The Role of Proximal muscles strength in treatment of Anterior Knee Pain

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ABSTRACT

Background and Purpose: *Anterior knee pain (AKP) is a common complaint for many patients with a large variety of possible causes. The purpose of this study was to investigate the role of hip, pelvis, and trunk strengthening exercises in the treatment of patients with anterior Knee Pain.* ***Subjects:*** *Thirty male subjects diagnosed as AKP were participated in the study. Their mean age, height and weight were 32.33 ± 4.90 years, 172.13 ± 3.61cm, and 74.90 ± 6.83Kg, respectively.* ***Methods:*** *Patients were randomly assigned into two equal groups. Group A (Control group) treated with traditional physical therapy and group-B (Experimental group) treated with the same traditional physical therapy in addition to strengthening exercises for the proximal stabilizing muscles (hip, pelvis, and trunk). All subjects received 3 sessions per week for 4 weeks. Pain intensity (VAS), 10 - Meter walk test (TMW), and the Timed Up and Go test (TUG), have been used to measure the functional performance outcomes before and after the treatment program.* ***Results:*** *The post treatment results showed significant improvements for all measured variables in both groups, but the improvements in group B were greater compared with the improvements in group-A.* ***Conclusion:*** *It can be concluded that strengthening of hip, pelvis, and trunk musculature should be considered in the rehabilitation of patients with anterior knee pain.*
Key words: *anterior knee pain, exercises, outcome measures, Timed Up and Go.*

INTRODUCTION

Anterior knee pain (AKP) is a common symptom with a large variety of possible causes including pathologies related to the patellofemoral joint[12]. AKP accounts for approximately one third of musculoskeletal problems and can be a source of significant disability, restricting the ability to work or perform activities of daily living[6].

The term anterior knee pain is suggested to include all pain-related problems of the anterior part of the knee[28]. The most common symptoms in Anterior knee pain patients are crepitus and pain during and after physical activity, during body weight loading in walking up/down stairs and squatting, and in sitting with the knees flexed[23]. Common diagnosis associated with AKP can include patellofemoral pain syndrome, which characterized by pain in the vicinity of the patella and considered one of the most common reason for referral to physiotherapy[8].

The role of the lower extremity in the development of patellofemoral pain has recently received increased attention in the literature[26,7]. Current literature suggested that, in the absence of direct trauma, the etiology of patellofemoral joint pain is multifactorial. Factors related directly to the patellofemoral joint, including decreases hamstring, quadriceps or iliotibial band flexibility, vastus medialis obliquis insufficiency and femoral antiversion[30,32]. Factors distal to the knee have also been frequently suggested to contribute to patellofemoral malalignment and pain excessive pronation of the subtalar joint during functional activity is thought to lead to patellofemoral disorders[11].

Proximal factors including hip, pelvis, and trunk muscle weakness have been hypothesized to influence lower-limb malalignment and contribute to patellofemoral pain[25]. Ireland et al[19], in a recent article, and Mascal et al[22], in a case report, explained how proximal hip weakness may be related to patellofemoral pain. However, in the absence of objective evidence, this relationship has been reported based on observation and professional experiences[31]. It has been found that, in the absence of sufficient proximal muscle strength, the femur may adduct or internally rotate, which further increasing lateral patellar contact pressure. Repetitive activities with this misalignment may eventually lead to the retropatellar articular cartilage damage[21]. It was suggested that abnormal motion of the tibia and femur in the transverse and frontal planes due to hip and trunk muscles weakness, have an effects on patellofemoral joint mechanics and, therefore, patellofemoral pain[26].

The purpose of this study was to investigate the role of proximal stabilizing muscle strength (hip, pelvis, and trunk) in the treatment of AKP.

MATERIAL AND METHODS

Subjects

Thirty male patients aged 40 years or younger diagnosed as AKP were participated in this study.

Their mean age, height and weight were 32.33±4.90 years, 172.13±3.61cm, and 74.90±6.83Kg, respectively. Subjects were recruited from out-patient clinics, at King Saud University Hospitals, Saudi Arabia, after confirmed diagnosis by orthopedic surgeon.

Inclusion criteria

1) Anterior or retro patellar knee pain for 3 months duration, 2) Reproducible pain associated with activities including a) ascending or descending stairs, b) prolonged sitting, c) squatting or kneeling, 3) Objective signs were also including pain with a) compression of the patella into femoral condyles b) palpation of the posterior surface of the patella c) isometric quadriceps contraction.

Exclusion criteria

1) Pervious history of knee surgery, 2) History of traumatic patellar dislocation, 3) Meninscal lesion, or 4) concurrent ligament instability.

All subjects were fully understood as to the nature of the study, and signed informed consent.

Experimental design

This study was prospective, randomized clinical trial with a 4-week follow-up.

After physical examination subjects were randomly assigned into two equal groups: group A (Control group) received traditional physical therapy. Group B (Experimental group) received the same traditional physical therapy in addition to strengthening exercise for the proximal stabilizing muscles including; the hip, pelvis and trunk muscles. All subjects received 3 sessions per week for 4 weeks.

PROCEDURES

Prior to assignment to group, all subjects were assessed for pain intensity using visual analog scale (VAS) and functional outcome measurements that include 10-meter walk test (TMW) and Timed Up and Go test (TUG). All assessments were done at the beginning of the

treatment and after the completion of 4-weeks of treatment program.

Assessments procedures

Pain intensity: Pain during rest and various activities were recorded on a 10 –cm VAS, where 0 indicated no pain and 10 indicated extremely intense pain. VAS was selected on the basis of its reliability and validity, its use in previous trials, and its relevance to patellofemoral pain[10]. The subject completed the scale by marking on the VAS at a point where he believed it represents the amount of pain he feels.

10- Meter walk test (TMW). A 10- meter walk time was assessed using digital stop watch, where the subject was instructed to walk at his normal comfortable speed. Timing began when the subject's leading foot crossed the start time and ended when the leading foot crossed the finish line. After one practice trial, the average time of 2 walking trials were used for subsequent analysis.

Timed Up and Go test (TUG). The subject was seated on standard height chair with his back against the chair back and hands on the chair arms on the word "go" the subject stood up, walk at a comfortable pace to a line 3 meters away, turned around, returned to the chair, and sat. A stop watch was used to calculate the time in seconds from the word "go" until sit down again. The subject performed one practice trial, the average time of 2 walking trials were used for subsequent analysis.

Treatment procedures

Group A:

Were treated by traditional physical therapy which includes:

- Cryotherapy for 20 minutes.
- Patellar mobilization to restore gliding of the patella.
- Flexibility exercises for tight muscles whic h may include ilio- tibial band, hamstrings, calf and / or quadriceps muscles. Each stretching was holed for 15 seconds and repeats 10 times.
- Strengthening exercises for knee extensors, knee flexors and calf muscles.

Quadriceps strengthening

The strengthening program consists of graded quadriceps exercises beginning with isometric quadriceps setting exercises, straight leg raises and terminal-arc extensions. In quadriceps setting, the subject lies supine on a firm surface with the affected knee fully extended and the foot dorsiflexed. The subject then tightens (contract) the thigh muscles which results in strong contraction of the quadriceps muscles and elevation of the patella. The contraction is held for 5 seconds, followed by muscle relaxation.

Straight-leg raises was done while the subject lying supine with his affected leg in fully extended, the subject raise his extended leg upward. The extended leg is held in this raised position for 5 seconds and then slowly lowered downward.

Terminal arc-extension was done while the subject lying supine with the knee held in about 20 degrees of knee flexion, from which the subject fully extend his knee. The subject holds his knee for 5 seconds in full extension and brings the leg back to its resting position[2].

Hamstring strengthening

Were done while the subject lying prone on a hard bad, he was asked to flex his legs straight until touching his buttocks by his foot.

Calf strengthening

Were done while the subject in long sitting with the leg resting on a rolled towel to slightly elevates the heel off the treatment

table. The subject holds onto the ends of elasticized material that is looped under the forefoot. Have the patient planterflex the foot against the resistance.

Progression was achieved by increasing the number of repetitions against low-load resistance.

Group B:

Were treated by the same traditional physical therapy in addition to strengthening exercises for the proximal stabilizing muscles which include

Hip abductor and adductors muscles

Strengthening of hip abductors muscles were done, while the subject on side lying position with the lower limb flexed, the subject raises the upper leg (affected) upward. Strengthening for the hip adductors were done with the subject in side lying with the bottom leg aligned in the plane of the trunk and while the upper leg supported in abduction position. The patient lifts the bottom leg upward in adduction to touch the upper leg. Weights can be added to the ankle to progress strengthening.

Hip external rotators

Were strengthening while the subject sitting with knees flexed over the edge of the treatment table, secure elastic material around the patient's ankle and the table leg on the same side. Have the patient move the foot toward the opposite side, pulling against the resistance, causing external rotation of the hip.

Abdominal muscles

Were strengthening by lying supine doing sit-ups exercises.

Gluteus maximums and erectors spinae

Muscles were all strengthening by lying prone on a hard training bed , gluteus maximus by lifting one leg a time with the knee in flexion, and erector spinae by stabilize the leg while the subject lifting the upper body.

Quadratus lumborum

Have the patient prop up on his elbow and then lift the pelvis off the matt, supporting the lower body with the lateral side of the knee on the downward side. The position can be maintained for an isometric hold or performed intermittently for a dynamic contraction. Progression was done by having the patient support the upper body with the hand (with the elbow extended) and lateral aspect of the foot of the downward side.

Data Analysis

All dependent variables (VAS, TMW, and TUG) are presented as mean and standard deviations. The effects of treatment were evaluated separately in both groups before and after treatment using student t-test. The percentage of changes between pre and post treatment were calculated to compare the effect of treatment in both groups. The level of significance was set at 0.05 for all tests.

RESULTS

Thirty male subjects with AKP were randomized into two equal groups; group A (control group) performed traditional physical therapy and group B (experimental group) performed the same traditional physical therapy in addition to strengthening exercises for the proximal stabilizing muscles. The Subjects' characteristics in both groups were approximately similar with regards to their age, height and weight as shown in table (1).

Table (1): Characteristics of the Subjects

	Group-A. Mean ± SD	Group-B. Mean ± SD	significant
Age (year)	33.40 ± 4.43	31.26 ± 5.25	N.S
Height (cm)	171.40 ± 5.57	172.86 ± 5.74	N.S
Weight (Kg)	74.60 ±7.98	75.20 ± 5.72	N.S

N.S: non-significant

The collected data were statistically analyzed for both groups pre and post treatment programs. At initial assessment, the pre treatments mean values for VAS, TMW, and TUG between both groups showed non significant differences which demonstrate proper subjects matching.

1) The pain intensity

Group A:

Statistical analysis of pain intensity revealed significant reduction when comparing the pre and post treatment mean values. The mean value pre treatment was 6.73±1.12, while the mean value post treatment was 3.14±0.91 (P<0.05), as shown in table 2.

Group B:

Statistical analysis of pain intensity revealed significant reduction, where the mean value pre treatment was 6.92±1.08, and the mean value post treatment was 2.07±0.78 (P<0.05), as shown in table 2.

Comparing the post treatment mean value of pain intensity for group A and group B revealed significant difference between the mean value of group B compared with the mean value of group A, as shown in figure 1.

Table (2): The mean and standard deviations values for pain intensity pre and post treatment in both groups.

	Group-A. Mean ±SD	Group-B. Mean ±SD
Pre-test	6.73 ±1.12	6.92±1.08
Post-test	3.14 ±0.91	2.07 ±0.78
Mean difference	3.59±0.21	4.85±0.3
% change	53.34%	70.08%
P.Value	p< 0.05	p< 0.05

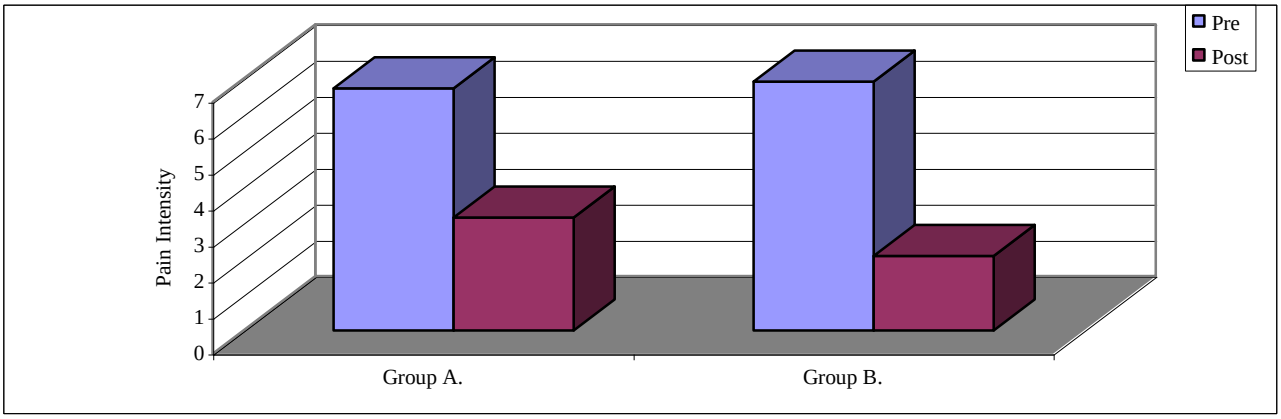

Fig. (1): Comparison of pain intensity values (mean ± standard deviation) pre and post treatment in both groups.

2) 10- Meter Walk test (TMW)

Group A:

Statistical analysis of TMW revealed significant improvement when comparing the pre and post treatment mean values. The mean value pre treatment was 1.18±0.72 m/sec, while the mean value post treatment was 1.76 ± 0.65 (P<0.05), as shown in table 3.

Group B:

Statistical analysis of TMW revealed highly significant improvement, where the mean value pre treatment was 1.09 ± 0.88 m/sec, and the mean value post treatment was 1.84±0.91 (P<0.05), as shown in table 3.

Comparing the post treatment mean value of pain intensity for group A and group B revealed significant difference between the mean value of group B compared with the mean value of group A, as shown in figure 2.

Table (3): The mean and standard deviations values for 10-Meter. Walk test (m/sec) pre and post treatment in both groups.

	Group A. Mean ±SD	Group B. Mean ±SD
Pre-test	1.18 ± 0.72	1.09 ± 0.88
Post-test	1.76 ± 0.65	1.84 ± 0.91
Mean difference	0.58 ± 0.07	0.75 ± 0.03
% change	49.15%	68.80%
P.Value	p< 0.05	p< 0.05

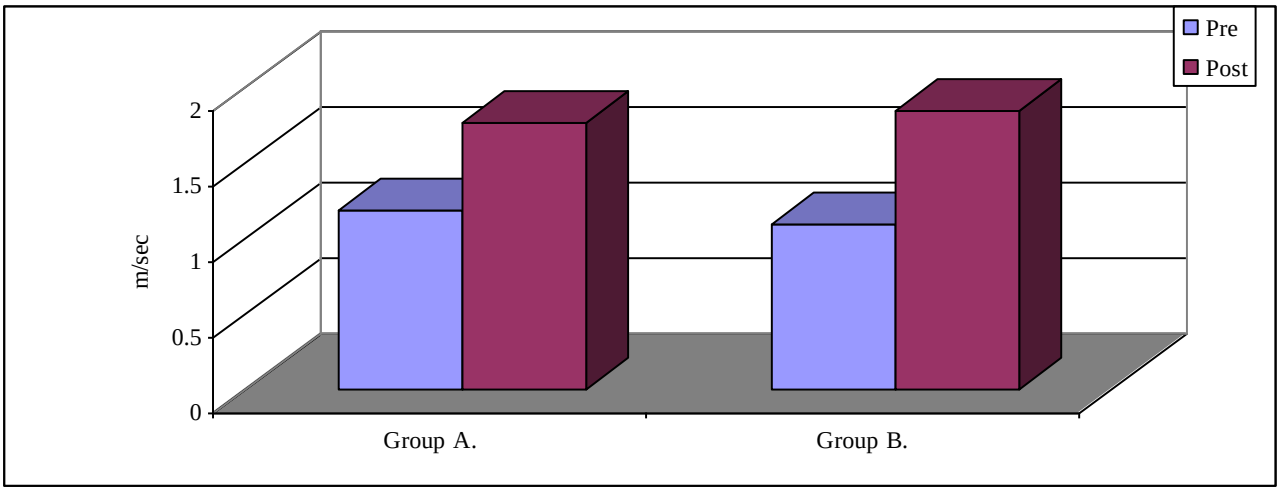

Fig. (2): Comparison of 10- Meter Walk test (m/sec) values (mean ± standard deviation) pre and post treatment in both groups.

3) Timed up and Go test (TUG)

Group A:

Statistical analysis of TUG revealed significant improvement when comparing the pre and post treatment mean values. The mean value pre treatment was 21.12±8.01sec, while the mean value post treatment was 10.67±6.12 sec (P<0.05), as shown in table 4.

Group B:

Statistical analysis of TUG revealed significant improvement, where the mean

value pre treatment was 20.95±7.09 sec, and the mean value post treatment was 9.02±5.10 sec (P<0.05), as shown in table 4.

Comparing the post treatment mean value of TUG for group A and group B revealed significant difference between the mean value of group B compared with the mean value of group A, as shown in figure 3.

Table (4): The mean and standard deviations values for timed up and go test (sec) pre and post treatment in both groups.

	Group A. Mean ±SD	Group B. Mean ±SD
Pre-test	21.12 ± 8.01	20.95 ± 7.09
Post-test	10.67 ± 6.12	9.02 ± 5.10
Mean difference	10.45 ± 1.89	11.93 ± 1.99
% change	47.24%	56.94%
P.Value	p< 0.05	p< 0.05

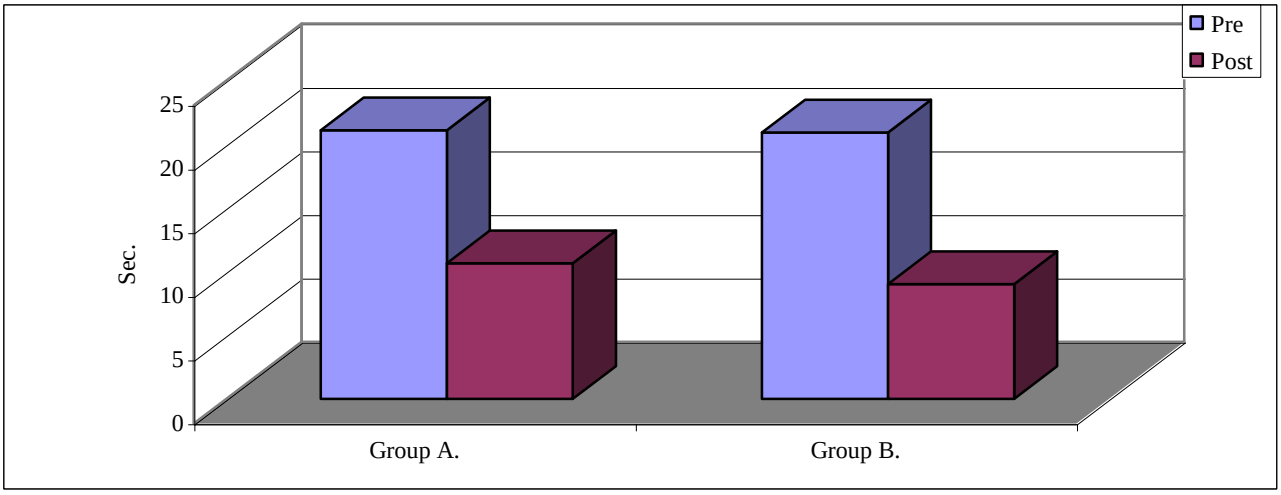

Fig. (3): Comparison of Timed Up and Go test (sec) values (mean ± standard deviation) pre and post treatment in both groups.

In summary, the results of this study revealed statistically significant improvements in pain intensity and functional outcome (TMW and TUG), but the improvements in group-B treated with traditional physical therapy in addition to strengthening exercise for the proximal stabilizing muscles compared with group-A treated with traditional physical therapy.

DISCUSSION

The purpose of this study was to investigate the role of hip, pelvis and trunk (proximal) muscles strengthening program in the rehabilitation of patients with anterior knee pain. Results showed significant results following strengthening programs to the proximal muscles in such patients.

Diminished hip strength has been implicated as being contributory to lower extremity malalignment and patellofemoral pain[19]. Repetitive movements with this alignment may cause injury to the retinaculum retropatellar articular cartilage or subchondral bone[15]. The results of this study supported the findings of the previous clinical evidence suggested that proximal stabilization programs may be beneficial for the treatment of patellofemoral pain[14,17]. It was concluded that strengthening of the gluteus medius results in increasing the control of thigh adduction and internal rotation tendencies during running, thereby, minimizing the valgus vector at the knee[14,19].

Studies investigate the relationship between lower extremity frontal or transverse plane stability and prevention of knee injuries are rare. Hewlt et al[16], suggested the value of hip strengthening program for non-symptomatic athletes in the prevention of PFP. It was concluded that, factors proximal to the knee have been frequently contributed to patellofemoral pain malalignment and pain[15]. Hip muscle weakness has been proposed to contribute to patellofemoral malalignment and the development of PFP. In the absence of sufficient proximal strength, the femur may adduct or internally rotate, further increasing lateral patellar contact pressure[24].

The correlation between adductor hip strength and increase quadriceps force comes from the fact that VMO originates on the adductors magnus tendon, which is the anatomical basis for recommending adductor strengthening[5]. Abductor strengthening helps to stabilize the pelvis dysfunction of the hip external rotation results in compensatory foot pronation which result in lateral patellar compression syndrome[20]. It has been proposed that lower-extremity torsional malalignment is a major cause of anterior knee pain. Persistent antiversion of the femoral neck with greater medial rotation than lateral rotation may result in abnormal mechanics of the patellofemoral joint[7].

In daily weight-bearing activities involves multiple muscle groups acting in synergy, motion at the knee joint is accompanied by motion at the hip and ankle joints. It is concluded that, quadriceps muscle strength correlates with gluteus maximus muscle and triceps surae muscle strength[1,9].

The results of this study are in agreement with other studies, which demonstrate a relationship between lower extremity muscle strength and functional ability[3,18,27]. It has been concluded that increase in muscle strength activity are associated with a higher level of functional ability[4,28].

Furthermore, increased strength improves functional performance and independence in older adults[29].

Conclusion

It can be concluded that hip, pelvis and trunk strengthening exercise programs should be considered in the rehabilitation of patients with anterior knee pain.

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الملخص العربي

دور برنامج تقوية العضلات القريبة في علاج ألم الركبة الأمامي

تهدف الدراسة الحالية إلى تقييم دور تمرينات التقوية لعضلات الفخذ، الحوض والجزع في علاج مرضى ألم الركبة الأمامي. أشترك في الدراسة ثلاثون مريضا متوسط أعمارهم 32.33 ± 4.9 عاما، قسموا عشوائيا إلى مجموعتين: المجموعة الضابطة والتي عولجت بالعلاج الطبيعي التقليدي و المجموعة التجريبية والتي عولجت بنفس العلاج الطبيعي التقليدي بالإضافة إلى تمرينات تقوية العضلات المثبتة القريبة. تلقى المرضى ثلاث جلسات أسبوعية لمدة أربع أسابيع. تم قياس شدة الألم، واختبار المشي لعشرة أمتار واختبار وقت الوقوف والمشي قبل وبعد انتهاء البرنامج العلاجي. أظهرت النتائج تحسن ذو دلالة إحصائية في كلتا المجموعتين ولكن التحسن كان كبيرا في المجموعة العلاجية والتي عولجت بالعلاج الطبيعي التقليدي بالإضافة إلى تمرينات تقوية العضلات المثبتة القريبة مقارنة بالمجموعة الضابطة والتي عولجت بالعلاج الطبيعي التقليدي.أوصت النتائج بضرورة استخدام تمرينات تقوية العضلات المثبتة القريبة في علاج مرضى ألم الركبة الأمامي.