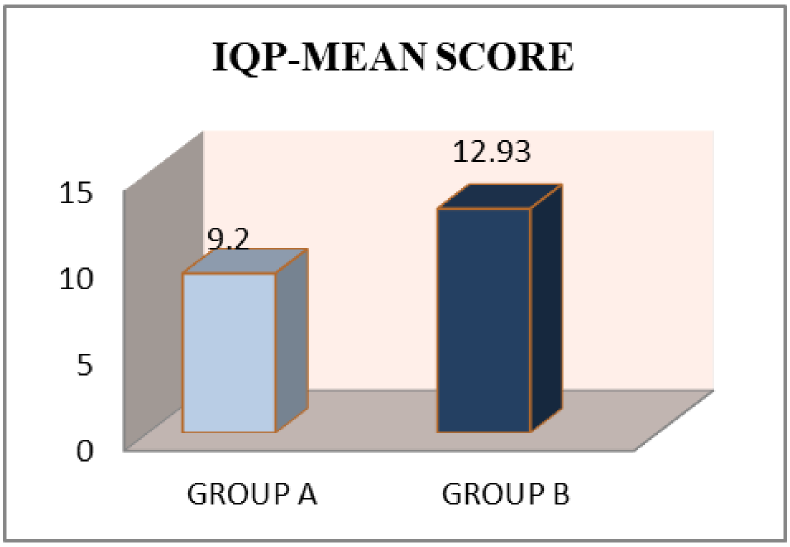
GRAPHICAL REPRESENTATION: 1: AKPS mean score between group A& B:



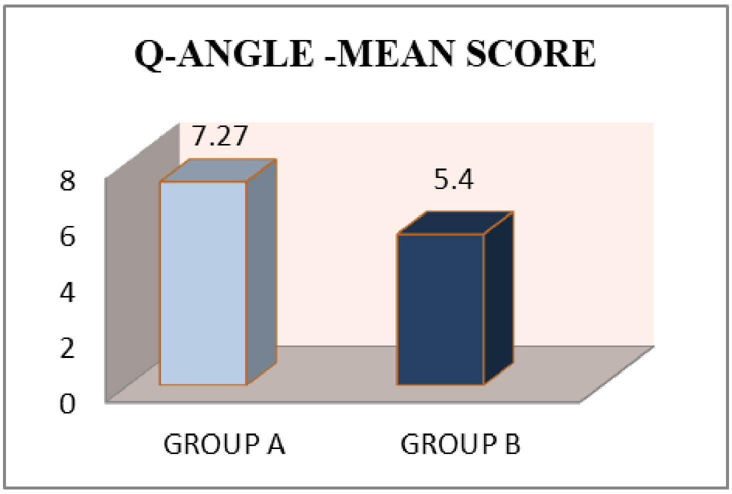
GRAPHICAL REPRESENTATION: 2 Tampa scale mean score between Group A & B:



GRAPHICAL REPRESENTATION: 3: Isometric Quadriceps pressure mean score between Group A & B:



GRAPHICAL REPRESENTATION: 4: Q-Angle mean score between Group A & B:



In Between group analysis, the mean values shows that Group B is more significant than Group A and there is improvement in the AKPS, Isometric Quadriceps Pressure and decrease in Tampa score , ʻQ ̓-Angle in Group B (Kinetic Motor Control exercise along with SWD) than Group A (Neurocognitive exercise along with SWD).

ANTERIOR KNEE PAIN RATING SCALE: (Between Group Analysis) Table No: 1: Showing the Difference between Group A and Group B:

Group	Mean	SD	t-value	p-value	Significance
Group A	6.20	42.40	-2.895	0.0072	<0.05
Group B	9.00	154.00			

The ‘p’ value of AKPS is < 0.05 considered significant. The ‘t’ value of AKPS is -2.895 with 28 degree of freedom.

TAMPA SCALE: Table No: 2: Showing the Difference between Group A and Group B:

Group	Mean	SD	t-value	p-value	Significance
Group A	17.87	299.73	2.404	0.0230	<0.05
Group B	14.07	224.93			

The ‘p’ value of Tampa scale is < 0.05 considered significant. The‘t’ value of Tampa scale is 2.404 with 28 degree of freedom.

ISOMETRIC QUADRICEPS PRESSURE: Table: 3: Showing the Difference between Group A and Group B:

Group	Mean	SD	t-value	p-value	Significance
Group A	9.20	198.40	-4.162	0.0002	<0.05
Group B	12.93	158.93			

The ‘p’ value of IQP is < 0.05 considered significant. The‘t’ value of IQP is -4.162 with 28 degree of freedom.

Q-ANGLE Measurement: Table: 4: Showing the Difference between Group A and Group B:

Group	Mean	SD	t-value	p-value	Significance
Group A	7.27	94.93	2.1620	0.0393	<0.05
Group B	5.40	61.60			

The ‘p’ value of Q - Angle is < 0.05 considered significant. The‘t’ value of Q – Angle is 2.1620 with 28 degree of freedom.

The result of this study shows that Group B (Kinetic Motor Control exercise along with SWD) shows decreased Tampa score,' Q '-Angle measurement and improvement in the AKPS score and Strength of Isometric Quadriceps Pressure than Group A(Neurocognitive exercise along with SWD).

7. DISCUSSION

The present study is to compare the effects of neurocognitive training versus kinetic motor control exercise on Patellofemoral pain syndrome. Our goals of this study is to enhance proprioception, reducing kinesiophobia, decrease ' Q '-angle, and fixing the motor issue which cause patellofemoral discomfort.

Due to a lack of motor control parameters, patients in this study had trouble executing the exercise at first, experiencing excruciating pain and closing their eyes.Patients experiencing extreme discomfort received SWD treatment, rest that day, and instructions to do exercises at home. After receiving wall and parallel bar support at first, patients with poor motor control were progressively moved to no support. They became more confident as a result of the workout reeducation. Verma Chhaya et al., [14] For two weeks, PFP received continuous SWD treatment, which helped them with pain management, sedation, tissue healing promotion, muscular spasm reduction and increased range of motion through analgesic effects, decreased viscosity, and increased in collagen extensibility. The present study also followed the same physiological effects mentioned above therefore it helps to alleviate the pain and improving the functional status in patients with PFP.

Numerous investigations have demonstrated that PFPS might result from a weak thigh muscle group that throws off the knee alignment [21, 22, 23]. Insufficient hip muscular strength, particularly in the abductor and external rotators, causes the hips to adduct and rotate internally, which raises the ' Q '-Angle by increasing the lower extremities' relative valgus. The contact pressure on the patellofemoral joint might rise by 45° for every 10° increase in the ' Q ' angle [24]. The efficiency of strengthening the quadriceps vs the posterolateral hip muscles for PFP was investigated by Khalil Khcyambashi et al. [25].Six months after the intervention, the posterolateral hip exercise group continued to show superior results.

Physical therapists must treat PFPS with proximal hip intervention since it provides both short-term and long-term pain alleviation and increased function, according to a comprehensive review by Jeroen S.J. Peter et al. [1]. According to Seyed Esmaeil Shafiei et al. [26], six weeks of abductor and adductor muscle exercise, in particular, improved step-down test performance when compared to the adductor group. This suggests that strengthening the abductor muscles is more crucial and effective in reducing pain and enhancing joint function in patients with PFPS. Given the findings of Mascar et al. [27], it becomes sense to assume that stronger hip abduction and external rotation muscles resulted in a decrease in adduction and internal rotation of the stance limb during the functional activity, which could lower the dynamic Q-Angle and thereby lower the lateral force acting on the patella. All the above studies seems to be consistent with the finding of our study that Kinetic Motor Control exercise for proximal hip flexors, abductor and external rotators help to decrease hip adduction and internal rotation which decrease the ' Q '-Angle and thereby reduce the lateral force acting on the patella . This combination of increased muscle strength and improved motor control of motion results in pain relief and an improvement in lower extremity kinematics. **Diana M Higgins et al**., [19] in their study of " The relationship between chronic pain and neurocognitive function" suggested that untreated pain may be linked to neurocognitive impairment in areas like memory, attention, processing speed, and executive function, as well as to emotional distress. These factors may affect the patient's capacity for pain self-management and may lead to a decline in overall functioning .**F.Capellino et al.,** [18] have shown that Neurocognitive Rehabilitation protocol uses higher cognitive structure such as memory, attention, perception, vision, motor imaginery and problem solving in ACL reconstruction patients. The joint afferent, which acts on gamma motor neurons and indirectly determines the excitability of motor neurons that control various muscles, would give the task of advancing future course of action, according to the information structure of joint studies conducted by **Johanson**. The joint lesion changes the way afferents travel from the periphery to higher levels of processing like the cortex, making it more difficult to build the necessary information.

The findings of our study correlates with the above statement by providing adequate afferent information from joint structure like proprioception and proper muscle coordination of Quadriceps leads to increase in corticomotor excitability of motor neuron in the higher cortex. In order to improve motor behavior and rectify the incorrect lower extremity motor strategy in patellofemoral pain syndrome, neurocognitive exercises help the patient regain control over the cerebral parameters of functional movement, such as spatiality, timing, and intensity.

As discussed above, the study's results indicate that both the neurocognitive exercise (Group A) and the kinetic motor control exercise (Group B) improve PFPS's Q-angle, kinesiophobia, proprioceptive difficulty, and motor issue. However, kinetic motor control (Group B) exhibits more significance than neurocognitive rehabilitation exercise (Group A). The study's shortcomings included compensatory movements such as pelvic hiking, excessive hamstring strain, and other factors that affected the actual value of quadriceps muscle strength as measured with a pressure cuff and gluteus muscle activity. The Isometric Quadriceps Pressure strength was not compared between the affected and unaffected limb in this study.

Future Studies can be conducted for patellofemoral arthritis in the elderly population. Neurocognitive & kinetic motor control exercises can be conducted on musculoskeletal conditions like IT band syndrome, Piriformis syndrome and soft tissue injury around the knee joint and the above exercises can be compared with manual therapy techniques. Other tools can be used to measure the muscle activity like EMG & Sensor devices.

8. CONCLUSION

This study concluded that 10 weeks intervention of Kinetic Motor Control Exercises along with SWD (Group B) shows more significant than neurocognitive exercise along with SWD (Group A) in improving the Q-angle, Kinesiophobia, proprioceptive and motor problem in PFPS.

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