EVALUATION AND REHABILITATION FOR ANTERIOR KNEE PAIN

A Case Report

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By
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Rehabilitation for Anterior Knee Pain

APPROVAL SHEET

This case report is submitted in partial fulfillment of
the requirements for the degree of
Doctor of Physical Therapy

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The final copy of this case report has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the abovementioned discipline.
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# Rehabilitation for Anterior Knee Pain

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ABSTRACT

Study Design: Case report

Background: Research has demonstrated that anterior knee pain may be the result of biomechanical changes in both proximal and distal structures surrounding the knee; therefore an algorithm was developed to encompass the many causative factors, evaluative techniques, and treatment options for individuals presenting with this particular condition. This case report details the implementation of a rehabilitation program for an active female with complaints of patellofemoral pain, utilizing a comprehensive anterior knee pain algorithm.

Case Description: The patient was a 59-year-old female, otherwise healthy and active, but presenting to physical therapy with a history of insidious anterior knee pain. Following a fall the patient suffered a Jones fracture of the right foot and was prescribed a walking boot with instructions for non-weight bearing for 6 weeks. Following discharge from the boot the patient noticed knee pain. At initial evaluation, primary findings included: inadequate pelvic control, crepitus with active knee extension, navicular drop and forefoot abduction of the right foot, and weakness of the right knee flexors, extensors, and abductors. Outcome measures including the numeric pain rating scale, Kujala scale for patellofemoral pain, and the Lower Extremity Functional Scale. Treatment consisted of therapeutic exercises targeting the hip abductors and external rotators to establish normal pelvic control during dynamic activities. Stretching exercises focused on elongation of the quadriceps musculature and the gastrocnemius and soleus. Following 9 visits the patient demonstrated improved dynamic control of the hip, normal strength values for hip musculature, and no pain with activities.
Outcomes: Scores on the NPRS improved 70 to 80%, and the Kujala scale score improved by 31 points, signifying a significant improvement. At discharge, the patient reported 0/10 knee pain during all work and recreational activities, and she was able to completely return to her prior level of function.

Discussion: This case example describes the immediate and short-term clinical outcomes for a patient presenting with symptoms of knee pain following prolonged immobilization. This case report also demonstrates the effectiveness of an anterior knee pain algorithm in the treatment of knee pain, utilizing a regional interdependence approach.
INTRODUCTION

Patellofemoral pain syndrome (PFPS) is a medical diagnosis associated with pain at the anterior knee, including the patella and surrounding soft tissue structures. Common complaints include pain with prolonged knee flexion or with climbing or descending stairs. It is also commonly referred to as chondromalacia.\textsuperscript{1} Patients with patellofemoral pain may also complain of the knee giving way, which may be secondary to quadriceps weakness or it may indicate patellar instability.\textsuperscript{2} It is known to afflict female and youth athletes more than other subpopulations, and is one of the most prevalent diagnoses that require referral to physical therapy. Boling et al. studied one thousand five hundred and twenty-five participants from the United States Naval Academy and found the incidence rate for PFPS to be 22/1000 during a 2.5-year longitudinal study.\textsuperscript{3} Physicians and certified athletic trainers documented cases of PFPS based on diagnostic criteria. These criteria included: pain with ascending/descending stairs, hopping/jogging, prolonged sitting, kneeling, and squatting. Furthermore, each patient had to be examined for pain with palpation of the patella or femoral condyles. The examination also served to rule out ligamentous or other soft tissue pathology. The study demonstrated a higher prevalence in females of 2.23:1, which echoes historical data.\textsuperscript{3} In 240 middle and high school female athletes the presence of PFPS occurred in 16.3 per 100 athletes, which supports the clinical data that young female athletes are the greatest at-risk population for developing patellofemoral pain.\textsuperscript{4}

A 2006 examination of clinical and radiological tests for patellofemoral pain by Haim et al.\textsuperscript{5} employed few sensitive tests, which could be validated for PFPS. Haim et
al. \(^5\) evaluated the following tests: patellar tilt, active instability, patellar apprehension, and patella alta test. They found these four tests to have very low sensitivity (less than 50%), but specificity ranges were moderate to high (72% to 100%). Physical examination findings that were deemed significant by the study included: increased Q angle, lateral and medial retinacular sensitivity, patellofemoral crepitation, squinting patella, and reduced mobility of the patella. From a radiologic perspective, only patellar subluxation was found to be a significant indicator for PFPS in the subject pool. These findings all highlight the need for a comprehensive examination in order to truly understand the etiology of PFPS with research-based support.

Physical therapy intervention significantly improves outcomes when treating anterior knee pain associated with patellofemoral pain syndrome, as evidenced by Crossley et al. \(^6\) results from a randomized, double-blinded, placebo-controlled trial. \(^6\) Employing a six-week regimen of physical therapy in patients 40 years of age or younger with patellofemoral pain, the authors compared physical therapy outcomes to a placebo group. The results demonstrated significantly greater reduction in scores for average pain, worst pain, and disability in the physical therapy group, suggesting the efficacy of appropriate physical therapy interventions in treating patients with anterior knee pain. Effect sizes were large for these outcomes, with the relative risk of improvement for participants in the physical therapy treatment equal to 1.41 (p=0.05).

Dixit et al. \(^2\) identified numerous possible risk factors cited from different resources for patellofemoral pain syndrome including: anatomic anomalies, malalignment and altered biomechanics of the lower extremity, muscle dysfunction, patellar hypermobility, poor flexibility of lower extremity musculature, previous surgery,
tight lateral structures, training errors or overuse, and trauma. Treatment options can be variable due to these various etiological factors; in fact, PFPS can be a challenge if all possible contributing factors are not considered. It is important for the therapist to keep in mind that rehabilitation exercises may restore joint homeostasis, but anatomical malalignments may not be corrected.7

Patellofemoral pain syndrome is one of the most prevalent diagnoses in the orthopedic setting; in fact, 2.5 million of the 20 million runners in the United States will be diagnosed with PFPS.8 As a result, gaining comprehension in a more efficacious manner is strongly suggested to be advantageous in treating these patients. Much of the literature on PFPS has focused on the diverse contributing factors; however, there are minimal rehabilitation protocols that integrate a multi-factorial approach. Successful physical therapy is reliant upon the appropriate diagnosis and its predetermining factors. Therefore, to achieve better outcomes with PFPS patients, one must develop knowledge of known risk factors and the use of evidence-based interventions. As a result, it is necessary to determine rehabilitation protocols for patients with anterior knee pain based on the underlying etiology.

Anterior knee pain early in life can be clinically significant in determining a patient’s risks of developing functional deficits and joint degeneration. In fact, some authors suggested a predisposition to patellofemoral osteoarthritis later in life when anterior knee pain presents itself in adolescence or young adulthood. Understanding the underlying pathology and its implications is vital to patient prognosis. Patellofemoral pain syndrome is often associated with decreased physical activity and may impact a patient’s likelihood of developing osteoarthritis.9 Changes in quality of life, physical
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activity level, financial burden, and psychological stress related to the chronic nature of PFPS are only a few of the reasons why this condition is a serious health risk. To properly understand and treat PFPS, its many aspects must be addressed and evaluated. It is the role of the physical therapist to integrate past knowledge with current research to treat the symptoms and ultimately improve patient outcomes. When used appropriately, physical rehabilitation programs to treat anterior knee pain have demonstrated to be an effective conservative option, with results ranging from 82% success rate in decreasing the severity of symptoms in athletes with chondromalacia patella, to an 87% initial success rate for a combination physical therapy and NSAIDs intervention.10

CASE DESCRIPTION

The patient was a 59-year-old female presenting to physical therapy with a history of gradually increasing knee pain that began approximately 2 months prior to the initial visit. The patient reported the pain started following a fall; thus, she underwent a series of plain films after seeing her primary care physician, and she was diagnosed with a Jones fracture of the right foot. The patient was immobilized with instructions for non-weight bearing for 6 weeks followed by prescription of a walking boot for approximately 6 weeks. Following discharge from the walking boot the patient noticed pain in her foot and knee with daily activities. She denied improvement with conservative therapy and rest, stating that it actually made her symptoms worse.

The patient was an otherwise healthy active female without any prior medical complications that could possibly restrict her from participating in a physical therapy program. Her chief complaints upon arrival to physical therapy included: intermittent, moderate ache in the anterior aspect of the knee and intermittent, moderate ache in both
quadriceps muscle groups. Activities that increased the patient’s symptoms were stair
climbing and squatting, and she reported symptoms were worse in the morning. The
patient described one to two prior episodes of similar knee pain, with the most resent
onset occurring five months prior to evaluation. Work-related physical tasks required by
the patient’s occupation included standing and walking, while the patient’s home required
her to mount interior stairs. Prior and existing conditions included the aforementioned
Jones fracture of the right foot as well as a history of high cholesterol. A total knee joint
arthroplasty of the right side was performed three years prior, with the patient reporting
no complications following the procedure. The patient stated her goals for therapy were
to return to her prior fitness-related activities including dance aerobics, which she
performed on average five times per week.

LITERATURE REVIEW

Biomechanics

The knee actually consists of multiple joint structures—the tibiofemoral joint and
the patellofemoral joint. The tibiofibular joint does not actively contribute to knee
motion; therefore it is typically not addressed in the discussion of knee biomechanics.
Tibiofemoral joint motion occurs in all three anatomical planes; however, range of
motion is greatest in the sagittal plane. Range of motion in the sagittal plane is typically
from 3° of knee hyperextension to 155° of knee flexion. Transverse plane motion may
also be described scientifically as laxity; motion in this plane is restricted by soft tissue
structures including ligaments, the joint capsule, and menisci. Transverse plane motion is
most restricted in full knee extension, as the femoral and tibial condyles are in a closed-
pack position. Laxity increases as the knee is flexed, reaching a maximum around 30° to
40° of flexion. Peak transverse plane movements are 18° of external tibial rotation and 25° of internal rotation. These ranges remain constant until about 120° of knee flexion, where they then decrease as knee flexion angles increase. Similar to transverse plane motion, frontal plane motion varies with sagittal plane movements. Abduction and adduction movements increase up to 30° of knee flexion, but only occur within a few degrees. Extension kinematics of the knee are characterized by the “screw-home” mechanism, which occurs when the tibia rotates externally and contact points shift anteriorly during end range of knee extension. The screw-home mechanism occurs due to the size relationship between the medial and lateral femoral condyles, as well as tibial bony surfaces. The result of this mechanism is a stable knee position in the full-extended position. The patellofemoral joint is comprised of the patella’s articulation with the femoral trochlea. The patella is a sesamoid bone, which acts as a lever to increase the moment arm of the patellofemoral joint, creating a greater mechanical advantage. The patella rests near the femur’s cartilage-bearing surface in early flexion, initiating contact with the femur at 20 degrees of flexion then following the intercondylar notch of the femur near 90° of knee flexion.6 Near terminal flexion the patella sinks down between the femoral condyles.11 Dynamic and static stabilizers control the patellofemoral joint, in particular the tracking of the patella throughout knee flexion ranges. If these stabilizers are weak or malaligned, the potential for subluxation or dislocation injury increases, particularly during the first 30° of flexion, as the patella has not yet engaged with the patellar groove.12 Stabilization of the patella is achieved from several soft tissue structures including the medial and lateral retinaculum. The medial retinaculum is thinner, and consists of three ligaments—the medial patellofemoral ligament, the medial
patellomeniscal ligament, and the medial patellofibial ligament. The medial patellofemoral ligament merges with the vastus medialis obliques to create the primary mechanism for resisting excessive lateral patella deviation. The lateral retinaculum consists of a superficial and deep layer, and provides support along with the IT band.\textsuperscript{13}

Anterior knee pain originating from these structures may be physiologically linked to substance-P, which is involved in nociceptive input to the spinal cord. Substance-P creates vasodilation and encourages inflammation, and it has been found in the soft tissue supports of the patella.\textsuperscript{14}

**Evaluation**

Due to the multifactorial etiology of PFPS, evaluation tools chosen to determine the nature of the patient’s anterior knee pain must target any and all of these potential causes. Despite inconsistent literature supporting the specific causes of PFPS, the therapist must take into account all current evidence-based research to determine the appropriate tests to employ during the evaluation procedure. Papadopoulos et al. aimed to identify the clinical assessment tool that could differentiate PFPS patients from those with other lower limb pathology.\textsuperscript{15} Their research followed a previous study in which the methods therapists used to assess, treat, and measure PFPS outcomes were identified. Strength and flexibility were primarily targeted, while visual analogue scales were utilized to track subjective patient data. The special tests examined in Papadopoulos’ research included: a Modified Thomas test, Patella Compression test, Flexibility tests, a series of isometric strength tests measured by a portable dynamometer, and a functional stress protocol. Quadriceps and hamstring tightness were the primary targets of flexibility tests, while strength tests evaluated knee extension, hip abduction, and hip
external rotation strength. The functional stress protocol involved two sets of 30 repetitions from a clam position to 30° of hip abduction with resistance from a red Thera-Band (The Hygenic Corporation, Akron, OH, USA). No statistical difference was found between patients with PFPS and those without from the Modified Thomas test or the Patella compression test. The only flexibility measure that showed significance between groups was the iliopsoas, which showed a significantly greater trend within the PFPS group. Strength tests revealed no between-group differences; however, the Functional Stress test revealed that both groups experienced fatigue, but that the PFPS group had much greater difficulty recovering successfully (p≤0.001). This study demonstrates the difficulty this pathology presents to physical therapists, as even the diagnostic tools have not yet reached an acceptable standard. Nevertheless, evaluation of the lower limb in its entirety along with the core must be taken into consideration. Strength, flexibility, and neuromuscular control have been previously shown to contribute to anterior knee pain, and these are key components of a comprehensive examination.

Contact Pressures

One of the underlying themes in PFPS research centers on factors that create increased patellofemoral joint stress. Farrokhi et al.\textsuperscript{16} matched ten females with anterior knee pain with ten gender, age, and activity-matched pain-free controls. Patella and femur stress profiles were measured with the joint at 15° and 45° of knee flexion. Peak and mean hydrostatic pressure as well as octahedral shear stress were quantified. The results revealed individuals with PFPS had consistently greater peak and mean hydrostatic pressure as well as peak and mean octahedral shear stresses. Elevated joint stress, in turn, leads to cartilage degeneration, and eventually subchondral bone damage.
Maltracking

Altered tracking of the patella during knee extension is considered one of the primary factors related to PFPS. Deviations in patellar tracking are often the result of anatomical variables, such as the quadriceps or Q-angle. The Q-angle, a static measurement, is an angle centered at the patella formed by the anterior superior iliac spine (ASIS), center of the patella, and tibial tuberosity (Figure 3). As the quadriceps contract, the angle is reduced and the patella is pulled into a more lateral position. An excessive Q-angle (>15°) is considered a possible etiological factor in anterior knee pain, particularly in the female population; however the usefulness of the Q-angle as a predictive measure of anterior knee pain is divisive. Females are more likely to display larger Q-angles as a result of the wider pelvis in female anatomy because the femur must be situated at an increased angle so that the femoral condyles may run parallel with the ground.
Figure 3. Measuring Q-angle. From Kisner & Colby (2007).

Figure 4. Figure 4. (A) Real-time MR images of the patellofemoral joint of a pain-free control subject during upright, weight-bearing knee extension. (B) Real-time MR images of the PF joint of a subject with pain during upright, weight-bearing knee extension. Notice the lateral position and rotation of the patella relative to the femur as the pain subject nears full extension. These are oblique-axial views through the knee corresponding to four knee flexion angles between 0 and 60°. From Draper et al. (2009).
Patellar Position

Aside from irregular movement patterns of the patella during extension activities, initial position of the patella may be a contributor to this disorder. For instance, patella alta, or high-riding patella, has been associated with increased patellofemoral pain from less medial-lateral soft tissue constraint and lateral tracking at lower knee flexion angles.\textsuperscript{19} Although there are several radiologic methods that have traditionally been used to evaluate patellar height, there is some disagreement about the best and most reliable approach.

Pes Planus

Altered subtalar joint motion has been linked to anterior knee pain including changes in joint position and timing of motions during normal gait motion. Levinger and Gilleard measured rearfoot and tibia motion as well as the ground reaction forces during the stance phase of walking between healthy subjects and those with a PFPS diagnosis.\textsuperscript{20} Employing a four-camera motion analysis system and force plate technology, all three planes were measured in 13 symptomatic female subjects and 14 healthy females. Results revealed a significant difference in peak rearfoot eversion and peak dorsiflexion. The PFPS group displayed a significantly delayed time to reach peak rearfoot eversion, while peak dorsiflexion was achieved earlier for this group. Moreover, significantly lower ground reaction forces were found in the PFPS group, suggesting less ability to perform propulsion during a normal gait sequence.\textsuperscript{21}

Heel Height

High-heeled shoe wearing has often been identified as a risk factor for developing knee pain; however, few studies have objectively put this theory to the test. Ho et al. \textsuperscript{22}
aimed to measure the patellofemoral joint kinetics during high-heeled walking to determine if these shoes significantly increased forces on the knee. Kinematic and kinetic measurements were obtained using three different shoe conditions—low heel, medium heel, and high heel. With increasing heel height, the authors found a significant increase in peak patellofemoral joint stress.

**Lateral Retinaculum & IT Band Tightness**

The lateral retinaculum plays a direct role in patellar stabilization, as it serves as the primary lateral attachment of this sesmoid bone. Continuous with the large and lax joint capsule of the knee, the lateral retinaculum contributes to the non-muscular constraint of the patella. Tautness of the lateral restraints may contribute to increased lateral forces on the patella, thus increasing contact pressures at the patellofemoral articulation.\(^{23}\)

The iliotibial band (ITB), if under enough tension, has been implicated as another possible reason for excessive lateral tracking of the patella due to its attachment to the lateral retinaculum. This taught fascial structure serves as an attachment site for the gluteus maximus and tensor fascia lata that contributes to stance stability and preventing large torques at the knee.\(^{24}\)

**Hallux Valgus**

Based on the theory that PFPS is derived from biomechanical gait deviations with various etiologies, Kaya et al.\(^{25}\) hypothesized that patients with anterior knee pain would also exhibit hallux valgus on the affected limb. The authors argued that hallux valgus is often associated with over-pronation, and so they measured hallux valgus and
intermetatarsal joint angles using anteroposterior radiographs in ninety-nine patients with unilateral patellofemoral pain.

**Hamstring Muscle Length**

Branching off the idea that increasing muscle length is a common treatment for PFPS, White et al.\(^{26}\) performed a cross-sectional observational study using 11 subjects with patellofemoral pain syndrome and comparing them with 25 asymptomatic controls to determine if restrictions in hamstring muscle length were correlated to PFPS. Using passive knee extension to measure the popliteal angle, White et al.\(^{26}\) found a mean difference between the control and symptomatic group of 8.0° to be statistically significant. With such a small sample size as one possible detriment to the study, the authors pointed out that this data does not reveal whether decreased hamstring length was a cause or effect of PFPS, and further inquiry into this relationship is necessary.

**Hamstring Weakness/Under-activation**

There is a significant amount of literature identifying hamstring weakness as a possible link for anterior knee pain. Liebensteiner et al.\(^{27}\) examined hamstring activity during maximum eccentric leg press exercise in nineteen patients with PFPS and 19 controls. To simulate functional conditions, foot endplates with variable stability were used to assess activation patterns under each circumstance. Surface electromyography assessed the level of activation of muscles crossing the knee during the eccentric activities, and the results suggested that PFPS is associated with under-activation of the hamstrings during eccentric loading. PFPS patients were found to have significantly lower degrees of hamstring activation during the eccentric activities, with differences
ranging from 20% (semitendinosus, stable footplate) and 21% (biceps femoris, unstable footplate), to 32% (semitendinosus, unstable footplate).

**Hip Muscle Weakness**

Physical therapy practices have matured through time, and with the increased use of a regional interdependence model it should come as no surprise that PFPS has been linked to hip muscle weakness. Numerous studies have focused on the hip in determining the association between proximal muscle activation patterns and anterior knee pain. Magalhães et al. \(^{28}\) compared hip strength between sedentary females with and without patellofemoral pain syndrome under the belief that hip muscle weakness may be an important factor in the etiology of PFPS. A cross-sectional study consisting of females ranging in age from 15 to 40 years old was performed to assess the strength of all six hip muscle groups bilaterally in a symptomatic group (n = 50) and a control group (n = 50). The researchers found statistically weaker hip musculature in sedentary females with bilateral PFPS (12%-36%, p < 0.05) than the control group for all muscle groups. In subjects with unilateral PFPS, the hip abductors, lateral rotators, flexors, and extensors of the affected side were statistically weaker (15% to 20%, p < 0.05). However, only the hip abductors were significantly weaker when compared to the unaffected side. These results demonstrated that hip weakness is a common finding in sedentary females with PFPS.\(^{28}\)

**Lumbar Radiculopathy**

In the presence of leg pain, lumbar radiculopathy and stenosis are common etiologies. Lumbar radiculopathy occurs when lumbar nerve roots are damaged, causing radicular symptoms in one or both of the lower extremities. Direct nerve compression
may be a result of acute or chronic disc herniations, bone spurs, foraminal stenosis, central stenosis, or vertebral segment hypermobility. Any of the lumbar nerve roots may be affected; however, L5 and S1 nerve roots are typically involved. Another typical complaint of patients with stenosis is lower extremity weakness and leg pain as a result of neurogenic claudication.

**Joint Laxity**

Joint laxity associated with generalized hypermobility may lead to reports of musculoskeletal pain, and at the knee this may coincide with acute episodes of pain and even dislocation. Benign joint hypermobility syndrome (BJHS) is a connective tissue disorder characterized by hypermobility with the absence of systemic rheumatologic disease. The primary clinical presentation of BJHS is hypermobility and pain in multiple joints.

**Quadriceps Weakness**

A plethora of research has been dedicated to the role of the quadriceps in the development of anterior knee pain. The quadriceps muscle group serves as a dynamic stabilizer of the knee, and therefore directly affects the patellofemoral joint. Consequently, changes in quadriceps function may be attributed to anterior knee pain. Some research suggested that knee joint effusion may cause a decrease in muscle force output and motor neuron recruitment of this muscle group. Arthrogenic muscle inhibition (AMI) is said to be the mechanism behind this theory.

Strengthening of the quadriceps is necessary in many cases of anterior knee pain, particularly if the patient demonstrates significant losses in quadriceps force. In a randomized controlled trial, Herrington and Al-Sherhi compared the efficacy of non-
weight-bearing single-joint quadriceps exercise versus weight-bearing multiple-joint quadriceps exercise for individuals with PFPS. The results from two exercise groups compared to a control demonstrated a statistically significant decrease in pain and an increase in muscle strength between both groups after one group performed knee extension exercises and the other a seated leg press for a 6-week treatment period.

Another treatment option with research-based evidence is the implementation of taping to normalize the VM vs. VL strength ratio, and therefore patellar tracking. Paoloni et al. performed a cohort study of forty-four patients with diagnosed PFPS and an activation imbalance between the vastus medialis obliquus and vastus lateralis and attempted to identify the long-term functionality and pain outcomes following rehabilitation and taping techniques. Using patellar taping followed by a rehabilitation program, Paoloni et al. saw significant differences in all the outcome measures between the affected and unaffected sides before treatment. This included significant declines in pain scores post treatment and at a 12-month follow-up.

**Symptomatic Bipartite Patella**

Bipartite patella occurs when ossification centers in the patella fail to fuse, resulting in separate bone fragments that are connected by fibrocartilaginous tissue. This anatomical anomaly has a reported incidence of 0.2% to 6% in adults, while another study of young adult men serving in the military reported 9.2 cases per 100,000 recruits. Bipartite patella is often asymptomatic; however, anterior knee pain may be reported after a single direct trauma or repetitive minor injuries. Patients with symptomatic bipartite frequently report pain while squatting, jumping, or climbing stairs, as well as most movements with active quadriceps contraction.
Leg Length Discrepancy

Along with previously discussed biomechanical factors affecting the prevalence of anterior knee pain, leg length discrepancy may be a factor in chronic knee symptoms. Knutson performed a web-based search related to data on leg-length inequality and found the incidence of leg length discrepancy to be 90%, with the mean difference equaling 5.2 mm, with a standard deviation of 4.1.³⁵

Poor Quadriceps Flexibility

Goniometric measurements focusing on quadriceps flexibility showed significant differences between those with patellofemoral pain and control subjects.³⁶ The subjects with symptomatic patellofemoral pain showed significantly lower values in degrees (124.62 PFPS compared to 132.21 in the control).

Articular Cartilage Injury

Injuries to the articular cartilage lining the joint surfaces can contribute to anterior knee pain as well. Lesions in weight-bearing joints often fail to heal on their own due to the poor vascularity of articular cartilage, and pain, loss of function, and long-term complications are typical markers for this pathology.³⁷ Clinical presentation may include insidious onset pain with or without effusion, joint-line and/or patellofemoral pain, locking or catching of the knee, or a loose body.³⁸

Bone Tumors

Primary bone tumors are rare, and they typically affect children and adolescents in greater numbers; however, benign bone tumors are more likely to occur as a metastasis from another source in the body. There are numerous classifications of malignant bone tumors, with most presenting in a relatively similar manner. Specific considerations in
the evaluation that may point to this pathology are prior benign/malignant lesions, family history, and previous radiotherapy.\textsuperscript{39}

**Osgood-Schlatter Disease**

Osgood-Schlatter disease is caused by repeated tensile force from the patellar tendon on an immature tibial tuberosity. Inflammation, avulsion fractures, and excess bone growth at the tibial apophysis are common findings.\textsuperscript{40} Typical presentation of the disease includes anterior knee pain with gradual onset, swelling and point tenderness at the tibial tuberosity, with increased pain reported during knee extension activities.

**Osteochondritis Dissecans**

Osteochondritis dissecans (OCD) is a typically idiopathic acquired condition in which subchondral bone becomes avascular. If healing does not occur, the bone-cartilage complex may become loose from the underlying bone, which may result in loose bodies within the joint. Knee pain, loss of motion, and destruction of articular cartilage are associated with osteochondritis dissecans.\textsuperscript{41} Possible etiologic factors contributing to osteochondritis dissecans include trauma, endocrinopathies, and vascular insults.\textsuperscript{42}

**Patellar Stress Fracture**

Stress fractures of the patella are a rare source of anterior knee pain, secondary to the miniscule frequency of this pathology. Having to withstand significant axial tension originating from the quadriceps and patellar tendon attachments, the patella is at risk for fracture as a result of repetitive stress of time. These fractures are more frequently seen in the athletic population, and various systemic factors play a role in the development of a patellar stress fracture. These may include: hormone imbalances, nutritional deficiency, sleep deprivation, collagen abnormalities, or a metabolic bone disorder.\textsuperscript{43}
Patellar/Quadriceps Tendinopathy

Also known as “jumper’s knee,” patellar tendinopathy is an overuse condition that is most prevalent in young athletes, particularly those who perform repetitive jumping, kicking, or running movements. The extent of damage can range from chronic degeneration of the tendon to an actual tear. Quadriceps tendinopathy is less common than patellar tendinopathy; however, the findings for each are very similar.

Osteoarthritis

Knee osteoarthritis is classified as either primary or secondary. Primary osteoarthritis (OA) is idiopathic, while secondary OA may have many possible sources. Possible etiologies associated with secondary OA of the knee include: post-traumatic, congenital/malformation, malposition, postoperative, metabolic, endocrine disorders, or aseptic osteonecrosis. The hallmark of osteoarthritis is the breakdown of the cartilaginous matrix of the femur and/or tibia, and the greater breakdown of cartilage that occurs, the more the disease will progress. The knee is the most commonly affected joint associated with osteoarthritis, and pain is the most common symptom. Severity of knee pain; however, ranges widely, from none to immobilizing or disabling.

Pes Anserine and Prepatellar Bursitis

The combined insertion of the sartorious, gracilis, and semitendinosis tendons is referred to the pes anserinus. Immediately below this common insertion point is one of many bursa found around the knee. As a result of the difficulty in differentiating between tendinitis and bursitis at this location, complaints of pain may be referred to as pes anserinus tendino-bursitis. Knee pain is a common complaint with pes anserinus tendino-
bursitis syndrome; however, the specific structural defect responsible for this pain is not easily understood.\textsuperscript{45}

**SUMMARY**

Anterior knee pain is a commonly seen disorder in the physical therapy profession. In order to design an individualized rehabilitation protocol for a patient, a physical therapist must fully understand the factors contributing to the pathology; however, not all therapists take the time to perform a comprehensive examination. As a result, improvements must be made that make it easier for a clinician to understand and identify the common causes of patellofemoral pain. Furthermore, once the underlying pathology has been identified, resources should be available for therapists to make an educated and proper decision for future interventions. The development of a rehabilitation algorithm may fit these needs.

**CASE REPORT**

Anterior knee pain, or patellofemoral pain, is a condition in which symptoms of pain, swelling, weakness, and possibly instability result from a dysfunction of the articulation between the patella and the femur. There are numerous conditions of musculoskeletal origin that can elicit such symptoms; and the etiology of this condition is multifactorial. Anterior knee pain has become one of the most frequent diagnoses seen in orthopedic physical therapy clinics with a reported incidence of 10\% of all visits in this setting, including 30\% of adolescents.\textsuperscript{46} Additionally, the athletic population is afflicted with greater incidence, with one in four athletes experiencing anterior knee pain.\textsuperscript{47} The source of patellofemoral pain can come from many origins, but most are the result of structural and/or movement-related deviations that predispose the patient to altered
kinematics at the patellofemoral articulation. Despite abundant research on associated risk factors for anterior knee pain, a clinical practice guideline has yet to be developed to outline the interventions with the highest level of research-based evidence. In order to appropriately treat the condition, the physical therapist must perform a thorough screening of the entire lower extremity including assessment of posture, range of motion, strength, and neuromuscular control. The chosen treatment plan should address deficits discovered during the examination phase, and with an individualized therapeutic approach that specifically addresses the patient’s needs a good prognosis is likely. Evidence has shown significant improvements in pain and function with physical therapy intervention compared to no treatment; however, the lasting effects of physical therapy intervention have yet to be proven on a long-term basis.48

Tests and Measures

The following results were derived from examination of the patient’s right knee:

**Differential Diagnosis Screening:** A thorough screening process including a detailed past medical history was performed to identify any possible differential diagnoses of non-musculoskeletal origins to determine the appropriateness of physical therapy intervention for this particular patient. The results of this screening were unremarkable, and the physical therapist determined that the patient’s presentation was consistent with musculoskeletal disorder.

**Observation:** The patient was unable to perform a single leg stance with eyes open for thirty seconds. Moderate movement abnormality was noted as patient performed this task with compensations, but no pain. Single leg squat revealed severe impairment on the left side compared with complete impairment on the right side. The
patient was only able to complete 1 of 4 lower quarter segments during the squat on the left side, while alignment was not maintained in any of the 4 segments on the right side. Walking gait revealed inadequate control of pelvic lateral tilt during midstance. Audible cracking and crepitus could be heard during active knee extension. Mildly excessive navicular drop (6 to 10 mm) noted on the right foot as well as mildly excessive forefoot abduction. Although pes planus foot posture was observed bilaterally, the right foot was more severe than the left. Mild hallux valgus was observed on the left foot as well.

**Neurological Testing:** A quick screening of neurological function including myotomal testing was unremarkable.

**Special Tests:** Knee meniscal and ligamentous special tests were negative. The Clark’s sign for patellofemoral pain was positive.

**Palpation:** Palpation of the thigh musculature did not provoke any symptoms.

**Flexibility and Range of Motion:** Flexibility and muscle length testing revealed limited sciatic nerve/hamstring mobility as assessed by the 90/90 position, as the patient lacked between 30° and 60°. The patient was also limited in hip extension and knee flexion as well as ankle dorsiflexion. Left side ankle dorsiflexion was measured at 10°, while the right side was limited to 6° but the movement itself was reported as pain free.

**Strength:** Manual muscle testing revealed weakness of the right quadriceps, hamstring, and hip abductor muscle groups. Knee extension strength was measured at 4/5. Knee flexion and ankle plantarflexion were both within normal limits. Severe impairment of a dynamic strength exercise was found as the patient was unable to control anteromedial dynamic balance of the right side compared to the left.
Functional Assessment: The patient reported mild difficulty with standing weight shifts, with complaints of reproduction of knee symptoms as well as feelings of unbalance. Squatting elicited symptoms past 45° of knee flexion; however, kneeling did not elicit symptoms, as the patient stated she could stand for periods up to 45 minutes without knee pain. The patient described severe difficulty with walking long distances, as she was only able to ambulate household distances without pain, and she also had difficulty walking on uneven surfaces without an external support for balance. Pain with stairs, descending greater than ascending, limited the patient to climbing less than 10 steps due to knee symptoms.

Self-Reported Measures

Numeric Pain Rating Scale: The patient’s current pain intensity for knee symptoms was measured using an 11-point numeric pain rating scale (NPRS) ranging from 0 (no pain) to 10 (worst pain imaginable). Follow-up pain intensity scores derived from the scale are provided in TABLE 1. The NPRS is a commonly utilized tool used in the clinic setting to track patient progress, and it has been found to have a moderate overall standardized effect size in patients with patellofemoral pain.49 Piva et al. found a decrease of at least 1.2 points on the NPRS represented a meaningful improvement in physical function and patient satisfaction in patients with PFPS.

Kujala Index: The Kujala patellofemoral outcome score is a 13-item validated outcome measurement specifically designed to look at outcomes in the patellofemoral pain patient population. The overall score can range from 0 points (worst function) to 100 points (excellent function), and patients are assessed on their abilities and symptoms related to activities such as: limping, standing, walking, stair climbing, squatting,
running, jumping, and prolonged sitting. Each activity is categorized by 3 to 5 levels, indicating the severity of symptoms or difficulty of the activity.  

**Lower Extremity Functional Scale (LEFS):** The Lower Extremity Functional Scale (LEFS) is a reliable and validated tool based on the World Health Organization’s model of disability and handicap. It was designed to be an efficient means of evaluating a broad range of lower-extremity orthopedic conditions including a wide range of patients. Papadopoulos et al. 51 found the LEFS to be effective in differentiating between patients suffering from patellofemoral pain syndrome and other lower extremity conditions. The LEFS consists of 20 items, each with a maximum score of 4, for a total possible score of 80. Reliability and validity of the LEFS has been shown in numerous studies, and the minimal detectable change has been reported as 9 scale points. 51 The patient in this case report had an initial score of 28, which underlines a severe activity limitation.

**Clinical Impression**

Based on findings from the initial examination, the patient in this case report presented with symptoms suggesting knee movement coordination deficits associated with a patellar tracking dysfunction. This diagnosis was based on strength and flexibility deficits as well as observations of decreased neuromuscular control during functional single leg activities. The patient primarily fell under the following categories in the anterior knee pain algorithm: muscle weakness, pes planus, and muscle tightness. Therefore, the following recommendations were established for treatment: proximal strengthening including the trunk and hip external rotators, muscle lengthening and soft tissue interventions to address flexibility deficits, strengthening of the quadriceps
musculature, and foot and ankle soft tissue mobilization. At present, there has not been a clinical prediction rule or guideline developed for this population; however, there is sufficient evidence for the abovementioned treatment options to create an applicable plan of care for this patient. Along with clinical reasoning, the physical therapist used evidence-based practice to determine the patient’s physical therapy management. Adjustments to the plan of care were made accordingly based on patient reports of pain, anxiety, or fear.

**Intervention**

Subsequent treatment sessions focused on addressing flexibility and strength deficits as well as minimizing pain during functional and recreational activities. Closed chain strengthening exercises are preferred in this patient population during early rehabilitation phases in order to protect the knee joint from joint positions near full knee extension that may exacerbate symptoms. To address range of motion and flexibility deficits, therapeutic exercise interventions involved passive stretching of the quadriceps. Squatting and lunging activities in multiple planes with various means of support aimed to improve strength of the hip stabilizers while recruiting core musculature for balance. Studies have consistently proven that these exercises target the hip abductors, which have been shown to be weak in PFPS patients compared with patients with different lower extremity dysfunctions. Furthermore, Ferber et al. found that a 6-week rehabilitation protocol with an emphasis on hip and core strengthening allowed patients to achieve earlier reductions of pain while maintaining similar strength gains compared to a knee-focused rehabilitation program.
To address flexibility deficits, therapeutic exercise interventions included a prone quadriceps stretch and a standing calf stretch. Strength impairments were addressed with a progression of dynamic lower extremity power and balance exercises. Examples of these exercises included: single-leg squats, forward step ups, wall squats with a physioball, and lunges with a BOSU. Strengthening exercises were performed with 2 sets of 10 repetitions, with verbal cueing for posture and form to decrease excessive forces at the knee joint. Balance and agility drills were incorporated into the treatment sessions to address dynamic control of the surrounding hip musculature. Examples of these interventions include: forward/backward and medial/lateral hops, standing BAPS board circles, and agility drills. McConnell tape was employed to stabilize and assist with appropriate patellar tracking with movement; however, the patient developed skin irritation, and this intervention was discontinued. Patellar taping and bracing have been shown to be effective on patellofemoral pain by decreasing pain levels anywhere from 56% (brace) to 80% (tape); however, objective data regarding the mechanism behind these improvements in self-reported pain have not been as eagerly explored.\textsuperscript{55, 56}

Throughout the plan of care the patient received education regarding posture and body mechanics in daily activities to reduce the risk of further exacerbation of knee pain symptoms. Furthermore, the physical therapist provided the patient with information and suggestions related to stretching and cardiovascular exercises that could be implemented to her already-active lifestyle.

**Outcomes**

The patient attended 9 physical therapy sessions over the course of 9 weeks. Clinical outcomes were measured at the initial evaluation, throughout the episode of care,
and at discharge. NPRS reported scores were assessed at each treatment session, while
the Kujala and LEFS were re-assessed at discharge. Upon discharge, the patient reported
no lingering knee symptoms with activities of daily living as well as recreational exercise
activities. Improvements in dynamic control of the hip abductors and extensors were
noted, as evidenced by pelvic control during single-leg dynamic strengthening and
balance exercises as well as 5/5 strength on manual muscle testing. No pain was reported
with stair ascent and descent, and the patient had resumed all jumping activities without
any incidence of knee symptoms. NDI scores improved from 7-8 to 0 (70-80%
Improvement). Scores on the Kujala scale changed from 66 to 97 from initial evaluation
to discharge, marking a significant objective improvement in patellofemoral pain
symptoms.

Discussion

Patellofemoral pain symptoms are one of the most common orthopedic
complaints in the outpatient setting, particularly in active individuals, with women
presenting more than men. The patient described in this case report mirrors these trends,
as her knee pain was initiated with high-intensity recreational activities, including dance
aerobics. The purpose of this case report was to demonstrate the presentation of anterior
knee pain in an active adult, and to demonstrate the successful physical therapy
management, based on up-to-date empirical evidence. Concurrently, the present case
report also aimed to highlight the importance of a comprehensive evaluation and plan of
care based on theories of regional interdependence. Utilizing the Anterior Knee Pain
Algorithm, several known causes of anterior knee pain were identified in this case
patient, including structural and functional deviations leading to altered tracking of the
patella during dynamic movements. Implementing stabilization techniques to control pelvic movement as well as lower extremity stretching and general strengthening interventions to address weakness and muscle length restrictions, the chosen interventions resulted in successful alleviation of the patient’s symptoms. Overall, the patient described in this report was able to return to all previous activities including recreational dance aerobics and standing for hours at a time for her work. Objective measurements showed improvements in pain and function, as evidenced by patient-reported pain scales and lower extremity and patellofemoral-specific measurement tools.

At present, there are no clinical practice guidelines for the physical therapy treatment of anterior knee pain, specifically, patellofemoral pain syndrome; however, with a comprehensive look at the research, there are underlying themes that arise as successful options. The therapist involved in this case report utilized clinical reasoning while adhering to the guidelines suggested by the Anterior Knee Pain Algorithm, which was developed as a clinical tool for therapists to use during evaluation and treatment. Patient values and preferences were taken into account during the evaluation and subsequent creation of a plan of care. Given the patient’s active status, the therapist took into account activities she hoped to get back to that would also fall under the appropriate interventions for a patient with her symptoms.

There are a few limitations related to this case report that must be addressed. First, the patient had a prior history of knee pain, including a total knee replacement performed years earlier to coming to the clinic. This could have led to symptoms mimicking a patellofemoral pain syndrome; however, as a clinician it would be difficult to exclude the past surgical history as a contributor to the patient’s knee pain symptoms.
Second, due to family and other obligations, the patient was not able to attend physical therapy sessions regularly each week. As a result, the therapist was unable to consistently monitor symptoms and determine the efficacy of the chosen treatment plan at regular intervals. Finally, the patient continued to perform recreational physical activity throughout the course of treatment, sometimes with modifications. By regularly attending dance aerobics classes while also maintaining a consistent gym schedule, the patient was limited in her adherence to the prescribed home exercise program, as she did not always have time to perform all of the exercises suggested to her by the therapist.

Future research related to patellofemoral pain should aim to identify sub-categories within the patellofemoral pain umbrella in order to effectively categorize and treat patients based on clinical presentation. Furthermore, evidence continues to be contradictory in regards to patellar taping and bracing as a means of altering patellar tracking deviations, and strong evidence to determine the usefulness of these methods should be developed.

CONCLUSION

Although there is an abundance of research related to interventions for patellofemoral pain patients, there is not currently a clinical practice guideline for treating this population. Due to the high prevalence of patellofemoral pain in patients presenting to orthopedic physical therapy settings, it is important for clinicians to have the best possible evidence supporting their chosen intervention strategies. Patellofemoral pain symptoms can affect a number of common daily functional activities, thus successful therapy outcomes can significantly impact a patient’s quality of life. The anterior knee pain algorithm was designed to provide physical therapists a quick reference that
summarizes the current evidence-based practices related to this pathology. Utilizing the anterior knee pain algorithm for identifying potential causes and the appropriate therapeutic interventions, this case report illustrates the successful treatment of a patient presenting with anterior knee pain.

**TABLE 1.** Clinical outcome measures

<table>
<thead>
<tr>
<th>Clinical Outcome Measure</th>
<th>Initial</th>
<th>Follow-Up (Visit 6)</th>
<th>Discharge (Visit 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPRS knee</td>
<td>7-8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Kujala</td>
<td>66</td>
<td>Not assessed</td>
<td>97</td>
</tr>
<tr>
<td>LFES</td>
<td>28</td>
<td>Not assessed</td>
<td>Not assessed</td>
</tr>
</tbody>
</table>
REFERENCES


APPENDIX A: ANTERIOR KNEE PAIN ALGORITHM

ANTERIOR KNEE PAIN ALGORITHM
Erin Pauley, SPT

[Diagram of the Anterior Knee Pain Algorithm]