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Effect of Quadriceps Muscle Strengthening Exercises on Knee Pain and Quadriceps Angle in Subjects with Patellofemoral Pain Syndrome

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Abstract: ***Background: Patellofemoral pain syndrome is a collective term describing the diffuse pain conditions the anterior compartment of the knee and is one of the most common musculoskeletal problems seen in people with high level of physical activity. Patellofemoral pain affects up to 25% of active individuals and is thought to be linked to the development of patellofemoral osteoarthritis later in life. Objectives: To find out the effect of different quadriceps strengthening exercises on pain by using V.A.S scale in subjects with patellofemoral pain. To find the effect different Quadriceps strengthening exercises on Quadriceps- angle by using goniometry in subjects with patellofemoral pain. Methodology: The study was conducted on 40 subjects with patellofemoral pain syndrome with age group of 45-55 years was included in the study. All the subjects who fulfilled the inclusion criteria were recruited for the study after obtaining informed consent from all the subjects before study starting the treatment. participants were randomly assigned into two group pre and post experimental study. They receive quadricep strengthening with TheraBand along with ultrasound [group-A]and quadriceps table exercises with ultrasound [Group-B] for 4 weeks. The base line evaluation of pain by V.A.S and Quadriceps angle by goniometry outcome measures were taken from all subjects before and after the treatment. Results: The analysis of pre and post intervention values for pain and Q-angle group A is significantly more effective than group B. Conclusion: Quadriceps strengthening with TheraBand was more effective in reducing pain, and greater reduction in quadricep angle in subjects with patellofemoral pain syndrome.***

Keywords: Quadriceps strengthening, Q – angle, TheraBand, Goniometry, V.A.S, Ultrasound

1. Introduction

Patellofemoral pain syndrome is one of the most common causes of anterior knee pain. Patellofemoral pain syndrome is a collective term describing the diffuse pain conditions the anterior compartment of the knee and is one of the most common musculoskeletal problems seen in people with high level of physical activity [1]

Patellofemoral pain is characterized by diffuse retro patellar and peripatellar pain that is aggregated with squatting, prolonged sitting, and stair activities. Three major contributing factors of PFPS are discussed: (i) malalignment of the lower extremity and/or the patella; (ii) muscular imbalance of the lower extremity; and (iii) overactivity [2]

Women are affected about more than twice as often as men. The causes for anterior knee pain are multifactorial Patellofemoral pain constitutes nearly 23% of injuries to the knee. [3] The patellofemoral pain syndrome (PFPS) is a common cause for “anterior knee pain” and mainly affects young women without any structural changes such as increased Q-angle or significant pathological changes in articular cartilage [4] The average recreational runner has a 37 % and 56 % incidence of being injured during the course of a yearly training. A greater Q angle has been suggested as a risk factor for patellofemoral pain.

The patellofemoral joint plays a vital role in increasing the mechanical advantage of the quadriceps muscle during activities such as walking, running, stair climbing, squatting, and rising from a chai44r. During knee flexion, the contact area and compressive forces between the patella and femur increase. Abnormal patellar tracking, muscle imbalance, altered lower limb biomechanics, or excessive loading can increase stress on the knee joint.

Among the possible factors related to knee crepitus, buildup of air in the synovial fluid and meniscal hyper mobility have been mentioned as physiological crepitus, and cartilage defects, Quadriceps atrophy and weakness, and patellofemoral instability as pathological crepitus.

patellofemoral joint kinematics in females with PFPS was related to excessive medial rotation of the femur and lateral rotation of the patella[5]. The pain of PFPS often worsens with prolonged sitting or descending stairs. Patellofemoral pain syndrome (PFPS) is a common cause of knee pain in adolescents and adults younger than 60 years.

2. Materials

Materials used for the study: High couch, Goniometry, Thera band, Quadriceps table, Chair.

3. Methods

This study was conducted at SVIMS college of physiotherapy. Tirupathi, over 6 months of period. The participants were selected through purposive sampling method and taken as two groups. The study duration was four weeks.

Inclusion Criteria and Exclusion Criteria: Subjects diagnosed with patellofemoral pain syndrome. Age group: 30-50 years. Subjects experiencing anterior knee pain. Subjects with pain during activities such as squatting, stair climbing, walking. Subjects willing to participate in the study. Subjects who provided written informed consent. Subjects with history of any previous surgery, Any Neurological disease-like spine and lower limbs, Any malignancies, Any other pathological conditions in spine, No limb length discrepancies.

Treatment Procedure:
Forty subjects diagnosed with Patellofemoral Pain Syndrome (PFPS) were randomly allocated into two groups, with 20 participants in each group. Both groups received treatment for four weeks.

Group A – Ultrasound + Theraband Exercises
Participants received therapeutic ultrasound over the anterior aspect of the knee at a frequency of 1 MHz in pulsed mode for 5–10 minutes, three sessions per week for four weeks. This was followed by quadriceps strengthening exercises using TheraBand resistance.

Straight Leg Raising: 10 repetitions × 3 sets, twice daily.

Resisted knee extension using TheraBand: 10 repetitions × 3 sets on alternate days.

Resistance progression: Yellow, red, green and black TheraBand from weeks 1 to 4, respectively.

Group B – Ultrasound + Quadriceps Table Exercises
Participants received the same ultrasound therapy and Straight Leg Raising exercises as Group A.

Quadriceps table exercises were performed in a sitting position with the hip flexed to 90°. Participants extended the knee against cuff weights, held the terminal position for 2–3 seconds and slowly returned to the starting position.

Progressive resistance was applied using the Delorme technique:
Set 1: 10 repetitions at 50% of 10 RM.
Set 2: 10 repetitions at 75% of 10 RM.
Set 3: 10 repetitions at 100% of 10 RM.
Both groups were reassessed after four weeks using VAS and Q-angle measurements.

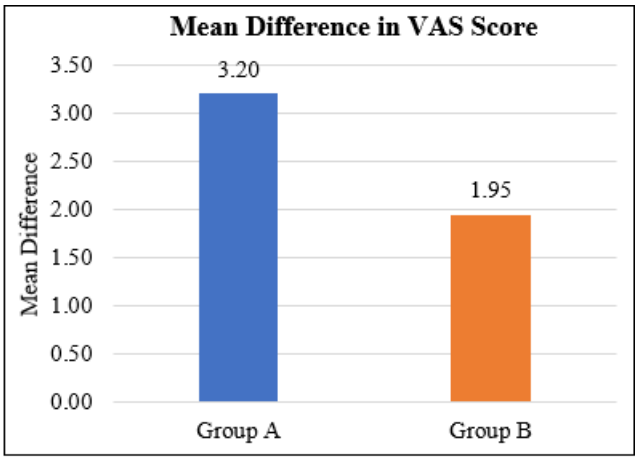
Outcome Measures:
Pain was measured by using visual analogue scale-angle was measured by using Goniometry. After completing 4 Weeks of treatment pre and post treatment values measurement were taken in all subjects and data was sent for statistical analysis.

Statistical Analysis and Results: Statistical analysis was performed using SPSS, with data tabulated in Excel and evaluated using mean, standard deviation, and paired t-test. P value <0.001 was considered statistically significant for pre - and post-test comparisons of Group-A and Group-B.

VAS Score –

Group A & Group B:

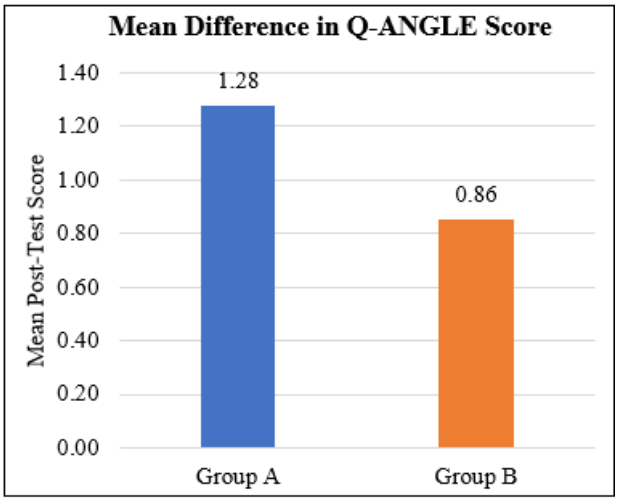
Parameter	phase	N	Mean	SD	t-value	p-value
VAS [Group A]	Pre &post	40	3.20	±0.77	-5.18	<0.001
VAS [Group B]	Pre &post	40	1.95	±0.76		



Q-Angle

Group A & Group B:

Parameter	phase	N	Mean	SD	t-value	p-value
Q-angle [Group A]	Pre &post	40	1.28	±0.46	-3.53	<0.001
[Group B]	Pre &post	40	0.86	±0.29		



The mean reduction in Q-angle was greater in Group A (Mean=1.28, SD = 0.46) than in Group B (Mean=0.86, SD = 0.29), indicating a greater reduction in Q-angle in Group A.

Hence, the evidence is sufficient to conclude that **Group A significantly more effective than Group B** in **reducing the Q-angle** among the study participants.

4. Discussion

The present study compared the effects of TheraBand-based quadriceps strengthening and quadriceps table exercises in subjects with Patellofemoral Pain Syndrome.

The findings demonstrated significant reductions in pain and improvements in Q-angle in both groups. However, Group A showed greater improvement compared with Group B.

The greater improvement observed in Group A may be attributed to progressive resistance training, which enhances quadriceps muscle strength and neuromuscular control. Improved quadriceps function may contribute to better patellar tracking and reduced patellofemoral joint stress.

These findings are consistent with previous research by Crossley et al., Bolga et al. and Wit vrouw et al., which emphasized the importance of strengthening exercises in the management of patellofemoral pain.

Overall, the findings support the use of progressive quadriceps strengthening exercises as an effective physiotherapy intervention for PFPS.

5. Conclusion

The present study concludes that both TheraBand-based quadriceps strengthening and quadriceps table exercises are effective in reducing knee pain and improving Q-angle in subjects with Patellofemoral Pain Syndrome.

However, TheraBand-based quadriceps strengthening combined with ultrasound demonstrated significantly greater improvement than quadriceps table exercises combined with ultrasound.

Therefore, progressive resistance exercises using TheraBand may be considered a beneficial intervention in the physiotherapy management of PFPS.

6. Limitations

- The study included a relatively small sample size of 40 participants.
- The intervention period was limited to four weeks.
- Long-term follow-up was not performed. The study assessed only pain and q-angle as outcome measures.

7. Recommendations

- Future studies should include larger sample sizes.
- Longer intervention and follow-up periods are recommended.
- Further studies can be conducted among different age groups.
- Studies involving different occupational groups are recommended.
- Additional functional outcome measures should be included in future research.

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