International Journal of Endorsing
HEALTH SCIENCE RESEARCH

IJEHSR

Original Article

Isometric & short arc exercises effect on the quadriceps muscle of patellofemoral knee pain patients.

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Doi: 10.29052/IJEHSR.v10.i2.2022.220-226
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Received 21/01/2022
Accepted 11/04/2022
First Published 30/05/2022

OPEN ACCESS

Abstract

Background: Background: Anterior knee pain is the most common problem encountered by clinicians with an estimated prevalence of 15-45% around the globe. Thereby, this study aimed to determine the effects of isometrics and short arc quadriceps exercises on patients with patellofemoral knee pain.

Methodology: The quasi-experimental study was conducted in Ameen Medical and Dental Centre, Karachi on a total of 80 anterior knee pain patients, including both genders and ages ranging from 16-40 years. The individuals were divided into two equal groups A and B (n=40) which followed isometric and short arc quadriceps exercises regimen, respectively. The pre and post-assessment of pain, muscle activity, muscle thickness measurement, and health-related quality of life (HRQoL) was done using Kujala assessment score, visual analog scale, Electromyography (EMG) biofeedback, and rehabilitative ultrasound imaging, respectively on the first day, 6th and 8th week of exercises session.

Results: The results showed that pain was much decreased from 1st to 8th week after following Short arc quadriceps exercises ($p<0.0001$). The results also showed the higher muscle efficacy and HRQoL after following short arc quadriceps exercises, whereas Rehabilitative Ultrasound showed the higher effectiveness of Isometric quadricep exercises in increasing the muscle mass.

Conclusion: It is concluded that the short arc quadriceps exercises have greater effectiveness in reducing pain, enhancing muscle activity, and increasing the HRQoL, whereas isometric quadricep exercises have shown beneficial effects in increasing muscle mass.

Keywords

Anterior Knee Pain, EMG Biofeedback, Visual Analog Scale, Rehabilitative Ultrasound, Kujala Assessment Questionnaire.

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Introduction

The prevalence of anterior knee pain among adult attending the Out Patient Department (OPD) concluded that anterior knee pain affects both physically active and sedentary individual with a prevalence of around 11-17%, respectively[1]. It has also been evident from the literature that the prognosis of the knee pain not always have a favorable outcome and almost 50% of adolescent and young adult continue to complain for knee pain after a year or so, which subsequently affects their quality of life and academic performance[2].

Moreover, one previous study revealed that the incidence of anterior knee pain is four times more common in females as compared to males[3] and the persistent knee pain in future might leads to the development of degeneration of Patellofemoral joint and increased Q-angle[4]. Studies have also provided significant evidences that anterior knee pain is a common musculoskeletal problem and is one of the reasons for people to seek primary health care services. Around 12–13% of total population suffered with anterior knee pain[5]. About half of the adult population complained about knee pain and incurred substantial cost in health system with an estimation of one out of every six individuals have a medical appointment annually out of which one-third might develop disability[6].

Anterior knee pain denotes only a symptom whereas its etiology includes chondromalacia of the patella, patellar tendinitis, lateral compression syndrome, quadriceps tendinitis and patella mal tracking[7]. It is characterized by pain in front of the knee, associated with activities such as sitting, ascending and descending stairs, squatting and other similar activities[8]. Conservative medical treatment remains the first line of choice with physical therapy interventions and exercises turn out to be vital to maximize the chance of good prognosis[9].

According to the research conducted by US Navy, the Patellofemoral /anterior knee pain is a common problem in adolescent and in adults. The prevalence of this disorder among young adults varies from 7% to 15% and it also constitutes 5% of all injuries and 25% of knee injuries. It is more common in females than males[10]. Hence, it is relevant to conduct a study to identify the best exercise regime for the treatment of anterior knee Pain which turn out to be both time and cost effective for the management and better prognosis of the problem. Thereby, the aim of this study was to determine the effects of isometrics and short arc exercises on quadriceps muscle of individuals with patellofemoral knee pain.

Methodology

The Quasi-experimental study was conducted among patients with patellofemoral knee pain, enrolled from the Physiotherapy department of Ameen Medical and Dental Centre, Karachi during august 2019 to January 2020. The Consecutive sampling technique was used to collect the data with a sample size of 80 individuals on the basis of availability of patients. The inclusion criteria for the study includes both male and female patients, who have been diagnosed with anterior knee pain with the age ranging from 16-40 years. The sample was divided into two groups, namely Group A-Isometric quadriceps exercises including 5 males and 35 females; and Group B-Short arc quadriceps exercises including 2 males and 38 females, where majority of females were documented in both the groups (group A: n=40, group B: n=40).

A written informed consent was taken prior to the study. This study was approved by ethical review committee of KIPRS with the reference number KIPRS/R&D/ERC/2020-02. The pre and post assessment of pain, muscle activity and muscle thickness measurement and health related quality of life of the participants was the objectives of this study. Patients were assessed on the first day of exercises session as well as after the completion of the sixth week of the training protocol and the last follow up session was on the eighth week which was done by using Kujala assessment score, visual analog scale, Electromyography (EMG) biofeedback and rehabilitative ultrasound imaging, respectively. The data obtained was compared to determine the effectiveness of the isometrics and

short arc exercise sessions on patients with anterior knee pain.

Each group was given interventions for one week including traditional physical therapy (Hot packs, Cold packs, Electrotherapy) and training of selected exercise regime under the supervision of qualified physical therapist followed by 7 weeks of home exercise program with a weekly visit to Physiotherapy department for assessment, to ensure that recommended exercises is not increasing pain or worsening the condition.

The Kujala scale proposed the scoring scale for assessment of Patellofemoral pain / anterior knee pain and focused on support, walking, running, jumping, stair climbing and provides score from least 0 to highest 10. Where 0 referred to as more severe and 10 to least severe. Reflecting health related quality of life (HRQoL) in patients with anterior knee pain, the Visual Analog Scale (VAS) was used for the measurement of pain before the start of the session and after the completion of 6th weeks and during the follow-up session on the 8th weeks to determine the effects of exercises on the level of pain of patients[11]. Electromyography feedback was also done to determine the activity of hamstring muscle during the exercises session and the visual stimulus was obtained. During assessment EMG Biofeedback was used to identify the level of activity performed by the muscle and the data obtained was used to compare the effectiveness of exercises performed during the study[12].

The participants were positioned in long-sitting with the knee in extension and support provided on the lateral aspect of the knee to stop lateral rotation of the hip. The images taken were investigated by the clinician looking at the distal images first to the proximal ones until the patella comes in view. Scan slices were added in the cephalad direction until the patella was not found in the field of view and this image was selected for the measurements. Two ultrasound (US) images were taken to check for best image in relaxed Vastus medialis muscle, scanned at the proximal border of the patella, using an ultrasound scanner, with an 8 MHz linear transducer, width 60 mm.

Further, to perform the Isometric quadriceps strengthening exercises, the patients were asked to lie in a supine position with a towel placed under the affected knee joint. The patients were then asked to compress the towel by applying downwards pressure on knee joint without elevating foot. Whereas, the Short arc quadriceps exercises were performed by asking the patients to lie in a supine position with a bolster placed under the affected knee joint and the patients were asked to lift their heel keeping knee extended and ankle in dorsi-flexion position while pressing the bolster and maintaining this position for 3 to 5 seconds, and then slowly returning to the starting point.

Group A received isometric quadriceps exercise for 8 weeks (at least 1 session/week under the supervision of physiotherapist) and regular home exercise[13]. Exercise needs to be performed in sets of 10 repetitions with initial dosage: 1st set of exercise performed twice a day for the 1st week. The advance training include 2nd set of exercise with 10 repetitions, twice a day (2-3 week) and the 3rd set with 10 repetitions twice a day until the (4-8 week). Group B received short arc quadriceps exercise for 8 weeks (at least 1 session/week under the supervision of physiotherapist and regular home exercise[14]. With initial dosage: 3 sets of 10 repetition/set for 3 weeks (1-3 weeks) and advance training include 3 sets of 20 repetitions/set for 4 weeks (4-8 weeks).

Results

The assessment includes for the first day i.e. week 1st and post assessment was done at the last week i.e. 8th week. With normal distribution the highest value pre data was 83 whereas the highest value post data was 85 for isometric quadriceps exercises. For short arc exercises the highest value pre data was 84 whereas the highest value post data was 95.

The average mean value for EMG of the participants of Group A (Isometric quadriceps exercises) at baseline was found to be 6.85 ± 0.43

that improved at week 6 to 9.8 ± 0.46, and was further improved till the 8th week as 11.6 ± 0.46. The results also showed that Group B (short arc exercises) was also improved till 8th week, the average mean value of Group B at baseline was found to be 6.2 ± 0.2 that improved at 6th week to 6.8 ± 0.3, and was further improved till the 8th week as 7.0 ± 4.0 (Table 1).

Table 1: EMG Biofeedback mechanism and Rehabilitative Ultrasound Imaging between the groups at 8th week.

Variable	Group A	Group B	Mean Difference	95% CI	p-value
EMG Biofeedback mechanism	11.6±2.9	7.04±4.0	4.625	3.50 to 5.74	0.0001*
Rehabilitative Ultrasound Imaging	4.3±1.36	6.15±5.72	1.83	8.67 to 6.79	0.0001*

*p<0.05 is considered significant.

There was a marked decrease in pain level after following short arc exercises regimen as compared to isometric quadriceps exercises showing the effectiveness of short arc quadriceps exercises, isolating that the p-value was 0.0001 for both the exercises (Table 2).

Table 2: The effects of Short Arc Quadriceps Exercises and Isometric Quadriceps exercises on Knee Pain (Visual analog scale).

Knee Pain	Group A	Group B	Mean Difference	95% CI	p value
8th week	2.0±2.82	4.0±5.65	2.0	2 to 3	0.0001*

*p<0.05 is considered significant.

Further, it was also found that muscle activity was enhanced and HRQoL was increased in group B at 8th week after following the short arc quadriceps exercises regimen (88.20 ± 6.64; p=0.0001) as compared to the group A after following Isometric quadriceps exercises regimen (82.07 ± 7.12; p=0.0001) (Table 3).

Table 3: Post data analysis of Isometric quadriceps and Short arc quadriceps exercises (Kujala assessment Score).

Kujala assessment Score	Group A	Group B	Mean Difference	95% CI	p value
8th week	82.07±7.12	88.20±6.64	6.12	3.05 to 9.19	0.05*

*p<0.05 is considered significant.

Discussion

The results of the current study revealed that short arc quadriceps exercises have beneficial effects on patients with anterior knee pain as compared to isometric quadriceps exercises. The results of the current study also showed that short arc quadriceps exercises have significant impact on pain, muscle activity and health related quality of life (HRQoL) in comparison to the isometric exercises in reducing Anterior knee pain.

In the current study, it was found that the pain was decreased with time and the most decrease in pain were found at eighth week after following the short arc quadriceps exercise regimen. Similarly, another study was conducted on the effect of exercise therapy on pain, function and recovery in adolescents and adults with Patellofemoral pain syndrome[15] and found that exercise therapy was found effective in decreasing anterior knee pain, functional ability of the muscles and enhanced long

term recovery. However, the type of exercise therapy was found unknown[15]. Another study conducted by Alaca et al., found that isometric quadriceps exercises were not adequate for the maintenance of functional performance[16].

The current study also focused on the assessment of more effective exercise regimen in improving Activities of daily livings (ADLs) and focused on support, walking, running, jumping, and stair climbing and found that short arc quadricep exercises have greater effectiveness in reducing pain and improving HRQoL as compared to isometric quadricep exercises. Likewise, a previous study conducted by Foley et al., showed that statistical significant improvement was brought by the strengthening quadricep exercises and thereby increased the functional gains of the osteoarthritis patients[17]. However, the main difference between the study conducted by Foley et al., and the present study was the shorter duration of the intervention, which consisted of only eight weeks and shorter duration of the exercise regimen sessions.

Additionally, EMG Biofeedback was used as an assessment protocol for the current study to evaluate muscle performance in the anterior knee pain patients for which referenced muscle used was Vastus medialis. It is one of the quadricep muscle of the lower limb and it was found that short arc quadricep exercises were found to be more efficient to produce strength and enhance health related quality of life (HRQoL) with pain relief. Similar results were reported in the study conducted by Briani et al.[18] where it was reported that the Biofeedback mechanism system identifies the efficiency of the muscle especially on Vastus medialis and Vastus lateralis muscles. The only difference in both the studies was that Briani et al. in his study performed exercises in sitting position whereas in the current study exercises were performed in supine lying position. Another study suggested that the main muscles of the lower limb that was effectively involved in the biomechanics of the lower limb are the quadricep[19].

Accordingly, in the current study, it was identified that after applying Rehabilitative Ultrasound imaging, the patients who performed isometric quadricep exercises have better muscle mass of Vastus medialis oblique muscle in first week (4.44 ± 0.162), at 6th week (4.85 ± 0.193) and at 8th week (6.15 ± 0.212) as compare to those with short arc quadricep exercises which was (4.32 ± 0.21) on 8th week. Thus, this exercise regimen produced muscle bulk. Further, it was also found that short arc quadricep exercises produced strength in quadricep muscle group as it reduces the level of knee pain and rectifies the biomechanical alignment of the knee joint i.e. alignment of Q-angle which plays a great role on the alignment of hip and knee joint with stability of the pelvis.

This study compares the two exercise interventions and has led to significant clinical outcomes. However, there is not enough evidence to choose one exercise intervention over another. However, the study had some limitations like the results were independent of time but the duration of the exercise program was shorter (8 weeks). Follow-up periods have confirmed the evidence supporting of intervention, however only one to two follow up sessions were entertained during the exercise regimens in this study. Moreover, physiotherapist assisted exercise therapy was not initiated as individuals were following the exercise regimen at their homes except for the follow up sessions.

In addition, large, high-dose randomized controlled trials are needed to further evaluate the possible effects of different therapeutic modalities for exercise for patellofemoral pain. This study shows evidence that exercise therapy has a strong anti-pain effect and reduces patient-reported measures of activity limitations and participation restrictions (PRMALP) in patients with patellofemoral pain.

Conclusion

The study concluded that the short arc exercises showed greater efficiency on EMG Biofeedback mechanism, and reduction of pain as compared to isometric quadricep exercises. However, isometric quadricep exercises showed greater effectiveness as they produced more muscle bulk in comparison to short arc exercises on quadricep muscle i.e.

(Vastus Medialis Oblique). Further, it was also showed that the short arc quadricep exercises were more effective in improving Activities of daily livings (ADLs) as compared to isometric quadricep exercises. Hence, effectiveness of Short arc quadricep exercises was more than isometric quadricep exercises for pain reduction and efficacy of muscle work, hence increasing the HRQoL; whereas Isometric quadricep exercises were more effective to enhance muscle bulk.

Conflicts of Interest

The authors have declared that no competing interests exist.

Acknowledgement

The authors are thankful to the study participants for their support and cooperation.

Funding

The author(s) received no specific funding for this work.

References

1. Kim TW, Gay N, Khemka A, Garino J. Internet-based exercise therapy using algorithms for conservative treatment of anterior knee pain: a pragmatic randomized controlled trial. JMIR. 2016;3(2):e5148.
2. Saes MO, Soares MC. Knee pain in adolescents: prevalence, risk factors, and functional impairment. Braz J Phys Ther.2017;21(1):7-14.
3. Rathleff MS, Rathleff CR, Crossley KM, Barton CJ. Is hip strength a risk factor for patellofemoral pain? A systematic review and meta-analysis. Br J Sports Med. 2014;48(14):1088.
4. Kim YM, Joo YB. Patellofemoral osteoarthritis. Knee Surg Relat Res. 2012;24(4):193.
5. Roush JR, Bay RC. Prevalence of anterior knee pain in 18–35 year-old females. Int J Sports Phys Ther. 2012;7(4):396.
6. Urquhart DM, Phyomaung PP, Dubowitz J, Fernando S, Wluka AE, Raajmaakers P, Wang Y, Cicuttini FM. Are cognitive and behavioural factors associated with knee pain? A systematic review. Semin Arthritis Rheum. 2015;44(4):445-455.
7. Korkmaz O, Genc Y, Cimen O, Oltulu I, Gülabi D, Cecen G. Effect of patellar resurfacing on clinical outcomes, range of knee motion and anterior knee pain in patients with total knee arthroplasty. Serb J Exp Clin Res. 2019;20(4):309-312.
8. Grelsamer RP, Klein JR. The biomechanics of the patellofemoral joint. J Orthop Sports Phys Ther.1998;28(5):286-298.
9. Sanchis-Alfonso V. Holistic approach to understanding anterior knee pain. Clinical implications. kssta. 2014;22(10):2275-2285.
10. Boling M, Padua D, Marshall S, Guskiewicz K, Pyne S, Beutler A. Gender differences in the incidence and prevalence of patellofemoral pain syndrome. Scand J Med Sci Sports. 2010;20(5):725-730.
11. Watson CJ, Propps M, Ratner J, Zeigler DL, Horton P, Smith SS. Reliability and responsiveness of the lower extremity functional scale and the anterior knee pain scale in patients with anterior knee pain. J Orthop Sports Phys Ther. 2005;35(3):136-146.
12. Angoules AG, Balakatounis KC, Panagiotopoulou KA, Mavrogenis AF, Mitsiokapa EA, Papagelopoulos PJ. Effectiveness of electromyographic biofeedback in the treatment of musculoskeletal pain. Orthopedics. 2011;31(10):e980-4.
13. Alghadir AH, Anwer S, Sarkar B, Paul AK, Anwar D. Effect of 6-week retro or forward walking program on pain, functional disability, quadriceps muscle strength, and performance in individuals with knee osteoarthritis: a randomized controlled trial (retro-walking trial). BMC Musculoskelet. Disord. 2019;20(1):1-10.
14. Hasan S. Quadriceps femoris strength training: effect of neuromuscular electrical stimulation vs isometric exercise in osteoarthritis of knee. Indian J Physiother Occup Ther. 2015;9(3):129.
15. Van der Heijden RA, Lankhorst NE, van Linschoten R, Bierma-Zeinstra SM, van Middelkoop M. Exercise for treating patellofemoral pain syndrome. Cochrane Database Syst Rev. 2015;1:CD010387.
16. Alaca R, Yilmaz B, Goktepe AS, Mohur H, Kalyon TA. Efficacy of isokinetic exercise on functional capacity and pain in patellofemoral pain syndrome. Am J Phys Med Rehabil. 2002;81(11):807-813.
17. Foley A, Halbert J, Hewitt T, Crotty M. Does hydrotherapy improve strength and physical function in patients with osteoarthritis—a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening programme. ARD. 2003;62(12):1162-1167.
18. Briani RV, de Oliveira Silva D, Pazzinatto MF, de Albuquerque CE, Ferrari D, Aragão FA, de Azevedo FM. Comparison of frequency and time domain electromyography parameters in women with patellofemoral pain. Clin Biomech. 2015;30(3):302-307.

19. Landry SC, McKean KA, Hubley-Kozey CL, Stanish WD, Deluzio KJ. Neuromuscular and lower limb biomechanical differences exist between male and female elite adolescent soccer players during an unanticipated side-cut maneuver. Am J Sports Med. 2007;35(11):1888-1900.