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ORIGINAL ARTICLE

Posterolateral Hip Muscle Strengthening Versus Quadriceps Strengthening for Patellofemoral Pain: A Comparative Control Trial

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Abstract

Objective: To compare the efficacy of posterolateral hip muscle strengthening versus quadriceps strengthening in reducing pain and improving health status in persons with patellofemoral pain (PFP).

Design: Comparative control trial.

Setting: Rehabilitation facility.

Participants: Persons with a diagnosis of PFP (N=36; 18 men, 18 women).

Interventions: Patients were alternately assigned to a posterolateral hip muscle strengthening group (9 men and 9 women) or a quadriceps strengthening group (9 men and 9 women). The posterolateral hip muscle strengthening group performed hip abductor and external rotator strengthening exercises, whereas the quadriceps strengthening group performed quadriceps strengthening exercises (3 times a week for 8wk).

Main Outcome Measures: Pain (visual analog scale [VAS]) and health status (Western Ontario McMaster Universities Osteoarthritis Index [WOMAC]) were assessed at baseline, postintervention, and 6-month follow-up.

Results: Significant improvements in VAS and WOMAC scores were observed in both groups from baseline to postintervention and baseline to 6-month follow-up ($P<.001$). Improvements in VAS and WOMAC scores in the posterolateral hip exercise group were superior to those in the quadriceps exercise group postintervention and at 6-month follow-up ($P<.05$).

Conclusions: Although both intervention programs resulted in decreased pain and improved function in persons with PFP, outcomes in the posterolateral hip exercise group were superior to the quadriceps exercise group. The superior outcomes obtained in the posterolateral hip exercise group were maintained 6 months postintervention.

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Patellofemoral pain (PFP) is the most common lower extremity diagnosis among those who are physically active.[1-3] Historically, the etiology of PFP has been attributed to abnormal patella tracking secondary to impairments in quadriceps muscle performance (eg, weakness or insufficiency of the vastus medialis oblique relative to the vastus lateralis).[4-7] As such, conservative interventions (eg, patella taping, vastus medialis oblique strengthening) are commonly prescribed for persons with PFP.[8,9] Although the ability to selectively strengthen the vastus medialis oblique has been questioned,[10,11] several clinical trials have shown that quadriceps strengthening is beneficial for persons with PFP.[12-16]

The premise that a strength imbalance between the vastus medialis oblique and vastus lateralis contributes to abnormal patella tracking has been recently challenged. Dynamic imaging studies performed in weight-bearing suggest that lateral patella displacement and lateral tilt are a function of medial rotation of the femur as opposed to patella motion.[17,18] This suggests that impaired hip muscle performance may be a contributing factor

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with respect to abnormal patella tracking and PFP. Indeed, biomechanical studies have reported that persons with PFP demonstrate excessive hip internal rotation[19,20] and hip adduction[21] compared with pain-free individuals. Furthermore, persons with PFP have been reported to exhibit impaired muscle performance of the hip abductors,[19,21-23] hip extensors,[19,21,23] and external rotators.[21]

Because of recent focus on the contribution of abnormal hip mechanics to patellofemoral disorders, several randomized controlled trials have sought to evaluate the effects of hip muscle strengthening on PFP symptoms.[15,16,24-26] Khayambashi et al[25] reported that 8 weeks of hip abductor and external rotator strengthening resulted in reduced pain and improved health status in women with PFP compared with a control group that did not receive hip strengthening exercises. The improvements in the hip strengthening group were sustained at 6-month follow-up. Studies by Fukuda,[15,16] Nakagawa,[26] and colleagues found that the combination of hip and quadriceps strengthening resulted in a greater reduction in PFP compared with quadriceps strengthening performed in isolation.

To date, to our knowledge, only 1 study has compared hip strengthening with quadriceps strengthening in persons with PFP. Dolak et al[24] reported that 4 weeks of hip strengthening was superior to 4 weeks of quadriceps strengthening in reducing symptoms in women with PFP. However, the between-group difference was not maintained when followed by an additional 4 weeks of combined hip and knee functional training. Although the findings of Dolak[24] suggest that hip strengthening may be superior to quadriceps strengthening, at least in the short term, additional research is necessary to test this hypothesis.

The purpose of the current study was to compare the immediate and short-term efficacy of posterolateral hip strengthening versus quadriceps strengthening in reducing pain and improving health status in persons with PFP. Based on existing biomechanical and clinical studies, we hypothesized that patients assigned to the hip strengthening group would exhibit greater improvements in pain and health status than patients assigned to the quadriceps exercise group. Information obtained from this study will assist clinicians in better prescribing rehabilitation exercises for this population.

Methods

Screening for specific inclusion and exclusion criteria was performed by 2 physicians. Only subjects with a diagnosis of unilateral or bilateral PFP were included. The diagnosis of PFP was based on symptom location (peripatellar and/or retropatellar) and reproduction of pain with activities commonly associated with this condition (eg, stair decent, squatting, kneeling, prolonged sitting). Patients were screened by physical examination to rule out ligamentous laxity, meniscal injury, pes anserine bursitis, iliotibial band syndrome, and patella tendinitis. Patients who reported a history of patella dislocation, patella fracture, knee surgery, previous physical therapy, or symptoms that had been present for <6 months were excluded from participation.

List of abbreviations:

ANOVA	**analysis of variance**
PFP	**patellofemoral pain**
VAS	**visual analog scale**
WOMAC	**Western Ontario McMaster Universities Osteoarthritis Index**

Thirty-six patients (18 men, 18 women) met the study inclusion criteria. The men and women were sequentially assigned in an alternating fashion to the posterolateral hip exercise group (n=18; 10 with bilateral pain, 8 with unilateral symptoms) and the quadriceps exercise group (n=18; 12 with bilateral pain, 6 with unilateral symptoms) (fig 1). Demographic data for the 2 groups at baseline are included in table 1. In general, patients were not physically active and did not participate in recreational sport activities or exercise beyond that of activities of daily living. Prior to participation, all patients were informed of the purpose of the study and provided written informed consent.

Intervention

Study participants completed exercises supervised by a physical therapist 3 times per week for 8 weeks. Exercises were performed bilaterally in patients with bilateral pain and on the symptomatic side in patients with unilateral pain. Each session consisted of 5 minutes of warm-up (walking around the gym at a self-selected pace), 20 minutes of directed exercise, and 5 minutes of cool-down (walking around the gym at a self-selected pace). Patients participating in the study were asked to refrain from exercises beyond that of their assigned exercise sessions throughout the duration of the study. Patients were allowed to take over-the-counter pain and/or anti-inflammatory medication as needed; however, subjects were asking to refrain from taking medications for 24 hours before sessions in which outcome measurements were obtained.

Patients assigned to both groups performed standardized protocols. Resistance and repetitions were progressed at 2-week intervals (table 2). TheraBand elastic tubing[a] was used to provide resistance during each exercise. Subjects were required to complete at least 19 out of the 24 treatment sessions (~80%) to remain in the study. In addition, if a patient missed 3 consecutive treatment sessions, their participation in the study was terminated. All subjects completed the required number of treatment sessions over the 8-week intervention period.

Patients assigned to the posterolateral hip exercise group performed 2 exercises: one targeting the hip abductors and the other targeting the hip external rotators. Hip abductor strengthening was performed with patients positioned sidelying on a treatment table. Elastic tubing was tied just above the ankle at one end and attached to the bottom of the treatment table at the other (fig 2). The length of tubing was individualized across patients based on their lower limb length (distance from the anterior superior iliac spine to the medial malleolus). The distance between the exercise limb and the bottom of the treatment table was adjusted to remove slack from the tubing. Patients were allowed to hold on to the edge of the table for stabilization purposes. The exercise was performed against the resistance by abducting the hip from 0° to 30°.[24]

Hip external rotator strengthening was performed with patients seated at the edge of a treatment table and the knee flexed to 90° (fig 3). A strap was used to prevent sagittal and frontal plane motion of the thigh. Elastic tubing was tied around the ankle and was secured to a rigid pole. The length of tubing was individualized across patients based on thigh length (distance from the anterior superior iliac spine to the medial femoral epicondyle). The distance between the exercise limb and pole was adjusted