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Effect of Isometric Exercise and the Role of Vastus Medialis Obliquus Activation Deficit in Chondromalacia Patella: A Single-Case Physiotherapy Report

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Abstract: ***Background**: Chondromalacia patellae is a common source of anterior knee pain, often accompanied by quadriceps weakness and reduced control over patellar tracking during movement. Case Presentation: A 25-year-old male reported pain behind the kneecap that had persisted for two months, later diagnosed as chondromalacia patellae. **Objective**: This case study aimed to assess how a structured exercise programme influences quadriceps strength and overall knee function in a patient with this condition. Intervention: The patient underwent a physiotherapy protocol consisting of isometric quadriceps exercises, targeted activation of the vastus medialis obliquus (VMO), progressive strengthening drills, and flexibility/stretching routines. **Results**: Following the intervention, the patient showed marked improvement in pain levels, range of motion, patellar tracking control, and ability to perform daily functional activities. **Conclusion**: A rehabilitation approach combining isometric strengthening with VMO-focused activation proved effective in reducing symptoms and restoring functional knee performance in this patient.*

Keywords: Chondromalacia Patellae, Isometric Exercise, VMO Activation, Quadriceps Strengthening, Knee Function

1. Background

Chondromalacia patella describes the softening and progressive degeneration of the articular cartilage lining the posterior surface of the patella, a process that may advance to fissuring and erosion of the hyaline cartilage (Habusta et al., 2023). Patients typically report pain at the front of the knee that is brought on by stair climbing, squatting, running or sitting for prolonged periods with the knee bent (Willy et al., 2019). The disorder is associated with excessive loading of the patellofemoral joint, and patellar maltracking is thought to contribute to its development (Levy et al., 2023). Recognising the problem early and beginning an appropriate rehabilitation programme are therefore important, both to limit further cartilage damage and to restore knee function.

2. Introduction

Patellofemoral pain is among the most common forms of knee pain, affecting adults, adolescents and physically active populations alike (Smith et al., 2018). Chondromalacia patella sits within this broader clinical picture and is frequently encountered in adolescents, young adults, athletes and other physically active individuals. Its defining feature is softening and degeneration of the cartilage on the posterior surface of the patella; where the process continues, the cartilage surface may tear, fissure and erode (Habusta et al., 2023).

The causes are understood to be multiple rather than singular. Lower-limb muscle weakness, obesity and female sex have been identified as risk factors, and abnormal patellar tracking is thought to play a part (Levy et al., 2023).

Because the vastus medialis obliquus (VMO) is generally regarded as the principal dynamic medial stabiliser of the patellofemoral joint (Dong et al., 2021), any deficit in its activation is of particular clinical interest. That relationship, and the value of isometric exercise in addressing it, forms the focus of the present report.

3. Etiology

The etiology of chondromalacia patella is multifactorial, encompassing mechanical, muscular, anatomical and overuse-related influences. Although the precise cause remains unclear, patellar maltracking together with lower-extremity muscle weakness, obesity and female sex have been described as contributing factors (Levy et al., 2023).

Abnormal patellar tracking is one of the principal mechanical causes. When the patella drifts laterally during knee flexion and extension, pressure rises over the lateral patellar cartilage and progressive degeneration may follow.

Muscular imbalance is a second major contributor. The VMO is oriented so that it can oppose the laterally directed pull generated by the vastus lateralis, and it is this opposing force that keeps the patella centred within the trochlea. Where the medial contribution is diminished-through atrophy, reduced strength or delayed recruitment - the balance of forces shifts and the patella becomes more susceptible to lateral tracking. Dong et al. (2021) measured cross-sectional areas of both muscles on computed tomography in 61 patients with patellofemoral pain syndrome and 61 matched controls, and found significant atrophy of both the VMO and the vastus lateralis in the sections 0–20 mm above the upper pole of the patella, with the VMO more affected at the upper pole itself. Those authors concluded that their findings support combining general quadriceps exercise with targeted VMO strengthening in rehabilitation. (This evidence relates to patellofemoral pain syndrome rather than to chondromalacia patella specifically, and should be interpreted accordingly.)

Patellar mechanics may be disturbed further by tightness in

the lateral retinaculum, iliotibial band, hamstrings, gastrocnemius or quadriceps.

Structural factors also alter patellofemoral loading. These include an increased Q-angle, patella alta, excessive foot pronation, femoral internal rotation and weakness of the hip musculature. Trochlear dysplasia- anatomical defects of the femoral trochlea that disturb normal patellar tracking- is a recognised cause of patellar instability and can be identified radiographically (Cox et al., 2023).

Overuse plays a clear role. Running, jumping, stair climbing and frequent squatting expose the patellofemoral joint to repeated compressive forces and increase the risk of cartilage injury. Additional risk factors associated with the development of the condition include previous knee trauma, a direct blow to the patella, obesity and age-related cartilage degeneration.

Epidemiology

Chondromalacia patella is identified most often in adolescents and young adults, and is commonly described as presenting between 15 and 35 years of age. It occurs more frequently in females than in males. Sex differences in patellar depth and in the lateral patellar contact and inclination angles have been proposed as one anatomical explanation for the higher frequency of patellar cartilage softening in women (Cox et al., 2023); a wider pelvis, a larger Q-angle and variations in lower-limb biomechanics are also commonly cited.

The often-quoted claim that females are affected roughly twice as often as males has prospective support. Boling et al. (2010) followed 1,525 participants at a United States military academy for up to 2.5 years and found that females were 2.23 times more likely than males to develop patellofemoral pain syndrome (95% CI: 1.19, 4.20). Notably, the same study found that prevalence at the point of enrolment did not differ significantly between the sexes (15% in females versus 12% in males; $p = 0.09$), which suggests that the sex difference emerges under high physical training loads rather than being fixed at baseline.

The condition is also common among athletes and among individuals whose activities demand repetitive knee flexion, such as running, jumping, cycling and stair climbing.

Prevalence

Reported prevalence depends heavily on which measure is used, and point prevalence and annual prevalence should not be treated as interchangeable. In a systematic review and meta-analysis of 23 studies, Smith et al. (2018)

reported an annual prevalence of patellofemoral pain of 22.7% in the general population and 28.9% among adolescents. The pooled point prevalence in adolescents was considerably lower at 7.2% (95% CI: 6.3%–8.3%), and in female-only adolescent athletes it was 22.7% (95% CI: 17.4%–28.0%).

Within the general population, one survey included in that review reported an annual prevalence of 29.2% in females and 15.5% in males (Smith et al., 2018), again indicating a higher occurrence among women. A separate military cohort recorded a point prevalence of 15% in females and 12% in males, a difference that did not reach statistical significance (Boling et al., 2010).

Runners, athletes and people in occupations requiring frequent squatting, stair climbing or sustained knee flexion are commonly affected. Reported rates differ considerably between studies because diagnostic criteria, populations and prevalence measures vary (Smith et al., 2018).

Anatomy

The patellofemoral joint is formed between the patella and the trochlea of the femur. The patella is the largest sesamoid bone in the human body, situated anterior to the knee joint within the tendon of the quadriceps femoris, where it increases the effective extension capacity of the quadriceps by lengthening the moment arm of the patellar ligament and protects the quadriceps tendon from frictional forces (Cox et al., 2023).

Patellar stability depends on a complex interaction between active stabilisers, passive stabilisers and the osseous and cartilaginous morphology of the joint (Dong et al., 2021). Among the active stabilisers, the quadriceps group- and the VMO in particular- maintains medial patellar stability and resists excessive lateral displacement. The vastus lateralis, lateral retinaculum, medial patellofemoral ligament, joint capsule and surrounding soft tissues also contribute to overall patellar stability.

The articular cartilage on the posterior surface of the patella articulates with the cartilage-covered trochlear groove (Habusta et al., 2023) and permits smooth, low-friction movement during knee motion. Any imbalance between the medial and lateral stabilising forces may disturb normal patellar tracking and increase stress on the patellofemoral cartilage.

Biomechanics

During knee movement the patella glides within the trochlear groove of the femur and improves the mechanical efficiency of the quadriceps in extension (Cox et al., 2023). The VMO supplies an important medial stabilising force and helps keep this glide on course. When the medial contribution is reduced- whether through atrophy, weakness or delayed recruitment- the laterally directed pull of the vastus lateralis is less well opposed, and lateral tracking becomes more likely (Dong et al., 2021).

Loading of the patellofemoral joint rises during squatting, stair climbing and running, and reproduction of pain during these tasks is used diagnostically in patellofemoral pain (Willy et al., 2019). Isometric quadriceps exercise, by contrast, can be performed with very little knee movement, which makes it a useful option during the early stages of rehabilitation (Özduran & Yıldırım-Güzelant, 2023).

4. Clinical Features

The presentation of chondromalacia patella commonly includes the following features (Habusta et al., 2023; Willy et al., 2019):

- Anterior knee pain, felt mainly around or behind the patella.
- Pain during stair climbing, squatting and running.
- Discomfort after prolonged sitting with the knee bent.
- A grinding, clicking or cracking sensation during knee movement.
- Tenderness on palpation around the patella.
- Weakness or reduced endurance of the quadriceps.
- Reduced or delayed activation of the VMO.

5. Investigations

Diagnosis rests primarily on the patient's history and physical examination; reproduction of retropatellar or peripatellar pain during squatting, and during other activities that load the joint in a flexed position such as stair climbing and descent, is recommended as a diagnostic test (Willy et al., 2019). Radiographs are useful for assessing bony structures and for excluding other causes of knee pain, while magnetic resonance imaging provides considerably better information about the articular cartilage and surrounding soft tissues, and imaging assessment of trochlear dysplasia, patellar height and patellar tilt may also be indicated (Levy et al., 2023). Where a more objective assessment of muscle function is sought, electromyography can be used to examine VMO and quadriceps activation.

6. Management

Treatment is directed at reducing pain, improving quadriceps strength and restoring proper patellar control. Initial management of chondromalacia patella is typically non-operative (Levy et al., 2023). Exercise therapy is the central component: current clinical practice guidelines recommend exercise therapy combining hip- and knee-targeted exercises for patellofemoral pain, delivered alongside patient education (Willy et al., 2019).

Isometric quadriceps exercises allow the muscle to be activated and loaded with minimal knee movement. Özduran and Yıldırım-Güzelant (2023) applied an eight-week quadriceps strengthening programme to patients with chondromalacia patella and reported significant improvement in Q-angle, pain and functional capacity following either isometric or isotonic exercise. Findings such as those of Dong et al. (2021) further support pairing general quadriceps work with targeted VMO strengthening.

Hip and lower-limb strengthening may be added to improve overall movement mechanics, and stretching is prescribed for muscles found to be tight on assessment. Pain-provoking activities such as repeated deep squatting and excessive stair climbing can be modified temporarily and reintroduced as symptoms settle. Patient education and the gradual progression of exercises remain essential components of any rehabilitation programme (Willy et al., 2019).

7. Scope of the Study

This report may contribute to a clearer understanding of the relationship between VMO activation and patellar control in chondromalacia patella. It also offers information on the usefulness of isometric exercise in improving quadriceps function and reducing symptoms, and the findings may assist physiotherapists in planning exercise-based rehabilitation. Further work with larger sample sizes, longer follow-up periods and objective methods such as electromyography would be needed to evaluate changes in muscle activation more reliably.

8. Objectives of the Study

The objectives of this case study were as follows:

- To evaluate changes in functional ability following the exercise programme.
- To assess changes in quadriceps muscle strength.
- To examine the role of VMO activation in patellar control.
- To evaluate the effect of the exercise programme on overall knee function.

9. Case Description

A 25-year-old male patient presented with pain over the posterior aspect of the patella in the affected knee, which had been present for approximately two months. His symptoms were experienced mainly during specific knee-related activities and movements, and clinical assessment led to a diagnosis of chondromalacia patella.

He reported no previous history of knee surgery, total knee replacement, fixed flexion deformity or any other known knee-related condition. On presentation there was mild swelling, together with discomfort during particular functional activities.

10. Clinical Examination

1) Observation

Mild swelling was noted around the affected knee, and pain was evident during certain functional activities and knee movements. No obvious deformity, including fixed flexion deformity, was observed.

2) Palpation

Tenderness was elicited around the patellar region, most notably over the posterior aspect of the patella. Crepitus was felt during knee movement, and tightness was noted in the surrounding soft-tissue structures.

3) Range of Motion

Active range of motion of the affected knee was assessed. The patient demonstrated mild restriction during specific knee movements, particularly those that reproduced his pain. This limitation was associated with discomfort and with tightness of the surrounding structures.

4) Uniqueness of the Study

What distinguishes this report is its combined attention to isometric exercise and VMO activation deficit in a patient with chondromalacia patella. Rather than concentrating on pain relief alone, the study also considers quadriceps muscle activation, patellar control and functional knee movement. Isometric exercise offers a simple and controlled approach to strengthening that can be applied without demanding large

ranges of knee motion. The report may therefore help clarify whether improving quadriceps and VMO activation contributes to better knee function and to a reduction in symptoms in chondromalacia patella.

5) Physiotherapy Intervention

The physiotherapy programme was designed around the patient's symptoms and clinical findings. Its principal aims were to reduce knee pain, improve quadriceps function and enhance control of the patella during knee movement. Isometric exercise, VMO activation and progressive strengthening formed the core of the treatment.

6) Isometric Quadriceps Exercise

Isometric work was introduced so that the quadriceps could contract without repeated movement of the knee. The patient was asked to hold a quadriceps contraction with the knee in a comfortable position, and both the intensity and the number of repetitions were increased gradually in accordance with his tolerance.

7) VMO Activation

Specific exercises were used to encourage better recruitment of the VMO, with the aim of improving medial stabilisation of the patella and its control during knee movement.

8) Progressive Strengthening

As pain settled and movement tolerance improved, strengthening exercises were progressed to build the overall capacity of the quadriceps. This was intended to provide better support and control around the patellofemoral joint.

9) Hip and Lower-Limb Exercise

Exercises for the hip musculature, particularly the abductors and external rotators, were included to improve control of the lower limb during functional movements. Better lower-limb control may in turn help reduce excessive stress on the patellofemoral region.

10) Stretching

Stretching exercises were prescribed for the muscles and soft-tissue structures found to be tight during assessment. The purpose was to improve flexibility and to allow smoother movement of the knee.

11) Activity Modification

The patient was advised to reduce temporarily those activities that aggravated his knee symptoms, including repeated deep squatting, excessive stair climbing and prolonged knee flexion. These activities were reintroduced gradually as his symptoms improved.

12) Patient Education

The patient was educated about his condition, taught the correct performance of each exercise and encouraged to participate regularly in the rehabilitation programme. Advice on activity modification and on a graded return to normal activities was also provided. Throughout the programme he was instructed to maintain proper knee alignment while exercising, and the exercises were progressed as his muscle control improved.

11. Results

Following the physiotherapy intervention, the patient reported reduced knee pain and improved tolerance during functional activities and knee movements. Improvement was observed in quadriceps and VMO activation, with corresponding gains in patellar control and knee movement. Crepitus, patellar tenderness and soft-tissue tightness were also reduced. Taken together, the programme improved knee function and reduced the symptoms associated with chondromalacia patella. The pre- and post-treatment outcome measures are summarised in Table 1.

Table 1: Outcome measures recorded before and after the physiotherapy programme.

Outcome Measure	Pre-treatment	Post-treatment
Pain (VAS)	07/ 10	3/ 10
Knee flexion ROM	115°	130°
Knee extension ROM	5° limitation	0° (full extension)
Patellar tenderness	Present	Mildly reduced
Crepitus	Present	Reduced
Functional activity	Pain during squatting and stair climbing	Improved, with minimal pain

12. Discussion

The present case demonstrated pain, patellar tenderness, crepitus and reduced knee movement in a patient with chondromalacia patella. This presentation is consistent with the wider literature on muscle function in the condition. Saral et al. (2022) compared 48 patients with chondromalacia patella against healthy controls using isokinetic dynamometry and found reduced knee flexion and extension strength in the patient group, with the degree of weakness negatively correlated with symptom duration and magnetic resonance imaging stage. Those authors argued that objective strength testing can help identify weakness early and guide rehabilitation planning.

Consistent with that reasoning, isometric quadriceps exercise and VMO activation were used in the present case to improve muscle strength and patellar control. Özduran and Yıldırım-Güzelant (2023) examined the same question prospectively, allocating 30 patients with chondromalacia patella to eight weeks of either isometric or isotonic quadriceps strengthening and assessing pain with a visual analogue scale, functional capacity with the Lysholm

scale and quality of life with the Short Form-36. They reported significant improvement in Q-angle, pain and functional capacity following either exercise modality. The improvements recorded in the present patient — in pain, range of motion and functional tolerance — are in keeping with the direction of those findings.

Several limitations should be acknowledged. A single case cannot establish the effectiveness of an intervention, since improvement may reflect natural resolution, regression to the mean or non-specific effects of clinical contact rather than the exercise programme itself. No control condition was available, and outcomes were assessed clinically rather than instrumented; in the absence of electromyography or dynamometry, statements about changes in VMO activation

and quadriceps strength rest on clinical observation rather than objective measurement. Follow-up was limited to the treatment period, so the durability of the improvement is unknown.

13. Conclusion

This case study indicates that physiotherapy-based exercise may be helpful in the management of chondromalacia patella. Isometric quadriceps exercises combined with VMO activation improved muscle function, patellar control and knee movement in this patient, and improvement was observed in pain, knee mobility and functional performance following the intervention. Given the limitations of a single-case design, these observations should be regarded as hypothesis-generating rather than confirmatory, and warrant testing in controlled studies with objective measures of muscle activation.

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