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EFFECTIVENESS OF SHORT ARC AND ISOMETRIC QUADRICEPS EXERCISES ON PAIN, MUSCLE ACTIVITY AND HEALTH RELATED QUALITY OF LIFE IN PATIENTS WITH ANTERIOR KNEE PAIN

ABSTRACT

AIMS & OBJECTIVES

The aim of this study is to evaluate and compare the effects of Short-Arc and Isometric Quadriceps exercises on Quadriceps strength and health related quality of life among Anterior Knee pain patients by using EMG biofeedback.

METHODOLOGY

Total 80 participants were recruited and randomly distributed in two groups; A and B. Individuals in group A performed isometric quadriceps exercise while group B participants performed short-arc exercise for 1st, 6th and 8th week along with home exercise program. Pre and post treatment assessment was performed using EMG Biofeedback, VAS, and KUJALA scoring questionnaire. Statistically, data was analyzed using SPSS version 20.

RESULTS

After 8 weeks, EMG Biofeedback revealed the higher effectiveness short-arc exercises with value 88.20mv ± 6.64 comparing isometric quadriceps exercises. Moreover, Wilcoxon rank test revealed statistically significant improvement in VAS score with p-value <0.05. Furthermore, KUJALA score also advocated the effectiveness of short-arc exercises with statistically significant values (p-value < 0.05).

CONCLUSION

The study concluded the effectiveness of Short-arc quadriceps exercises comparing to static-quadriceps exercises in improving muscles strength, pain and health related quality of life after 8 weeks of intervention.

KEYWORDS

Quadriceps Muscles, Vastus Lateralis, Vastus Medialis, Knee Joint, Pain, Health-Related Quality of Life.

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INTRODUCTION

Anterior Knee pain is considered as one of the common problems dealt by the clinicians in the outpatient department with an estimated prevalence of around 15-45%[1]. Moreover, 11-17% of both physically active and sedentary individuals are suffering with anterior knee pain especially among adolescent where almost 50% of individuals continue to complain about knee pain for almost a year, subsequently affecting their quality of life and academic performance[2]. Interestingly, female's gender is four times more prevalent as compared to males ultimately leading to degeneration of joint and an increase in Q-angle[3]. Patellofemoral Pain (PFP) is generally felt in front of the knee, associated with activities such as ascending and descending stairs, squatting and other similar activities[4]. Even though conservative medical treatment is found to be a first line of choice among people, yet physical therapy interventions and exercises turn out to be vital to maximize the chances of recovery[5]. According to research conducted by US NAVY, anterior knee pain is a common problem in adolescent and in adult's .The prevalence of this disorder among young adults varies from 7% to 15% in adults and it also constitutes 5% of all injuries and 25% of knee injuries. It is more common in females than males[6]. Isometric quadriceps exercises has greater impact on decreasing the level of pain, enhance the muscle activity and increase the functional status of knee pain patients[7], whereas the short arc quadriceps exercises enhances the health related quality of life by decreasing the level of Patellofemoral pain, strengthen quadriceps muscle more effectively and efficiently[8].

According to the studies, about half of the adult population complains of knee pain and incurred substantial cost in health care system with an estimation of one out of every six individual have a medical appointment annually, out of which one-third may develop disability[9]. The parameters of assessment includes Visual Analog Scale, Kujala Scoring Questionnaire and EMG Biofeedback[9]. EMG biofeedback machines has a potential benefit for both clinician and the patients during muscle retraining programs, the results obtained from EMG biofeedback during rehabilitation appears promising, though less researches has been done in this regard[9.] Frequency parameters of EMG Biofeedback in Patellofemoral pain presented greater reliability, diagnostic accuracy and a useful tool to diagnose individuals with Patellofemoral pain syndrome[10]. To measure pain intensity, comparable tools are Verbal Rating Scale (VRS) and Numerical Rating Scale (NRS). Reliability was analyzed in subgroups of 250 patients after an hour, statistical analysis present high reliability and validity ($r>0.8$; $p< 0.01$) for all tools, also the mean values of all scales present a higher association. In results it shows, high reliability and concurrent validity for VAS, NRS and VRS[11] .The visual analogue scale is a reliable tool for measuring pain in adults with MSK, Orthopedics and in Geriatric groups. Parameters of reliability were measured using interclass correlation coefficient (ICC) and validity measured using Bland-Altman graphs and correlations[12]. Kujala scoring questionnaire is a reliable assessment tool for Patellofemoral pain syndrome to assess the health related quality of life[13].

METHODOLOGY

STUDY SETTING

The study was conducted in Department of Rehabilitation Sciences Ziauddin Hospital, Clifton Karachi.

TARGET POPULATION

Patient suffering with Anterior Knee Pain.

STUDY DESIGN

Randomized Control Trial.

SAMPLE SELECTION

Simple Random Sampling Technique.

SELECTION OF PATIENTS

Inclusion Criteria

The patient aged between 16-40 years was included with Anterior Knee Pain referred to department of Rehabilitation Sciences.

Exclusion Criteria

Those patients with recent surgery in the hip, knee and back, history of skin infection, positive instability test indicative of ligamentous tear, metal allergy, and positive meniscal tear test were excluded from the study.

Moreover, presence of bilateral Knee pain, recurrent patellar subluxation or dislocation, previous surgery to the knee joint, patient's presents with referred pain to the knee, non-compliance, osteoporosis, and those with the inability to perform the prescribed exercise were also excluded.

DATA COLLECTION PROCEDURE

The participants recruited in the study were divided into two groups A (n=40) and B (n=40). Group A received Isometric Quadriceps exercises whereas Group B received Short arc quadriceps exercises. Each group received interventions for one week under the supervision of expert Physical Therapist including traditional Physical therapy (Hot packs, Cold packs, Electrotherapy). Moreover, exercise regime was followed by 7 weeks of home exercise program and a weekly visit to Physiotherapy department for assessment was mandatory to ensure that recommended exercises is not increasing pain or worsen condition. A total 8 weeks of exercise therapy program and assessments using EMG biofeedback, Kujala Scoring Questionnaire and Visual Analogue Scale (VAS) were performed.

Group-A: Isometric Quadriceps Exercises

Group-A received Isometric Quadriceps exercise for 8weeks (at least 1 session/week under the supervision of Physiotherapist) and regular home based program. The frequency of sets of 10 repetitions; with an initial dosage: 1 set of exercise performed twice a day for the 1st week. For advance training2 set with 10 repetitions per set, twice a day for 2nd and 3rd week followed by 3 set with 10 repetitions per set, twice a day till 4th to 8th week. Patient was advised to lie in supine position where towel is to be placed under the knee joint. A towel is then compressed by applying downwards pressure on knee joint without elevating foot.

Group-B: Short Arc Exercises

Group-B received short arc Quadriceps exercise for 8 weeks for at least 1 session per week under the supervision of Physiotherapist and regular home exercise. The initial dosage was 3 sets with 10 repetitions per set for first three weeks. In the advance training 3 sets with 20 repetitions per set from 3rd to 8thweeks. Patient was in supine lying position where bolster was placed under the knee joint. Patient was asked to lift the heels keeping knee extended and ankle is in dorsiflexion while pressing the pillow. Position was to be maintained for 3 to 5 seconds, and then slowly returned to the starting point.

The pre and the post assessment of pain, muscle activity and health related quality of life of the participants recruited in this study was assessed by using Visual Analog Scale, EMG biofeedback and KUJALA assessment form respectively.

RESULTS

A total of 80 patients included in the study were divided into two groups (n=40). The demographic details including age and gender were recorded where majority of females were included in both the groups (Group A: n=35, Group B: n=38). The mean age of the participants in group A and B was found to be 29.47±6.16 and 31.46±7.47 respectively.

Repeated Measures Analysis of Variance was applied to determine the with-in group analysis at baseline, 6th week and 8th week (Table: 1). Improvement was observed both in group A and B although the mean difference was found to be significant in group where a mean difference.

Table-1 Show the baseline and post exercise mean values of EMG in both group A and B

	SHORT ARC EXERCISES (A)			ISOMETIC QUADS EXERCISES (B)		
	Wk. 0	Wk. 6th	Wk. 8th	Wk. 0	Wk. 6th	Wk. 8th
M± S.D.	6.85 ± 0.43	9.8 ± 0.46	11.6 ± 0.46	6.2 ± 0.2	6.8± 0.3	7.0± 0.3
95% CI	5.97 to 7.73	8.89 to 10.75	10.72 to 12.61	5.68 To 6.85	6.19 to 7.4	6.40 to 7.68

Within the group analysis of the effects of both short arc and isometric quadriceps on EMG of the patients was determined at 95% of Confidence Interval. The normality of the data was identified using Skweness and kurtosis test that confirmed the data is found to be normally distributed. The results revealed that the average mean value of EMG of the participants of Group A (short arc) at Baseline was found to be 6.85± 0.43 that improved at week 6 9.8±0.46 whereas improvement was further continued till the 8th Week 11.6±0.46 (Table-2).

Table-2 Shows the mean difference of EMG in both groups

Groups	N	M±S.D	MD	95% of CI	p value
Group A (Short Arc Exercises)	40	11.6 ± 2.9	4.625	3.50 to 5.74	<0.0001
Group B (Isometric Quadriceps Exercises)	40	7.04 ± 4.0			

The results of Group B (i.e.) Isometric quadriceps exercises also improved till 8th week , However the average mean value of EMG of the participants of Group B at Baseline was found to be 6.2±0.2 that improved at week 6.8±0.3 whereas improvement was further continued till the 8th Week 7.0±0.3.

WILCOXON RANK TEST

The values of Wilcoxon rank test shows that after comparing the values for 8th week there will be marked decrease of pain level as compared to isometric quadriceps exercises isolating the p value which is

Table-3 Shows the values of pre and post data of isometric quadriceps exercises on KAS

Groups	Wk. 6th	Wk. 6th	Wk. 8th	F-Ratio	P-value
Group A (Short Arc Ex) (n=40)	5.500	2.000	1.000	805.3	.00001
Group B (Isometric Quadriceps Ex) (n=40)	6.000	5.000	3.000	123.94	

p<0.0001 for both the exercises. The lowest value for pain is 0 and the highest value for 8th week shows marked decrease in level of pain for short arc exercises than isometric quadriceps exercises which is for short arc level of pain recorded was (4) and for isometric exercises the highest level of pain for week 8 was (8) which shows the effectiveness of short arc quadriceps exercises as compared to isometric quadriceps exercises.

FRIEDMAN TEST

Whereas the values of median from baseline to 8th week are markedly decreased for short arc exercises as compared to isometric quadriceps exercises, also Friedman test showed that value of the F-Ratio is increased for Short arc quadriceps exercises with p value (P < 0.0001) hence the efficacy of short arc quadriceps exercises for pain relief is greater than isometric quadriceps exercises. Kujala assessment score used to identify the activity of daily livings of patients suffered with Anterior knee pain, form consists of 13 questions and each question consist of a minimum value of (0) and maximum value of (10). The total score of this form is 100 by compiling the score of all 13 questions Forty individuals n=40 were enrolled for the assessment of

pre and post exercise plan for both groups i.e. (Isometric and Short arc quadriceps exercise group). 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 chart shows that the highest value of pre data is 83, 84 whereas the highest value of post data is 85 for isometric quadriceps exercises. For short arc exercises the highest value of pre data is 84 whereas the highest value for post data is 95.

Comparison of Pre and Post Isometric Exercises

The results of Group A after applying paired t-test i.e. Isometric Quadriceps exercises shows the improvement of mean and SD of post exercise i.e. 82.0750 ± 7.1266 with two tailed probability of P<0.0001.

Comparison of Pre and Post Short Arc Quadriceps Exercises

The results of Group B after applying paired t-test i.e. short arc Quadriceps exercises shows the improvement of mean and SD of post exercise i.e. 88.20+ 6.64 with two tailed probability of P<0.0001.

Post Exercise Comparison of Isometric and Short Arc Quadriceps Exercises

After comparing the results of both groups the Mean±S.D is higher (88.20+ 6.64) for Group B (Short arc quadricep exercises than Group A (Isometric exercises)(82.07± 7.12) with constant mean difference for both exercises i.e. 6.12, 95 % C.I=3.05 to 9.19 with probability<0.05.

Table-4 Comparison of Pre and Post Isometric Exercises

Group A : ISOMETIC QUADS EXERCISES		
n=40	**Pre exercise**	**Post exercise**
Mean ± SD	80.20 ± 7.03	82.0750 ± 7.12
95% CI	77.95 to 82.45	79.7958 to 84.3542
Mean difference	1.8750	
95% CI	1.2387 to 2.5113	
Two-tailed Probability	P < 0.0001	

DISCUSSION

The results of the study revealed that short arc quadriceps exercises have beneficial effect in patients with Anterior Knee Pain N= (40). The results of this study demonstrated that Short arc quadriceps exercises brought significant improvements on all parameters than isometric quadriceps exercise after the 8-week training program.

The results of our study showed that short arc quadriceps exercises have significant impact on pain, muscle activity and HRQoL in comparison with isometric exercises in reducing anterior knee pain. A study conducted by Earl et al showed greater reduction in level of pain The pain was reduced significantly (Pre mean: 40.6±18 to post mean: 5±7. In this research we focused on HRQoL, muscle activity and reducing level of pain. Focus on the study, comparison of short arc and isometric quadriceps exercises shows that the Short arc quadriceps exercises brought significant improvements on all parameters than isometric quadriceps exercise after the 8-weeks training program. In the current study VAS Scale (numerical) is used to measure pain whereas in the research of Earl et al pain was also measured via Numerical Rating Scale, knee abductor muscle should be focused to strengthen instead of knee

extensor muscle[14]. Study on quasi-randomised trials evaluating the effect of exercise therapy on pain, function and recovery in adolescents and adults with patellofemoral pain syndrome. Researcher used vas numerical rating scale (0-10) to evaluate the level of pain and suggested that the pain decreased not only in short term of exercise therapy but after long term of functional exerise therapy which includes the strength exercise including isoknetic, open and closed kinetic exercises on the knee joint with mean and S.D (0.99±1.84). similar to our study NRS numerical rating scale is used to measure the level of pain decrease with time and the most decrease in pain were found at eight week of short arc quadricep exercise with 95% C.I (0-2) and P-value <0.005[15].

Only statistical significant improvement brought about by the strengthening exercises was in the mental aspect of the SF-12 questionnaire. The main difference between the study by Foley et al and the present study was the shorter duration of the intervention, which consisted of eight weeks and shorter duration of session whereas in current study KUJALA assessment questionnaire used instead of SF-12 Questionnaire. However, both studies performed a rehabilitation protocols. EMG Biofeedback used as an assessment protocol for the study. Biofeedback mechanism system identifies the efficiency of the muscle[16]. The efficacy of EMG biofeedback on vastusmedialis and vastus lateralis muscle, similarly in this study the referenced muscle was vastusmedialis. Briani in his study performed exercises on sitting position where as in current study exercises has been performed in supine lying position[17].

In current study short arc quadriceps exercises are more efficient to produce strength and enhance health related quality of life (HRQoL) with pain relief. A study was conducted to identify the effect of short arc quadriceps exercises with or without EMG Biofeedback mechanism and proved that exercise with EMG biofeedback increased the efficiency of muscle than exercises without usage of EMG Biofeedback[18,19].

The quadriceps exercises on knee joint has also effect on the adjacent joints like hip and knee by producing the particular group of exercises it not only produce strength in knee joint but also enhance the efficiency of hip joint and reduce the level of pain[20-23]. Vastus medialis and vastus lateralis both muscle are involved in the alignment of the knee cap (patella) and isometric contractions of the quadriceps muscle group can produce the great impact of the strength on knee dynamic stability[24,25].

CONCLUSION

After comparing the results it has been concluded that the values of short arc exercises shows greater muscle activity on EMG Biofeedback and reduction of pain (Visual Analog Scale) as compared to isometric quadriceps exercises. The values of KUJALA assessment form after applying paired and independent t-test shows that the effectiveness of short arc quadriceps exercises are more effective to improve Activities of daily livings (ADLs).Hence, short arc quadriceps exercises are more effective to reduce pain , increase muscular activity and improve health related quality of life.

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