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Review Article

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A STUDY TO COMPARE THE EFFECTIVENESS OF OPEN KINETIC CHAIN EXERCISES VERSUS CLOSED KINETIC CHAIN EXERCISES ON PAIN AND RANGE OF MOTION IN SUBJECTS WITH CHONDROMALACIA PATELLAE.

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ABSTRACT

Background: Chondromalacia Patellae is the "softening of the articular cartilage of the kneecap". The articular cartilage refers to the cartilage lining under the knee-cap that joins with the knee joint, the condition is one of the most commonly reported limb injures and more common in girls. The open and closed kinetic chain exercises are beneficial in strengthening of the quadriceps muscles and management of chondromalacia patellae. This study was conducted to compare between open kinetic chain exercises and closed kinetic chain exercises in management of chondromalacia Patellae patients. **Methodology:** The present study included 30 subjects with Chondromalacia patellae. The individuals were randomly divided into 2 groups GROUP A and GROUP B. Group A were treated with open kinetic chain exercises and Group B were treated with closed kinetic chain exercises. Both the exercises were performed for a period of 6 weeks, 5 days per week. The outcome measures of pre-test and post-test were assessed by using visual analogue scale (VAS) and universal goniometer. **Results:** The post-test mean value of Visual Analogue Scale for Group A was 4.533 and for Group B it was 2.4. The post-test mean value for Universal goniometer for Group A was 33.933 and Group B it was 27.066. based on the above data analysis it is evident that Group B showed significant improvement than Group A. **Conclusion:** The present study concludes that closed kinetic chain exercises are more effective than open kinetic chain exercises in subjects with Chondromalacia patellae.

KEYWORDS: Chondromalacia patellae, open kinetic chain exercises, closed kinetic chain exercises, anterior knee pain, Extensor knee mechanism.

INTRODUCTION

Patellae, the largest sesamoid bone in the body, possesses the thickest articular cartilage. The articular surface, which can have a variable contour, articulates with the trochlear groove of the femur.[1] Most patellae possess a median ridge that divides the proximal patella into a medial and lateral facet; the medial facet usually is the smaller of the two. The patellar tendon, occasionally termed the patellar ligament, originates at the inferior pole of the patella and inserts onto the tibial tuberosity.[2,3,4]

Chondromalacia patellae is the "softening of the articular cartilage of the knee cap." The articular cartilage refers to the cartilage lining under the kneecap that joins with the knee joint. The articular cartilage is usually smooth and shiny so it is able to glide along the groove of the femur as the knee bends. However, softening of this cartilage can cause damage to the undersurface of the patella, which results in chondromalacia patella.[5,6] Chondromalacia patella can occur frequently in teenagers (especially girls) when the articular cartilage "softens" in response to excessive and uneven pressure on the cartilage, due to structural changes in the legs with rapid growth and muscle imbalance around the knee. Moreover, in many of these teenagers, the vastus lateralis and vastus medialis components of the quadriceps muscle are not well balanced.[7,8,9]

Chondromalacia patella afflicts women twice as often as it does men in a population of adolescents and young adults and occurs about equally among male and female athletic groups. Sports requiring continuous and heavy leg impact, such as track, aerobics, and dance, report a higher incidence of chondromalacia than low- impact leg sports.[10]

The etiology of chondromalacia patella is poorly

understood although it is believed that the causes of chondromalacia are injury, generalized constitutional disturbance and patella femoral contact, or as a result of trauma to the chondrocytes in the articular cartilage.[11]

Open kinetic chain exercises and Closed kinetic chain exercises are one of the methods to reduce musculoskeletal pain. This abnormality may cause increased pressure between the baseof the patella and the trochlear irritating soft tissues. In exercise and rehabilitation divided exercise into closed chain and open chain. Chain are links of the body parts. Such foot, ankle, knee and hip during walking. In open chains, the end is free. Such as seated leg extension. Closed chain tends to involve more muscles and joints then open chain leads to better coordination around each structure. Which improve overall stability.[31,32]

Open kinetic chain exercises are the exercises done to improve the strength. The general rule in open kinetic chain exercises is that the end of the limb moves freely in space. The common exercise for strengthening used in open kinetic chain exercise are Straight leg raise (SLR), shortarc quadriceps and sitting knee extensions.[33]

Closed kinetic chain exercises are physical exercises, the end of the limb is in contact with a surface or base and the adjacent points accompany the movement. The common exercise used in closed chain kinetic exercises are Squat exercises, leg press and step exercises. It has provided that the closed chain kinetic exercises may provide more sensory feedback that might be used to control movement.[34]

Many authors have advocated closed chain exercises as a recent category of exercises in rehabilitation of patellofemoral pain, because it can induce maximal vastus medialis obliquus firing especially from 0 to 60 degrees of knee flexion. Also these exercises safer than open chain exercises and place minimal stress on patellofemoral joint. while others reported that open chain exercises at low flexion angles (from 0 to 20 degrees of flexion) are recommended because these exercises are particularly effective and the quadriceps effort is the highest in this range. Open chain exercises are better tolerated and do not place supraphysiological stresses on the patellofemoral cartilage when the patients are unstable on their feet.[35] The aim of the current study is to compare between closed kinetic chain exercises and open kinetic chain exercises in management of chondromalacia patellae.

METHODOLOGY

Subjects are selected for the study if they fulfill the following criteria Age of patient: 20 to 35 years, Patient having pain during climbing up and stairs, Patient having any pain after long time sitting with knee flexion, Patient having any problem for knee extension after a long time sitting with knee flexion, Patient having a giving way sign during walking, Clinically diagnosed with positive Clark test, exclusion criteria Subjects with previous history of knee injuries , Subjects with previous history of subluxation or dislocations, Subjects with referral pain from spinal cords and nerve roots, Subjects with neuromuscular or musculoskeletal disorders, Subjects with Ligament ruptures, Subjects with other leg fractures, Subjects with Meniscal ruptures, Subjects with Patellofemoral joint dysfunction. Informed consent form was taken from every subject.

PROCEDURE

The design of the study is a randomized control study with a total number of 30 diagnosed subjects of chondromalacia patellae were selected for the study. 15 subjects were selected in each group (Group A and Group B). Group A subjects were treated with open kinetic chain exercises and Group B subjects were treated with closed kinematic chain exercises. The duration of each individual treatment session was about 5 days in a week for 6 weeks.

All the assessments were performed before the first sessions and at the termination of total treatment after obtaining informed consent from the patient and ethical committee approval. Measurement of subjective pain using a visual analogue scale (VAS) and active knee extension with the help of a goniometer were done before the first session and after each session. The anchor points of the VAS, of which all patients were informed were 0 (no pain whatsoever) and 10 (worst pain imaginable).

GROUP A- Patients who were treated with open kinetic chain exercises In the open kinetic chain exercise protocol, each exercise was held isometrically for a count of 6 seconds with a 3-second rest between repetitions. The open kinetic chain exercise program consisted of: Maximal static quadriceps muscle contractions (quadriceps muscle setting) with the knee in full extension., Straight-leg raises with the patient supine, Short arc movements from 10° of knee flexion to terminal extension, Leg adduction exercises in the lateral decubitus position.

Open chain exercises were given in the form of active strengthening exercises with minimum resistance of 10 repetitions with 3 sets, from 90º to 0º sitting on chair, 6 seconds rest between each repetition, and 1-minute rest between the sets. The resistance is progressed according to repetitions for the quadriceps muscles, and stretching hamstrings exercise with three repetitions, 30 seconds in position of stretching, 30 seconds in position of relaxation, and postural instruction (avoid flexion more than 90º). The program continued for 6 weeks, 5 sessions per week, performed and supervised.

STRAIGHT LEG RAISE IN SUPINE

SHORT ARC MOVEMENTSGROUP

GROUP B- Patients who were treated with closed kinetic chain exercises: In the closed kinetic chain protocol was performed dynamically with a 3-second rest between repetitions. The closed kinetic chain exercise program consisted of: Stationary bicycling, Semi squat exercises (twice daily with 10 repetitions each), Seated leg presses (10 repetitions), Step-up and step-down exercises (10 repetitions), Progressive jumping exercises.

Closed chain exercises were given in the form of Stationary bicycling without stressing the knee for 10 minutes at minimum resistance, adjust the seat high enough, range between 0º-90ºwith stretching hamstrings exercise with 5 repetitions, 30 seconds in position of stretching, 30 seconds in position of relaxation with postural instructions (avoid flexion more than 90º). The program continued for 6 weeks, 5 sessions per week, performed and supervised by the same physical therapist.

In both training protocols the patients were instructed to perform the conventional static quadriceps, hamstring, and gastrocnemius muscle stretching exercises after each training session. All subjects were instructed to perform three repetitions of a 30-second static stretch of these muscle groups.

In subjects of GROUP-A and GROUP-B at the end of the treatment program, that is after 6weeks of treatment duration pain is assessed by Visual Analogue scale and Range of Motionis measured by Universal Goniometer.

Data Presentation and Statistical Analysis

Table 1: Comparison between pre and post values for vas in group A.

	MEAN	STANDARD DEVIATION	P-VALUE	T-VALUE
PRE	7.266	1.163	<0.0001	17.833
POST	4.533	1.060		

Table 2: Comparision between pre and post values for vas in group B.

	MEAN	STANDARD DEVIATION	P -VALUE	T-VALUE
PRE	7.33	1.113	<0.0001	16.430
POST	2.4	0.8281		

Table 3: Comparision of post VAS in Group A versus Group B.

	MEAN	STANDARD DEVIATION	P-VALUE	T-VALUE
POST GROUP A	4.533	1.060	<0.0001	6.142
POST GROUP B	2.4	0.8281		

Table 4: Comparision between pre and post values of Goniometer in Group A.

	MEAN	STANDARD DEVIATION	P- VALUE	T-VALUE
PRE	83.0667	3.693	<0.0001	100.96
POST	33.9333	3.411		

Table 5: Comparision between pre and post values of Goniometer in Group B.

	MEAN	STANDARD DEVIATION	P-VALUE	T- VALUE
PRE	82.6	3.481	<0.0001	77.533
POST	27.0667	2.987		

Table 6: Comparision of post values of Goniometer between Group A VERSUS Group B.

	MEAN	STANDARD DEVIATION	P-VALUE	T-VALUE
GROUP A POST	33.933	3.411	<0.0001	5.865
GROUP B POST	27.066	2.987		

DISCUSSION

The purpose of the current study was to compare the effectiveness of open kinetic chain exercises versus closed kinetic chain exercises and its possible effect in reducing pain and improving range of motion.

In this research study 30 patients were taken. In group A (n=15), open chain exercises were performed on patients. In Group B(n=15), closed chain exercises were performed on patients. Both the groups shown significant improvement in for the knee Range of Motion and pain was assessed using visual analogue scale and goniometry. Better improvement was seen in pain and range of motion function in group B who performed closed kinetic chain exercises.

In subjects with chondromalacia patellae there is reduction of pain from pre mean 7.33 to post mean 4.533 in open kinetic chain exercises group and closed kinetic chain exercises group with pre mean 7.4 to post mean 2.4 and improve in range of motion from pre mean 83.0667 to post mean 33.933 in open kinetic chain exercises group and closed kinetic chain exercises group with pre mean 82.6 to post mean 27.0667.

This study indicated that six weeks of closed kinetic chain exercises were effective in the management of Chondromalacia patellae. These results support the use of closed kinetic chain exercises (Group B) for decreasing pain and improving function in patients with chondromalacia patellae. From the results above, we found that, there is a significant difference between pre and post measures of pain in the second group, because of there is increasing the power of the quadriceps muscles and stretching of hamstrings muscles leading to breaking down the circle of pain which is decreasing spasm of the muscles, increasing the muscle strength. This power of the quadriceps muscles also improves cd Range of Motion (up and down stairs). And also, there is a significant difference between pre and post measures of pain, Range of Motion (up and down stairs) in the first group, for the same reasons above but less than of the second group. The improvement of Range of Motion of knee extension occurs consequently to pain reduction which is responsible for improvement in muscle function. In the current study the pain intensity was determined by Visual Analogue Scale which is valid, reliable, and commonly used assessment tool of pain and universal goniometer to detect range of motion of knee extension from 90º -0º.

The results of this study come in agreement with many previous findings where they concluded that, the closed and open chain exercises are beneficial in strengthening of the quadriceps muscles, but the closed kinetic chain exercises are more effective than the open kinetic chain exercises.[36,37]

Doucette and Child et al reported that the Closed Kinetic Chain exercises may increase functional ability and activity of Vastus medialis muscles compared to the Vastus Lateralis muscle. This increased Vastus medialis muscle activity may correct the patellar alignment towards medial and reduce Q angle and showed that the Closed Kinetic Chain (semi-squat exercises) are more effective than the Open Kinetic Chain (SLR exercise).[38,39]

Post (2005) et al showed Closed Kinetic Chain exercise may cause better functional activity and less crepitation compared to the Open Kinetic Chain exercises. They also showed higher muscle strength improvement by Closed Kinetic Chain exercise that was confirmed by our results too. It seems from these findings, that Closed Kinetic Chain exercises may produce better patellofemoral joint performance during knee flexion and extension.[40]

In comparison of the pretreatment measures of pain, Range of Motion for both groups, there is no significant difference. But in comparison of the post treatment measures of pain, Range of Motion for both groups, there is highly significant results of the second group than the first group because of strengthening of quadriceps muscles by closed chain exercise is more effective than open chain exercises. This is explained by, there is no load on the patellofemoral joint due to concentric contraction of quadriceps and eccentric contraction of hamstrings muscles at the same time during extension, and eccentric contraction of quadriceps and concentric contraction of hamstrings muscles during flexion, leading to balance between anterior and posterior power of the muscles of the knee joint with decreasing the load on the patella. So, the joint reaction force and degeneration decreasing, and also the inflammation process and pain subsiding. Stretching of hamstrings muscles is increasing the Range of Motion of end extension of the knee which giving more power and stability of the joint during up and down stairs. All of these results was done from closed chain exercises between range of motion of 0º to 90º only, not more than 90º because the stability of the patella decrease after 90º, and also joint reaction force and degeneration is increasing.[41]

In the first group, balance between the power of anterior and posterior muscles of the knee joint increased, and the load on the patella decreased, but less than the second group. The improvement of pain was due to decreasing the hypertonicity and hyperactivity of the hamstrings muscles, and strengthening of the weak quadriceps

muscles.

The results of this study showed the effect of closed kinetic chain exercises. We found that theimprovement in the second group was more significant more than in the first group for pain, Range of Motion of knee end extension. From all of the above, we found that the closed kinetic chain exercises program and stretching of tight hamstrings muscles, are more effective for chondromalacia patellae patients than open kinetic chain exercises.

CONCLUSION

The present study concludes that the 6 weeks of closed kinetic chain exercises (Group B) found statistically more significant effect on reduction of pain and increasing range of motion than open kinetic chain exercises (Group A) in subjects with chondromalacia patellae. Therefore, closed kinetic chain exercises may be used for better treatment outcome than open kinetic chain exercises in reducing pain and increasing range of motion in subjects with chondromalacia patellae.

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