



Effect of Weight and Non-Weight Bearing Quadriceps Exercises Versus Weight-Bearing Quadriceps Exercises on Patellofemoral Pain, Quadriceps Strength and Functional Ability: A Randomized Clinical Trial

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ABSTRACT

Background: Patellofemoral Pain Syndrome (PFPS) is one of the most common knee complaints of both the young active sportsperson and the elderly. It often affects the function activities of an individual. **Purpose:** The purpose of the study is to compare the effectiveness of weight bearing and non-weight bearing exercises versus weight bearing quadriceps strengthening exercises in patella femoral pain. **Design:** A Randomized clinical trial Setting. The study was conducted at a tertiary care hospital. **Subjects:** 34 subjects with PFPS, between 18-42 years were recruited based on symptoms and Clark's Test. **Intervention:** Group A received conventional treatment along with weight bearing exercises and group B also received conventional treatment along with weight bearing and non-weight bearing exercises. **Measurements:** Subjects were assessed at baseline using Visual Analogue Scale (VAS), Quadriceps Strength assessed using HHD and functional ability using AKPS and re-assessed after 09 sessions. **Results:** The difference between the two groups was statistically significant in terms of pain, Quadriceps strength and functional ability with $p < 0.05$. **Conclusion:** Along with exercises, IFT and Taping helps in the reduction of pain. Thus, improving the ability of the individuals affected performs better in ADL's or athletic performance.

Keywords: Patellofemoral pain syndrome, Non-weight bearing, Weight bearing exercises, McConnell taping

INTRODUCTION

Patellofemoral pain syndrome (PFPS) can be defined as anterior knee pain involving the patella and retinaculum that excludes other intraarticular and peripatellar pathology. It can be insidious in nature or caused by direct trauma to the knee [1]. It is most prevalent in physically dynamic people, with as many as 54% of athletes and non-athletes. It is more common in females [2].

It occurs due to patella mal-alignment consequently, resulting in mal alignment between the hips and the ankles and muscular imbalances or weaknesses, especially in the quadriceps muscles [3]. Pain may also be experienced during exercise and activities prolong sitting such as in movie or travelling, while ascending and descending stairs [2].

Medical evidence strongly suggests that if PFP remains untreated, it could lead to chondromalacia patellae or osteoarthritis of the knee [4]. Goals of conservative management for patella femoral pain includes restoring muscle balance within the quadriceps group, the lateral forces of the Vastus Lateralis muscle of the quadriceps needs to be countered better by the Vastus Medialis. This is accomplished best by strengthening the quadriceps [5]. McConnell Taping is also suggested to relive pain and correct the patellar tracking [6].

Squat exercise performed from 45° to 0° of knee flexion and the knee-extension-with-variable-resistance exercise from 90° to 45° of knee flexion help to reduce Patellofemoral joint stress in healthy individuals [7]. Data obtained from this study will be useful in clarifying the best methods to promote quadriceps strengthening in subjects with patella femoral pain. Hence the need arises to compare the effectiveness of weight bearing and non-weight bearing exercises versus weight bearing quadriceps strengthening exercises in PFPS.

MATERIALS AND METHODS

After obtaining ethical clearance from the Institutional Ethical Committee, consent was taken from each participant. Data was collected from tertiary care hospital. Thirty-four subjects were randomly allocated into two groups (17 each) i.e., Group A- weight bearing quadriceps exercises, Group B- Non-weight bearing and weight bearing quadriceps exercises using envelope method. Based on available literature and consult with the expertise the sample was calculated using the formula:

$$(n=2s^2(Z_{1-\alpha/2}+Z_{1-\beta})^2/d^2)$$

where, SD=Standard deviation of difference s=pre-post, d=acceptable error=6.2, $Z_{\alpha}=1.96$, $Z_{\beta}=1.682$, $SD_1=2.647$, $SD_2=2.654$, $d=3.254$, power=95%.

Procedure

Inclusion criteria was as follows both male and female subjects between the age group of 18-42 years, anterior or retro patellar knee pain reported during at least 2 of the following activities: ascending and descending stairs, hopping, running, squatting, kneeling, prolonged sitting, positive Clarke's test, subjects willing to participate. Exclusion criteria: (1) Symptoms present for less than 2 months, (2) History of knee surgery, patella dislocations or subluxations, fracture, trauma, injuries, (3) Rheumatoid arthritis (4) History of stroke (5) Current significant injury affecting other lower-extremity joints (6) Subjects on medications in last 2 months.

Both the groups underwent conventional treatment i.e., therapeutic ultrasound, Interferential therapy and McConnel taping. Group A received squatting with 0 to 90 degrees of knee flexion. Three sets of 10 repetitions per session with 30 second rest period in between the sets. One session per day for a total of 9 days was given [8]. All the exercises were done under the supervision of physiotherapist. Group B received Squatting with 0 to 45 degree of knee flexion and 90° to 45° degree was done with on quadriceps table in high sitting position with estimated weight according to 10RM. Exercise progression was done according to de Lorme & Watkins progressive resistance exercise method [9]. Time duration followed was the same as that of Group A with rigid and maintained till next session. After the 9 sessions, on 10th day assessment was done in terms of VAS, Quadriceps strength and AKPS for functional ability.

Statistical Analysis

Statistical analysis was done using SPSS version 16. Mean and Standard deviation (SD) for different parameters were calculated. Mann Whitney U test, t-test, Wilcoxon matched pairs test were used. Probability values <0.05 were considered statistical significant.

RESULTS

A total of 47 participants were screened for anterior knee pain, 13 were excluded. Out of which 10 did not meet the inclusion criteria (above 42 years of age=06, history of fractures=02, RA=1, Subjects on medication=1) and 03 subjects refused to participate. Total 34 participants were positive for PFPS. The mean age distribution of the participants in group A was 30.4 ± 8.4 and group B was 28.6 ± 9.7 . Other Demographic data explained in Table 1.

Table 1 Comparison of two groups (Group A & B) with respect to age, height, weight, BMI

Variables	Group A	Group B	P-value
Age	30.47 ± 8.49	28.65 ± 9.75	0.5648
Weight	63.65 ± 7.39	60.94 ± 8.54	0.3306
Height	162.29 ± 7.35	165.65 ± 9.03	0.2439
BMI	24.32 ± 1.74	22.21 ± 3.26	0.0252*

*p<0.05

The difference between the two groups was statistically highly significant in terms of VAS, Quadriceps strength and AKPS (p<0.05) (Table 2).

Table 2 Comparison between two groups (Group A & B) with respect to VAS, AKPS, Quadriceps strength

Variable	Groups	VAS		Quadriceps Strength		AKPS	
		Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value
Pre-Test	Group A	6.71 ± 0.69	0.1737*	34.12 ± 7.47	0.2236*	66.88 ± 3.3	0.0438*
	Group B	6.24 ± 1.25		36.59 ± 3.41		70.06 ± 5.3	
Post Test	Group A	2.82 ± 1.19	0.0019*	39 ± 8.37	0.0383*	75.35 ± 3.18	0.2601*
	Group B	4.47 ± 1.28		43.76 ± 3.56		73.71 ± 5	
Difference	Group A	3.88 ± 1.36	0.0001*	4.88 ± 5.01	0.1613*	8.47 ± 2.92	0.0001*
	Group B	1.76 ± 0.75		7.18 ± 4.29		3.65 ± 1.8	

*p<0.05

Within group comparison of VAS, Quadriceps strength and AKPS showed reduction in pain, increased strength and improved functional ability respectively (Table 3).

Table 3 Comparison within group (Group A & B) with respect to VAS, Quadriceps strength, AKPS

Variable	Groups	VAS		Quadriceps Strength		AKPS	
		Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value
Group A	Pre-Test	6.71 ± 0.69	0.0003*	34.12 ± 7.47	0.0001*	66.88 ± 3.3	0.0001*
	Post Test	2.82 ± 1.19		39 ± 8.37		75.35 ± 3.18	
Group B	Pre-Test	6.24 ± 1.25	0.0003*	36.59 ± 3.41	0.0001*	70.06 ± 5.3	0.0001*
	Post Test	4.47 ± 1.28		43.76 ± 3.56		73.71 ± 5	

*p<0.05

DISCUSSION

In the present study, the effect of weight and non-weight bearing quadriceps exercises versus weight bearing quadriceps exercises of patellofemoral pain syndrome was investigated. The results of this study suggest that the exercises along with McConnell taping, IFT and ultrasound therapy in both the groups led to reduction in pain. Reduction in pain may be attributed to the effects of electrotherapeutic modalities and McConnell Taping given in both the groups. The neural effects of IFT may be explained by pain gate theory given by Melzack and wall [10]. Another mechanism could be due to descending pain suppression through stimulation of afferent A delta and C nucleus resulting in the release of inhibitory neurotransmitters at the spinal level [10]. The third probable mechanism for reduction in pain may be due to synaptic fatigue and increased thresholds of the peripheral nociceptive fibers. Stimulation above their maximum conduction frequency may cause cessation of action potential propagation [10].

One of the etiological factors of pain in PFPS is the involvement of peripheral nervous system around the patellae [2]. Also, there is an increased level of substance P. Ultrasound therapy is reported to cause a reduction in the local metabolite, toxin and chemical mediators. This can reduce the irritation of the nerve ending; leading to reduction in pain [10]. However there are studies suggesting that ultrasound has no effect on pain [11]. Similar was the case in the present study. Isolated effects of ultrasound therapy were not studied.

Mal-alignment of the patella, or altered patellar tracking, may be a predisposing factor for PFP. The McConnell patellar-taping program is intended to correct patellar tracking by medializing the patella, allowing patients to engage in pain-free exercises [12]. Hence, combined effects of electro therapy modalities, taping and exercises may have led to the reduction in pain.

Within group analysis group A was more effective in terms of pain reduction than the experimental group B. This may be attributed to neither increase in weights nor repetition in Group A, however in group B there was progressive increase in weights. A contradictory study suggests that squatting should be stopped till the pain subsides. In group B in addition to squatting, Open Kinetic chain exercises were done on quadriceps table with increasing weights. Exercise in closed kinetic chain promotes more balanced initial quadriceps activation than does exercise in open kinetic chain [13]. Both the groups showed similar statistically significant results, indicating that both groups were effective in improving strength.

The exercises selected in this study were to reduce the patellofemoral joint stress to minimum with subsequent training and strengthening the quadriceps. During squatting exercise, the PFJ stress is greatest at 90 of knee flexion [7]. This stress decreases as the knee taken into extension. This was the exercise given to individuals in the group A.

The stress on the PFJ during quadriceps strengthening using the quadriceps table is lowest at 90 of knee flexion with gradual increase as the knee is extended. The reason for increase in strength in group B could be due to the nature of the exercise i.e., non-weight bearing type of exercises. In such exercises there less, co-contraction of antagonist muscle as a result of which it provides better isolation of the quadriceps muscle. In contrast to those weight bearing exercises done in group A which are more functional in nature. Here there is both agonist and antagonist muscle contraction.

Another advantage of using the exercises used in group B is the range in which the muscle works. It encompasses both inner and outer range of muscle work. The advantage of using inner range in exercise is that it maintains the movement of the joint in the direction of the muscle pulls. In application to this study the muscle pull of the quadriceps is efficient and prevents the miss alignment of the patella. The advantage of outer range of muscle work is that, it as they help in muscle reeducation. Here the contraction is initiated easily from the stretch position reducing concentric type of contraction [9]. Also, concentric contraction is used to build up muscle power hence from this we can conclude that group B is effective than group A in terms of strength.

Changes were noted in functions like climbing up and down stairs and reduction in pain while walking. An important activity that showed a change was reduction in pain while squatting. In the Indian scenario squatting is an important element of activities of daily living which includes toileting, washing clothes, cooking etc. [3]. Improvement in strength along with the conventional treatment may have led to reduction in pain thereby allowing the patient to do all activities that require squatting. Helping a subject to do their ADL's definitely has a positive impact on the quality of life. Limitation of the study was that the study could not do a long term follow up. Moreover, positive effects noted in the study cannot be attributed to exercises alone but to also the conventional treatment. In the future, the effect of pain reduction in PFPS should be tried with only exercises and taping, not with electrotherapy modalities. Also, EMG muscle activity can be measured for muscle response time as an outcome measure which is very accurate and valid.

CONCLUSION

In the present study both the groups showed significant improvement, but Group A showed better results in terms of pain and functional status whereas, Group B, showed improvement in Quadriceps strength. Hence study concludes that along with exercises, IFT and Taping can help in the reduction of pain thus, improving the ability of the individuals of the affected individuals to perform better in ADL's or athletic performance.

DECLARATION

Conflict of Interest

The authors have disclosed no potential conflicts of interest, financial or otherwise.

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