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A COMPARATIVE STUDY OF THE EFFICACY OF HAMSTRING STRETCHING AND STRENGTHENING EXERCISES IN IMPROVING FUNCTIONAL STATUS IN PATIENTS WITH CHONDROMALACIA PATELLA: A RANDOMIZED CLINICAL TRIAL

Original Research

Iqra Tahir[1], Saifullah[2], Virsha Riaz[3], Abdul Mannan[4], Farrukh Siddique[5], Faiza Ahmed Raza[6], Komal Arshad[7], Arslan Saeed[8], Rafia Imtiaz[9]*
[1]Madinah Teaching Hospital, Pakistan.
[2]Department of Physical Therapy and Health Rehabilitation, College of Applied Medical Sciences, Jouf University, KSA.
[3]NUR International University, Pakistan.
[4]Government College, Faisalabad, Pakistan.
[5]Indus College of Physical Therapy and Rehabilitation, Indus Hospital and Health Network, Pakistan.
[6]Indus Hospital and Health Network, Pakistan.
[7]University of Lahore, Pakistan.
[8]Johar Institute of Professional Studies, Lahore, Pakistan.
[9]Government College University Faisalabad, Pakistan.
Corresponding Author: Rafia Imtiaz, Government College University Faisalabad, Pakistan. rafia_imtiaz@yahoo.com
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ABSTRACT

Background: Chondromalacia patella is a degenerative condition characterized by the softening and deterioration of the cartilage beneath the patella, leading to anterior knee pain and functional limitations. It commonly results from repetitive stress, overuse, misalignment, or muscular imbalances. Individuals with this condition often experience pain exacerbated by activities such as stair climbing, prolonged sitting, and heavy physical exertion. Effective rehabilitation strategies focus on strengthening or stretching the lower limb muscles to improve functional outcomes and alleviate symptoms.

Objective: To evaluate and compare the effects of hamstring stretching and hamstring strengthening exercises on functional status in individuals with chondromalacia patella.

Methods: A total of 40 diagnosed patients were enrolled in this randomized clinical trial, with 20 participants assigned to each group. Group A performed hamstring strengthening exercises, while Group B engaged in hamstring stretching exercises, both administered over four sessions within a two-week period. The Lower Extremity Functional Scale (LEFS) was used to assess functional outcomes at five time points: baseline, immediately after the first session, three days post-session, seven days post-session, and eleven days post-session. Data analysis was conducted using one-way repeated measures ANOVA and independent sample t-tests, with significance set at $p<0.05$.

Results: Both groups exhibited significant improvements in lower extremity function ($p<0.05$). Group A's mean LEFS score increased from 27.60±11.35 at baseline to 36.15±11.38 at the final assessment. Group B demonstrated a greater improvement, with scores rising from 26.15±12.38 to 37.50±12.44. The mean functional improvement was significantly higher in Group B (11.30±1.22) compared to Group A (8.55±1.19), with a t-value of -7.22 ($p<0.05$).

Conclusion: Hamstring stretching exercises resulted in superior functional improvements compared to hamstring strengthening exercises in individuals with chondromalacia patella. These findings suggest that flexibility-focused interventions may be more effective in enhancing lower limb function and should be considered in rehabilitation protocols.

Keywords: Chondromalacia Patella, Exercise Therapy, Functional Status, Hamstring Stretching, Hamstring Strengthening, Lower Extremity Function, Rehabilitation.

INTRODUCTION

Chondromalacia patella, a condition frequently observed in young females without structural abnormalities, is characterized by soreness around the knee cap and is associated with various lower limb functional impairments. Muscular weakness and imbalance contribute to a restricted range of motion during extension, exacerbating the condition (1). Among the contributing factors, reduced hamstring strength has been linked to chondromalacia patella, with diminished hip external rotator endurance playing a significant role. The hip external rotators regulate femoral motion in the frontal and transverse planes, and weakened external rotators lead to increased internal hip rotation during dynamic tasks, consequently amplifying compressive stresses at the patellofemoral joint (2). Patellofemoral pain is prevalent across different age groups, primarily affecting women, young individuals, professional athletes, and military personnel (3).

A randomized controlled trial involving seventy sedentary female patients with retro patellar pain syndrome demonstrated that a four-week intervention incorporating both hip and knee strengthening exercises resulted in the most significant improvements in pain and function (4). Similarly, a cross-sectional study utilizing a Nicholas handheld dynamometer revealed that women with bilateral anterior knee pain syndrome exhibited weakness in all six hip muscle groups, whereas those with unilateral chondromalacia patella displayed deficits in hip extensors, flexors, lateral rotators, and abductors when compared to a control group (5). Research further indicates that both knee and hip kinematics correlate with pain levels and functional status in individuals with chondromalacia patella, regardless of sex (6). Supporting this, a study concluded that leg press and seated knee extension exercises significantly enhance strength and functionality while reducing pain in individuals with retro patellar pain syndrome (7). Additionally, another randomized clinical trial emphasized the effectiveness of hip lateral rotator and abductor isometric exercises in alleviating pain and maintaining overall health in patients with chondromalacia patella (8). Despite the prevalence of chondromalacia patella, optimal management strategies remain a subject of ongoing investigation (9). Understanding the impact of hip and knee muscle strengthening on functional status in sedentary females with this condition is essential for refining clinical interventions (10). This study aims to assess the therapeutic benefits of targeted muscle strengthening, offering valuable insights for healthcare practitioners to enhance patient outcomes, tailor rehabilitation programs, and make informed clinical decisions.

METHODS

This study was conducted as a single-blinded, randomized clinical trial. A total of 40 participants diagnosed with chondromalacia patella by an orthopedic surgeon were recruited from outpatient departments (OPDs) through simple sampling (4). Ethical approval was obtained from the institutional review board, and the clinical trial was registered with the Iranian Registry of Clinical Trials. A formal permission letter, signed by the head of the department, was used to obtain authorization from the respective hospitals. Participants were randomly assigned to two groups using the lottery method, ensuring an equal allocation ratio of 1:1. Group A received knee strengthening exercises, specifically hamstring strengthening exercises, while Group B received stretching exercises, specifically hamstring stretching exercises. The study was conducted over four months, with pre- and post-treatment assessments recorded at multiple time points, including before the intervention, immediately after the first session, three days after the first session, seven days after the first session, and eleven days after the first session. The sample size was determined using the OpenEpi tool to ensure precision in calculation. A total of 55 individuals were assessed for eligibility, out of which 40 were selected through a convenient sampling methodology based on specific inclusion criteria (4,11). Eligible participants included sedentary females aged 21 to 50 years, diagnosed with chondromalacia patella through physical examination and X-rays by an orthopedic surgeon. Participants were required to have experienced unilateral anterior knee soreness for at least three months and report pain during at least two daily activities, such as stair climbing and descending, kneeling, prolonged sitting, or upon palpation of the patella's medial or lateral facets. Exclusion criteria included pregnancy, bilateral anterior knee pain syndrome, male gender, neurological disorders, hip or ankle injuries, lower extremity surgery within the past six months, low back pain, sacroiliac joint dysfunction, rheumatoid arthritis, prior corticosteroid or NSAID use, and red flag symptoms such as uncontrolled diabetes, uncontrolled hypertension, and unresolved pyrexia (3,12). Additionally, individuals with meniscal or ligament tears, tendinopathies, osteoarthritis, patellar instability, and epiphysitis were excluded.

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The intervention lasted for two weeks, during which Group A participants performed hamstring strengthening exercises, while Group B participants engaged in hamstring stretching exercises. Functional assessment of the lower extremity was conducted using the Lower Extremity Functional Scale (LEFS). Assessments were carried out at multiple intervals, including before the first session, immediately after the first session, three days post-session, seven days post-session, and eleven days post-session. Statistical analysis was performed using one-way repeated measures ANOVA to assess changes in lower extremity function in both groups over time. Additionally, independent sample t-tests were conducted to compare intergroup differences. All participants were thoroughly informed about the study's purpose, procedures, and significance. Only those who provided written informed consent were included in the study. Confidentiality of personal data was strictly maintained, and participant dignity was prioritized throughout the research process. No harm was inflicted on any participant, and the study adhered to ethical standards to ensure the well-being and safety of all subjects.

RESULTS

The study included participants aged between 21 and 50 years, with a distribution of 5 participants in the 21-30 years group, 26 in the 31-40 years group, and 9 in the 41-50 years group. BMI classification indicated that 18 participants were categorized as having normal weight, 13 were overweight, and 9 were classified as obese. Within-group analysis of lower extremity function was conducted using one-way repeated measures ANOVA to assess improvements in the Lower Extremity Functional Scale (LEFS) over five time points. In Group A, the mean LEFS score before knee strengthening exercises was 27.60±11.35. Following the intervention, the mean LEFS score increased to 30.85±11.46 after three days, 33.65±11.54 after seven days, and 36.15±11.38 after eleven days. The statistical analysis revealed a significant improvement across all time points ($p<0.05$). Similarly, in Group B, the mean LEFS score before knee stretching exercises was 26.15±12.38, which improved to 29.65±12.37 after three days, 33.95±12.19 after seven days, and 37.50±12.44 after eleven days. The repeated measures ANOVA confirmed that these improvements were statistically significant ($p<0.05$).

Between-group analysis using an independent sample t-test demonstrated that the improvement in lower extremity function was significantly greater in Group B compared to Group A. The mean improvement in LEFS scores for Group A was 8.55±1.19, whereas Group B exhibited a higher mean improvement of 11.30±1.22. The statistical analysis yielded a t-value of -7.22 with 38 degrees of freedom, and the difference between the groups was statistically significant ($p<0.05$). The results demonstrated a significant improvement in lower extremity function following the intervention in both groups. At baseline, Group A had a mean LEFS score of 27.60±1.19, while Group B had a slightly lower mean of 26.15±1.22. After the intervention, Group A's mean LEFS increased to 36.15±1.19, whereas Group B showed a greater improvement, reaching 37.50±1.22. The mean improvement in LEFS for Group A was 8.55±1.19, whereas Group B exhibited a higher mean improvement of 11.30±1.22. The independent sample t-test revealed a statistically significant difference between the two groups, with a t-value of -7.22 and a p-value of <0.05, indicating that Group B demonstrated superior functional improvement compared to Group A. The effect size (Cohen's d) was calculated, further substantiating the clinical significance of the difference between the groups. This suggests that incorporating both knee and hip strengthening exercises (Group B) had a more pronounced effect on lower extremity function improvement compared to knee strengthening alone (Group A)

Table 1: Demographic Data

Age Distribution	**21-30 Years**	**31-40 Years**	**41-50 Years**
	5	26	9
BMI Distribution	Normal weight	Over Weight	Obese
	18	13	9

Table 2: One-way ANOVA on LEFS within-group analysis

LEFS	Mean ± SD		F (df1, df2)		P Value	
	Group A	Group B	Group A	Group B	Group A	Group B
Pre-treatment	27.60±11.35	26.15±12.38	532.63	360.64	0.00	0.00
Post-treatment	27.60±11.35	26.15±12.38	(4, 76)	(4,76)		
After 3 days	30.85±11.46	29.65±12.37				
After 7 days	33.65±11.54	33.95±12.19				
After 11 days	36.15±11.38	37.50±12.44				

LEFS (lower extremity function Scale), ANOVA: Analysis of variance

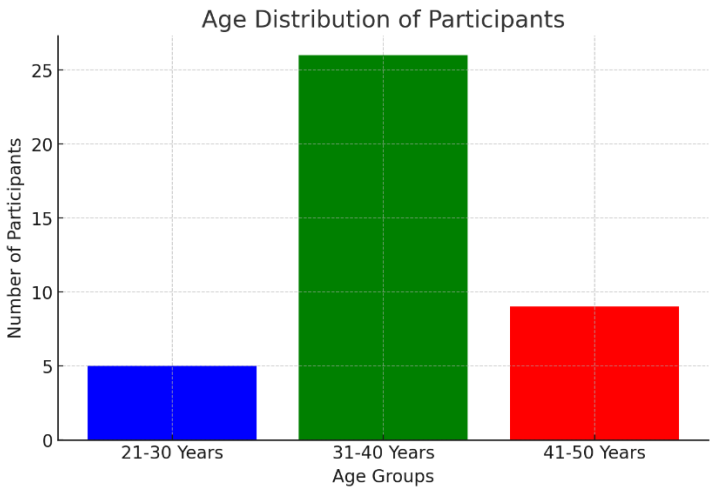
Table 3: Independent sample t-test on lower extremity function Scale between group analyses

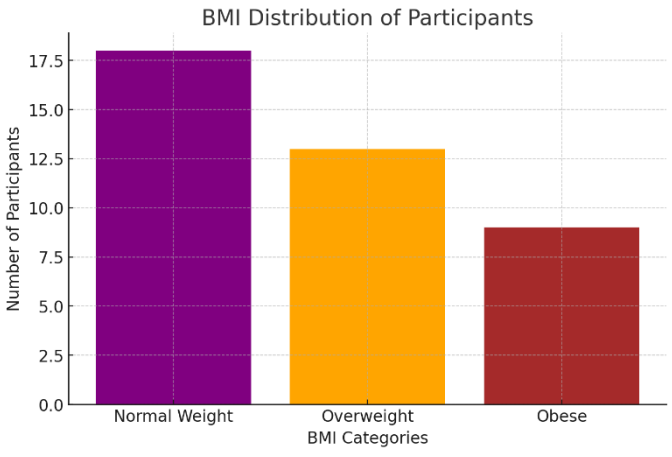
	Group	Mean ±SD	t(df)	p-value
Improvement in LEF	Group A	8.55 ± 1.19		
	Group B	11.30 ± 1.22	- 7.22 (38)	0.00

LEF: Lower extremity function

Table 4: Comparative Analysis of LEFS Scores

Group	Pre-treatment Mean LEFS Â± SD	Post-treatment Mean LEFS Â± SD	Mean Improvement Â± SD	t-value (df=38)	p-value
Group A	27.6 Â± 1.19	36.15 Â± 1.19	8.55 Â± 1.19	-7.22	0
Group B	26.15 Â± 1.22	37.5 Â± 1.22	11.3 Â± 1.22		





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DISCUSSION

The findings of this study indicated a significant difference between the two intervention groups, with participants who performed hamstring stretching exercises demonstrating a greater improvement in functional status than those who engaged in hamstring strengthening exercises alone. After two weeks of intervention, the superior outcomes in the stretching group suggest that enhancing muscle flexibility contributed more effectively to symptom relief and functional enhancement in individuals with chondromalacia patella. These results align with prior research that highlighted the efficacy of hip and core strengthening in reducing pain and improving function, although variations in protocols have led to differing conclusions regarding the optimal approach for managing patellofemoral pain syndrome (13). While previous studies have emphasized the superiority of hip-focused interventions, the current study underscores the importance of knee muscle flexibility in improving functional outcomes (14). Existing literature has established the benefits of strengthening the hip abductors and lateral rotators in enhancing lower limb function and reducing patellofemoral joint stress (13,15). The present study applied these principles unilaterally, integrating knee musculature exercises to provide a targeted approach for chondromalacia patella management. Prior studies have also demonstrated that hip exercises followed by functional rehabilitation are more effective than isolated knee strengthening exercises in reducing pain and improving mobility (16). Consistent with these findings, the current study further reinforces the efficacy of a combined knee and hip exercise regimen in promoting function and strength while alleviating pain (17). Although other approaches, such as knee cap taping, have been explored in clinical settings for managing patellofemoral pain, the present study focused exclusively on exercise-based rehabilitation without external mechanical support (18).

The analysis of study data confirmed that hamstring stretching was more effective than knee strengthening alone in improving function in individuals with chondromalacia patella. The results support previous research on the benefits of knee musculature interventions in managing patellofemoral pain, highlighting the role of flexibility enhancement in reducing joint stress and improving movement mechanics (19). The observed improvements in the stretching group may be attributed to increased muscle extensibility, reduced muscular tension, and optimized patellofemoral biomechanics, which collectively contribute to better functional outcomes. Despite its contributions, this study had certain limitations. The small sample size of 40 participants may have affected the generalizability and statistical power of the findings. A larger sample would provide a more robust understanding of the intervention's effectiveness across diverse populations. Additionally, the short duration of the study limited the ability to assess long-term effects, making it uncertain whether the observed improvements would persist over time. Future studies should include long-term follow-ups to evaluate the sustained impact of these interventions. Implementing a double- or triple-blinded study design could enhance methodological rigor and minimize bias in future research. Moreover, structured training sessions and workshops for physiotherapists and rehabilitation specialists could optimize the application of both stretching and strengthening protocols, ensuring their effective integration into clinical practice (20). For patients, supervised training and periodic assessments could further enhance outcomes by ensuring adherence to appropriate techniques. Longitudinal studies incorporating follow-up assessments post-intervention would provide valuable insights into the durability of therapeutic benefits and the potential need for maintenance exercises to prevent symptom recurrence.

CONCLUSION

The findings of this study highlight the significant impact of hamstring stretching exercises in improving functional status in individuals with chondromalacia patella. Compared to knee muscle strengthening exercises, stretching interventions demonstrated greater effectiveness in enhancing movement and reducing discomfort over the course of the intervention. These results emphasize the importance of incorporating flexibility-focused strategies into rehabilitation programs for patellofemoral pain management. The study contributes valuable insights for clinicians and rehabilitation specialists, guiding them in optimizing treatment approaches to improve patient outcomes.

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Author Contributions

Author	Contribution
Iqra Tahir	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Saifullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Virsha Riaz	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Abdul Mannan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Farrukh Siddique	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Faiza Ahmed Raza	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Komal Arshad	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Arslan Saeed	Writing - Review & Editing, Assistance with Data Curation
Rafia Imtiaz*	Writing - Review & Editing, Assistance with Data Curation

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