1999

The Conservative Treatment of Patellofemoral Pain Syndrome

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THE CONSERVATIVE TREATMENT OF PATELLOFEMORAL PAIN SYNDROME

by

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Bachelor of Science in Physical Therapy
University of North Dakota, 1998

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Physical Therapy

Grand Forks, North Dakota
May
1999

This Independent Study, submitted by Claude W. Massee in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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TABLE OF CONTENTS

To Renee Mabey

Your insight is appreciated,
your guidance invaluable,
Your zealous quest for perfection and attention to detail is. . .
Well, two out of three ain't bad.
Thank you for your time, effort, and wisdom.

ABSTRACT

It is estimated that up to 5% of outpatients to physical therapy will present with patellofemoral pain syndrome. This disease is rarely disabling but may significantly and negatively affect the adolescent's and young adult's participation in sporting and recreational activities. Appropriate management is essential to improve quality of life and prevent future musculoskeletal problems.

Historically, here has been some confusion in defining patellofemoral pain syndrome and in determining the exact cause of this troublesome disease. These factors may make the diagnosis and treatment of patellofemoral pain syndrome frustrating to the patient and clinician.

This study, using a review of the literature, will attempt to sort through the information currently available to determine the parameters used to define patellofemoral pain syndrome. Additionally, it will investigate possible causes of the syndrome, evaluation techniques, and conservative treatments of patellofemoral pain syndrome.

CHAPTER I

INTRODUCTION TO PATELLOFEMORAL PAIN SYNDROME

Anterior knee pain is a historically common musculoskeletal disorder in adults.[1] This condition has taken many names over the years. Aleman first coined the term "chondromalacia patellae" in 1928, a term that is still loosely used today. However, there is frequently no patellar degeneration to correlate with the pain experience[2,3] as is seen in true chondromalacia. Other terms used to describe essentially the same symptomology are anterior knee pain, patellofemoral stress syndrome, patellar chondropathy, runner's knee, and retropatellar pain syndrome.[1] The most recent term is "patellofemoral pain syndrome" (PFPS).[1,4,5]

The quandary to precisely name this disease is also seen in a difficulty to confirm a precise diagnosis or treatment regime. PFPS is a well known condition,[2] but the precise symptoms vary between studies. The most prominent feature, as the name infers, is pain. The pain is often nonspecific and nonradiating,[5] frequently described as "aching" or "burning",[6] often without any correlating laboratory findings,[5] and possibly accompanied by crepitis.[2,6] Pain commonly occurs when ascending and descending stairs and with prolonged sitting with knee flexion.[3,5] Some patients also reported a click, catch, or the

feeling that their knee is giving way.[3] It seldom results in significant disability,[2,5,6] though it can negatively affect sports participation and quality of life.

Frequently implicated causes of PFPS include an imbalance of the quadriceps muscles or peripatellar ligaments resulting in patellar malalignment and retropatellar surface changes.[5] Excessive lateral patellar tracking due to an excessively tight iliotibial band and/or deep lateral retinacular fibers is also indicated as a possible cause.[6] Pathologies leading to anterior knee pain, but often excluded from studies of PFPS include intrapatellar pathology, peripatellar tendinitis and bursitis,[4] subluxation, dislocation, and osteoarthritis.[2,6]

The treatment of PFPS, as one can imagine, may vary dramatically between cases and there is no consensus as to specific treatment guidelines. Rehabilitation may include little to no intervention,[2] patient education and exercise,[5,6] bracing and taping,[6] medication, and finally, surgical interventions.[3,7] Most authors agree that surgery is rarely necessary.[2,4,5,7] Even when surgery is indicated, it is generally preceded by aggressive conservative therapy.[3,7] Surgery is not reported as highly successful.[7,8]

PFPS is often a chronic and frustrating condition,[6] but patients can expect good prognoses with early diagnosis and intervention.[1] Conservative rehabilitation goals are aimed at decreased pain and improved function.[6] Conservative treatment generally focuses on increasing quadriceps strength and balance. The purpose of this paper is to investigate some of the possible causes, evaluation techniques, and treatment approaches of patellofemoral pain syndrome.

CHAPTER II

ETIOLOGY

The use of the term 'syndrome' suggests the difficulty in defining a specific etiology for Patellofemoral Pain Syndrome (PFPS). Most researchers generally accept PFPS as a combination of symptoms, and it is primarily a diagnosis of exclusion. PFPS was once labeled as chondromalacia patella. This term, which is a specific diagnosis, has recently lost favor. Patients presenting with PFPS frequently exhibit no signs of degenerative changes of the patellar cartilage as would be seen with chondromalacia patella.[2,3,9] A variety of causes may be implicated in the onset of PFPS, with none being primary and presentations may differ between individual cases.[10] Currently, no cause has been proven as irrefutable.[11]

The most prevalent theories on the causes of PFPS involve malalignment problems, specifically an abnormal Q-angle;[9] quadriceps muscle imbalance, primarily involving vastus medialis (VM) versus the vastus lateralis (VL);[12] and tight lateral structures, such as the lateral retinaculum and the iliotibial band (IT).[5,6,12] Other sources consider age, gender,[13] overuse, poor pre-activity conditioning, training errors, and bad technique[9] to be significant factors.

PFPS is, as stated previously, a diagnosis of exclusion. Rearfoot varus, patella alta, femoral anteversion, tibial rotation, genu valgus, leg length

discrepancies, patellar tendinitis, and meniscal involvement may certainly cause anterior knee pain.[3,8] However, these conditions present as specific diagnoses and must be treated as such. Therefore, while these conditions may be referred to in this paper from time to time, discussion will be limited primarily to rule them out or to highlight similarities to PFPS. The purpose of this chapter is to examine the most commonly implicated causes of PFPS, focusing primarily on patellar malalignment.

Patellar Malalignment

Patellar malalignment is often the main focus in the research of PFPS. The factors thought to have the greatest influence on patellar tracking in patients with PFPS, and discussed here, are the Q-angle, quadriceps muscle imbalance, tightness of the lateral retinaculum, and a tight iliotibial band.

The Q-angle

Most researchers measure and record the Q-angle.[3,6,9,13-16] The Q-angle is formed by the intersection of two lines on the ipsilateral lower extremity. One line is drawn from the anterior superior iliac spine (ASIS) to the center of the patella, the other from the center of the patella to the center of the tibial tubercle, and the acute angle is measured.[17] This angle roughly represents the quadriceps muscle's line of pull on the patella in relation to the tibia. The natural line of pull from the quadriceps tends to favor a lateral patellar tracking.[5] The quadriceps muscles cause a "bow string" effect on the patellar tendon and any increase in the Q-angle will increase the magnitude of this effect.[18]

The estimated maximum contact force of the patella in the trochlear groove is approximately six and a half times body weight at 90° of knee flexion.[19] Huberti and Hayes[19] reported patellofemoral contact to be uniform between the medial and lateral patellar facets. This pattern of uniformity can be significantly altered with a 10°- increase or decrease in the Q-angle.

A possible correlation is suggested between various abnormalities in Q-angles as a genesis to chondromalacia,[19] and it may be a predisposing factor in PFPS. Grana[20] found that 49 of 88 subjects with recurrent patellar dislocations had abnormal Q-angles. Reider et al[14] found, when compared to controls, patients with classic "chondromalacia patellae pain syndrome" (a term the authors admittedly interchanged with PFPS) tend to have increased Q-angles (~19°) and inward facing patellae. A Q-angle of 10° or less correlated with dislocating and outward riding patella.[14]

Changes in the Q-angle may alter patellar facet pressures.[19] Continued malalignment may lead to chondrol changes,[21] and that may lead to osteoarthritis.[3] There is some good news for patients with an abnormal Q-angle, however. A follow-up study of 22 variables in the non-operative treatment of PFPS reported the Q-angle did not have a significant impact on treatment outcomes.[13]

Quadriceps Muscle Imbalance

Patellar pathology can exist with normal Q-angles as well.[5,11,20,22] In PFPS, soft tissue often implicated are quadriceps muscle imbalances, a tight lateral retinaculum, and iliotibial (IT) band tightness.

There is a great deal of conflicting literature concerning an imbalance between the vastus lateralis (VL) and the vastus medialis oblique (VMO) muscles and the effect the imbalance has on patellar tracking. Several studies have addressed the possible implications these muscles have on various aspects of knee pathology and rehabilitation.[23-31]

Proponents of the VL/VMO imbalance theory claim that the primary function of the VMO is to prevent lateral patellar displacement. Its fiber orientation and muscle bone insertion show evidence for this.[26] It arises from the adductor tubercle and medial intermuscular septum, and inserts into the upper one-half to one-third of the medial patella. The more distal the insertion, the greater mechanical advantage it has against laterally pulling forces.[11] A muscle imbalance may aggravate knee pain, and if left untreated, become a chronic problem.[16] The forces on the patella are so great that any deviation of normal bio-mechanics may lead to a cartilage breakdown. Therefore, each cause of imbalance must be specifically identified and treated.[18] Abnormalities seen in PFPS may include VMO atrophy,[15] high insertion of the VMO tendon into the patella, and/or excessive tightness of the vastus lateralis.[10] It has also been reported that the vastus medialis muscle is the last of the quadriceps group to develop, the first to atrophy from disuse, and the last to be rehabilitated following injury or immobilization.[32]

Electromyographic studies show the vastus medialis functions throughout the range of motion, working in concert with the other quadriceps muscles to accomplish the same task, with weighted extension producing the greatest

muscle activity. Studies suggest that VMO activity increases more rapidly at the end of extension.[26] Normally, though, the VL and VMO will have approximately equal and low levels of EMG activity in the last 30° of knee extension.[23] Another study found no significant difference in the activation between the quadriceps muscle groups in patients with PFPS as compared to a control group without PFPS.[33] At this time, no scientific or clinical evidence exists to support claims that increasing VMO strength will decrease patellofemoral pain symptoms.[31]

The debate continues. It is up to clinicians to decide, given whatever information is pertinent to their patients' particular situations, which theory to follow in assessing and treating the patient with PFPS.

The Lateral Retinaculum

The lateral retinaculum may be a significant source of pain in PFPS. In a study of 78 knees, 90% of the subjects reported pain in the lateral retinaculum frequently at or near its insertion into the patella.[21]

Fulkerson et al[34] found histologic evidence of nerve damage in the lateral retinaculum of patients who had lateral releases done and experienced lateral knee pain before surgery. Conversely, those without lateral pain preoperatively exhibited normal histological findings comparable to uninvolved controls. Neural damage, when present, was evidenced by perineural fibrosis and somewhat less myelination, apparently due to the constant stretching caused by patellar malalignment.[34] Other authors believe pain may arise in the retinacular nerve endings which is due to tissue stress also.[16]

The Iliotibial Band

The iliotibial (IT) band may also be a source of anterior knee pain. Friction between the tight IT band and lateral femoral condyle in knee flexion and extension may lead to an overuse syndrome in which knee pain is experienced above the joint line, over the lateral femoral condyle. Its occurrence is frequent enough to warrant its own diagnosis (runner's knee), but is not a condition necessarily present in patients with PFPS. Other authors suggest the IT band does have a role in PFPS;[12] however, there exists little evidence to supports its role in patients with PFPS.[35] Further information is provided in the evaluation and treatment chapter.

Pain

There is much speculation as to what , precisely, causes the pain in PFPS. As mentioned earlier, patients who presented with lateral retinacular pain preoperatively showed histologic evidence of nerve damage to those structures.[34]

The other most implicated source of pain is the patellar sub-chondrol bone.[3] It is believed that the pain threshold of the bone is exceeded by excessive stress or force on the patella, or when normal stress is applied in an abnormal manner, as is the case with abnormal patellar tracking.[36]

CHAPTER III

THE ASSESSMENT OF PFPS

When assessing the knee for PFPS, a complete knee exam should be performed, both static and dynamic.[11] As mentioned earlier, PFPS is a diagnosis of exclusion. Therefore, specific diagnoses need to be ruled out.[10,37] The minimum evaluation should include a complete history, subjective complaints, functional assessment, physical exam[38] and, while not addressed here, radiographic studies.[5]

Subjective

The evaluation should begin with a good subjective history of the patient's condition on which to build a foundation of diagnosis.[5,6] To reiterate, the typical patient with PFPS will present with pain when climbing stairs or after sitting for prolonged periods in a flexed knee position (frequently referred to as a "theater sign")[15] and a feeling that his or her knee is "giving way."[6] When assessing activity, look at frequency, intensity, duration, and type.[39]

History

It is advisable to obtain a complete family history. Even though PFPS is not thought to be an inherited disease,[5] there is frequently a family history in patients with dislocating patella; this correlation does not exist with chondromalacia patellae.[14] In addition, poor development of the vastus medialis

is reported as a congenital family abnormality.[32] An inquiry should be made of any prior injury, operations, fractures, and childhood bracing or casting.[6]

Knee Scoring Scales

There are a variety of tools in the literature to score knee function. The subject is vast enough to warrant its own study and will not be covered in this writing. However, there is great merit in the use of questionnaires as an assessment tool, not only for the initial evaluation but to follow through treatment and outcome analysis. The reader is referred to a few knee scales that may or may not be specific to PFPS.[4,39-46] Scoring scales, such as the visual analog scale (VAS), are frequently used to assess pain as well.

Pain

Pain is the most prominent feature of PFPS. It is often described as an "aching" or "burning" sensation[6] and is usually not localized, but tends to be more diffuse in nature. Pain in patellar disorders may also be reported anteromedially, laterally, or posteriorly in the popliteal area.[3] If localized medially, meniscal involvement must be ruled out.[17] Pain commonly occurs with sporting events[12] and is elicited with the knee loaded in a flexed position.[9] It is interesting to note that it does not generally correlate with decreased activity because athletes will frequently play through the pain.[39] The precise etiology of pain is widely debated and may have much individual variance.

There is also the possibility that knee pain is referred from other anatomical structures. For example, lumbar radiculopathy may refer pain to the thigh, knee, or leg.[47] Pain is frequently referred medially with hip pathology, and

limited or painful hip range of motion may also refer pain to the knee.[11] A patient who leans to the affected side with gait may be displaying hip pathology, especially if the knee is not tender to palpation.[48]

Objective

All of the specific tests and possible diagnoses for the knee will not be discussed here. This chapter will focus primarily on evaluation and tests specific to PFPS and a few select others used for differential diagnosis. The list is by no means exhaustive nor are the descriptions as precise as they might be, but are merely included to introduce the reader to techniques and to be used as a point of reference. The reader is therefore encouraged to refer to the original authors for greater depth on each test or technique.

Differential Diagnosis

The structures within and surrounding the knee should be thoroughly evaluated and the knee ligaments tested for integrity.[38] Plica and meniscal tests are also important as PFPS is often mimicked by medial meniscal involvement which is commonly accompanied by atrophy of the quadriceps. Tibial rotation tests, such as Apley's and McMurray's, may be used to rule out meniscal involvement.[3,18]

PFPS generally does not present with edema. Therefore, any swelling should be measured and noted as this may indicate a more serious pathology, such as chondromalacia, synovitis,[15] or rheumatoid arthritis.[3]

Bony Abnormalities

A variety of bony abnormalities, such as leg length discrepancies, tibial torsion, femoral anteversion, genu valgum, genu varum, genu recurvatum, and patella alta, may also cause anterior or peripatellar knee pain.[38] Many of the aforementioned may present as a specific pathology requiring further evaluation and intervention than would be afforded by a diagnosis of PFPS.

The Tests

A survey by Harrison et al[39] asked physical therapists and doctors to rate tests they felt most likely to detect clinical change in patients with PFPS. "Lower extremity alignment, flexibility of the tensor fascia lata and rectus femoris muscle groups, static patellar orientation, and patellar mobility were rated as the five most important tests."[39(p169)] The patellar compression test, crepitus, Q-angle, and radiographs were less valuable. They stressed the importance of tests to be practical and easily performed in a clinical setting.[39]

A number of clinical tests used to evaluate PFPS are highly subjective and dependent on the therapist's skill in performance and evaluation. Further, not all patients with PFPS will clinically present in exactly the same way making selection of an ideal set of clinical tests difficult.[39] For example, the inter-tester reliability of patellar femoral alignment tests of medial/lateral displacement, tilt, and rotation was rated as fair to poor in one study.[49] It is ultimately up to the clinician to decide which tests will be most useful and relevant in the treatment of his or her patient.

Assessing Alignment

Assessing alignment of the lower extremity is essential in the evaluation of patients with PFPS. The following are several tests and measurements commonly used to assess lower extremity alignment and patellar tracking.

The Apprehension Test

It is thought that the most prominent test to separate PFPS from a subluxing patella is the apprehension test.[11] This test is performed with the patient in a supine position, knees extended, and quadriceps relaxed. The examiner gently lifts the patella and moves it laterally with the patient unaware of the examiner's intention to do so. For a positive sign, the patient will have a look of "apprehension" as the patella begins to dislocate.[50] If no problem exists, little reaction will be elicited. Hughston refers to this test as the "apprehension sign of Fairbank"[7(p153)] and claims it to be a useful test of subluxation.

The Q-angle

The Q-angle is an ever present, naturally occurring, physiological aspect of the knee contributing to the natural valgus found at the knee joint. Because of this law, any abnormalities of the knee extensor mechanism may lead to patellar malalignment.[51] "Abnormalities of virtually every structure of the anterior aspect of the knee have been implicated as responsible for pathological patellar tracking."[14(p270)] Though little can be done conservatively to alter the Q-angle, varying degrees of abnormality may indicate specific pathology; therefore, assessment of the Q-angle may be useful as a clinical tool in the diagnosis of PFPS.

The Q-Angle is generally measured with the patient lying supine. A straight line is drawn between the anterior superior iliac spines (ASIS) and the lower extremities extend perpendicular to this line. The feet are in a neutral position as are the hips, as any inversion, eversion, or rotation can skew the measurement.[52] With the knees extended and quadriceps relaxed, one line is drawn from the ASIS to the center of the ipsilateral patella, the other from the center of the patella down the center of the tibial tubercle. The intersection of these two lines forms the Q-angle.[17] A variation of this measurement is performed with the patient weight bearing in a standing position with 0° to 30° degrees of knee flexion, as this may give better dynamic assessment of the quadriceps line of pull.[4] The Q-angle is normally 15° with females having a slightly greater Q-angle than males.[53]

The J-sign

A small number of patients with patellar malalignment will present with a positive J-sign. It is usually indicative of mild subluxation which is more severe than PFPS and may require surgery.[48]

The patella normally will track in a straight line as the knee extends until just before terminal extension when it may deviate slightly medially. With a subluxing patella, the patellar shifts laterally as the knee approaches the last 40° of extension and returns to midline just prior to terminal extension; thus, the patellar path resembles an inverted J. The degree of lateral deviation depends on the amount of medial laxity. Outerbridge et al[18(p183)] describe this as a "wandering patella." A positive J-sign may be elicited by contracture,

hypertrophy, or low insertion of the vastus lateralis and with patella alta or trochlear deficiency.[10]

Assessing the Retinacular Structures

The following physical examination techniques by Kolowich,[54] the passive patellar tilt and the patellar tilt tests, are referred to frequently in the literature. These tests were developed in an attempt to determine indications and contraindications for a lateral release of the retinaculum. They may have clinical application in the physical therapy evaluation and treatment program, although this has not been specifically studied.

Passive Patellar Tilt

This test is performed with patient supine, knee extended, quadriceps relaxed, and the patella parallel to the treatment table. The therapist then stands at the patient's feet and, with an inferior view of the patella, gently lifts the lateral edge of the patella without allowing it to leave the femoral trochlea, subluxing or dislocating laterally. The amount of patellar tilt is compared to the horizontal. A neutral or lateral tilt is an indication of lateral tightness, indicating a shortening of the lateral retinaculum and loading of the lateral patellar facets.[55] Men tend to have 5° less tilt than females.

Patellar Tilt Test

This is a test used to determine parapatellar tightness. It is performed with the patient supine, knee flexed to 20° to 30°, and resting on a bolster to allow the quadriceps to relax. The patella is visually divided into four equal longitudinal segments. The therapist then gently lifts the patella with his or her

thumb and forefinger and tries to displace it medially and then laterally. A lateral glide of three quadrants indicates medial laxity and a medial glide of one quadrant indicates lateral tightness. A medial glide of three or four quadrants indicates a hypermobile patella.[54]

Palpation

As mentioned earlier, the pain experience with PFPS is generally diffuse in nature. However, it is suggested that with discriminant use of palpation techniques, pain may be more precisely located and its cause isolated. A physical finding highly indicative of PFPS is pain or tenderness elicited by palpation of the patella's posterior articular surfaces.[3,9,15] This is performed with the patient's knee fully extended and in a resting position. The heel of the therapist's hand depresses the lateral surface of the patella, while the fingertips gently lift the patella's medial border and palpate the articular surfaces. The lateral border is palpated in a similar manner.[15] At the same time, the lateral and medical retinacula can be palpated by displacing the patella medially and laterally, respectively. Specific bands of the retinaculum may then be palpated, stressing the peripatellar fibers, thus reproducing and localizing the source of pain. Often, tenderness will be apparent at the insertion of these fibers into the patella.[56]

Patellar Compression Tests

Patellar pain is considered a major clinical sign of PFPS and can be elicited by direct compression of the patella into the femoral sulcus.[3,9] This test

is performed with the patient supine or in long sitting and the knee flexed to approximately 20° to avoid pressure on synovium or the suprapatellar pouch.[3,12]

Clarke's Sign

This test is performed with the patient supine or long sitting and the knee in extension. The therapist's hand is positioned with the web space against the superior pole of the patella applying an inferior pressure. The patient is instructed to isometrically contract his or her quadriceps against the therapist's resistance.[15] If the patient cannot hold a muscle contraction without pain, the test is positive. Care must be taken not to use excessive pressure as pain may be elicited in a normal knee with excessive application.[52] This test should be performed in 30°, 60°, and 90° of knee flexion as well as in extension.

The Critical Test

The critical test is performed with patient long sitting and is a variation of the Clarke's test. The patient contracts his or her quadriceps against resistance at 0°, 30°, 60°, 90°, and 120° of knee flexion and maintains the contraction for 10 seconds in each position. If pain is elicited in any particular angle of knee flexion, the therapist passively returns the patient's leg to full extension and with the leg supported glides the patella medially. The patient then returns to the painful position and repeats the isometric contract and hold. Relief of pain is a positive sign and indicative of patellofemoral pathology.[52] This test is also referred to as the "McConnell test for Chondromalacia Patellae."[52(p566)] The reader is referred to McConnell for the original test and theory.[30]

Flexibility

Flexibility deficits of the rectus femoris, hamstrings, and gastrocnemius/soleus group have been identified in patients with PFPS.[12] However, muscular tightness may be the cause or an effect of PFPS.[39]

Flexibility deficits are commonly see in adolescents with overuse injuries, especially in two joint muscles (rectus femoris, gastrocnemius, IT band, hamstrings). Pain in the opposite side of the joint may occur due to tight muscles secondary to growth spurts of the long bones and muscle growth lag.[9] Flexibility screening tests, such as Ely's test for the rectus femoris, Ober's for the IT band, and measurement of the popliteal angle for the hamstrings, are frequently performed. Measurements of ankle dorsiflexion with knees flexed and extended (soleus and gastrocnemius) are also made.

Ely's Test

This test is used to assess rectus femoris length. With the patient prone lying and the pelvis stabilized on the treatment table, the knee is passively flexed. Rectus tightness is indicated if the pelvis lifts off the table in an anterior pelvic tilt with flexion of the knee. Both knees should be tested and compared.[52]

Ober's Test

The Ober's test, while scrutinized for its lack of standardization and numerous variations, remains as the test of IT band tightness. Grelsamer[48] claims it is the most under used test. It is frequently performed with the patient side lying on the uninvolved side. With the bottom knee flexed to 90° for support, the upper leg is examined by flexing the knee to 90°. The hip is then

brought into flexion and abduction, brought back in line with the trunk and allowed to adduct beyond neutral. The involved side is then compared to the uninvolved side. The IT band is considered tight if the involved side does not adduct beyond neutral as far as the uninvolved side.[57] This test may also be performed in the prone position to eliminate the effects of gravity.[9]

Dynamic Assessment

The patient's current level of function is important in the evaluation of PFPS.[39] As mentioned earlier, stair climbing generally elicits pain in patients with PFPS, so it would seem logical to include it as an assessment tool. With the exception of knee scoring questionnaires mentioned previously, there are surprisingly few functional assessment tools described in the literature. A couple of them are presented here.

Observation of Gait

While gait analysis is beyond the scope of this paper, the examination should include observation of the patient's gait. The evaluation should be performed with the patient standing and walking barefoot and with both legs and feet fully visible. Observation of the patient's gait may indicate the amount of pain he or she is in and provide the examiner with other physiological clues,[48] some of which have already been mentioned.

Stepping Exercise

The step down exercise, while not a specific test, was used in one study to assess pain. The subjects stepped down from a 9" stool and rated pain on a

1 to 10 VAS.[58] Another study assessed pain during functional activities of high-intensity sports, stair climbing, squatting, and jogging using a VAS.[4]

Waldron Test

In this test, the therapist palpates the patella while the patient performs slow deep knee bends. Pain during range of motion, crepitus, complaints of "catching," and patellar tracking are all noted with the movement. Pain with crepitus is considered a positive sign for patellofemoral syndrome.[52]

CHAPTER IV

CONSERVATIVE TREATMENT

As stressed in the previous chapter, a thorough examination of the knee and possible causes of patellofemoral dysfunction must be completed before beginning a rehabilitation program.[6] Beyond that, there remains much debate over the efficacy of specific exercises used to treat PFPS.[59] This should not come as a surprise given the difficulty in merely defining this disorder.

This chapter will look at some of the most frequently used exercises and techniques in the conservative, nonoperative treatment of PFPS. The exercises will not be specifically outlined as to performance, repetitions, sets, and frequency because there exists a multitude of variations for any given exercise. Further, each patient will present with varying symptoms and degrees of severity. A general approach will be presented and the clinician must decide what is best for his or her particular patient in terms of symptomology and desired outcome.

Patient Education

One factor that many authors do agree upon is the importance of patient compliance with the home exercise program and the avoidance or moderation of exacerbating activities. The patient must actively participate in the rehabilitation process if treatment is to be successful.[2,6,12,15,16,32,38,47] It is important to provide the patient with general information concerning his or her disorder, basic

anatomy and physiology of the patellofemoral joint, symptoms of PFPS, guidelines for the moderation of activity, and a comprehensive training program.[4] As an example of the importance of patient involvement, a study conducted by Yates and Grana[60] found that of 64 patients rated for exercise compliance, only five were considered compliant. Of 42 noncompliant patients, only 20 had successful outcomes.[60]

The patient needs to avoid activities that exacerbate symptoms and gradually return to activity as symptoms are resolved.[15] PFPS is considered by many to be an "overuse syndrome,"[5,9,61] and as such, it responds well to training modification.[9] When activity is initiated, the patient must be instructed on proper technique and avoid over doing it right away.[16]

The initial goal of most treatment programs for PFPS is to reduce pain and increase function.[6] Acutely, rest,[13,62] cryotherapy, compression, and elevation may aid in symptom relief.[15,28] The physician may also prescribe non-steroidal anti-inflammatory drugs (NSAIDs)[1,3,5,13,15,28] in an effort to reduce pain and edema, when present.

The Strengthening Exercises

It is generally accepted that exercises should be performed in a pain-free manner. If pain is elicited during movement, reflex inhibition may cause the patient further setbacks.[4,12,16,38] Many authors also agree that the exercise program needs to be individualized,[6,10] as no two patients will present in precisely the same way. The optimal treatment program should address all correctable conditions found in the evaluation.[16,41]

Strengthening exercises are frequently performed for the quadriceps, hamstrings, and hip adductors. It is purported that exercises to improve strength and endurance of the quadriceps, hamstrings, and gastrocnemius/soleus muscles may help prevent overuse disorders even when predisposing malalignment is present.[9]

The Quadriceps

Quadriceps exercises are the most frequently prescribed exercises for the treatment of PFPS and have been reported to relieve pain, although the mechanism of the decrease in pain is not fully understood.[3] Quadriceps exercises are usually begun isometrically and in a pain-free position.[49] EMG studies have shown the maximal contraction of the quadriceps is achieved with isometric contraction exercises.[59] Eccentric exercises are occasionally advocated, but a recent study found no significant difference in the outcomes of patients who performed exercises eccentrically as opposed to isometrically.[4] Concentric exercises are generally performed from 0° to 30° of knee flexion to avoid compression of the patella into the femoral groove.[3] However, the pain-free range may vary slightly from one patient to the next.

Short arc quadriceps (SAQ) or terminal extension exercises are frequently prescribed.[6,28,59] The SAQ is generally performed with a bolster under the knee in approximately 30° of knee flexion. The patient then actively extends the leg to 0° or terminal extension. The 40° to 60° range is usually avoided to prevent pain and crepitus, as maximal patellar loading is reported to occur in that

range.[27] The SAQ may be detrimental if the patient has patellar instability due to a decreased lateral ridge of the femoral trochlea.[59]

The straight leg raise (SLR) is advocated for PFPS as well. However, it is reported that the quadriceps only contract to 25% of maximum potential during this exercise due to the involvement of the hip flexors.[59] As the patient's condition improves and the quadriceps become stronger, progressive resistive exercises (PREs) may be initiated using an ankle weight of 1 to 15 pounds while performing SLRs.[28,59]

In addition to the SAQ and SLR exercises, a variety of open and closed chain exercises are proposed for the conservative treatment of PFPS.[5,6,28,30] There are a wide variety of these exercises; because of this, none will be specifically addressed here. It is important to consider the basic tenant of exercises performed for the treatment of PFPS, and that is for the involved knee to function in a pain free range and manner.

Vastus Medialis Oblique Versus Vastus Lateralis

There is a great deal of conflicting literature concerning an imbalance between the vastus lateralis (VL) and the vastus medialis oblique (VMO) muscles in terms of strength and the timing of recruitment. This conflict extends to the effect each has on patellar tracking.

This carries into the debate as to whether or not the VMO can be selectively strengthened when exercising the quadriceps. It is suggested that much of this debate is due, in part, to the difficulty in comparing studies because of methodological flaws.[48,59] It is not the intent of this paper to suggest which

theory is correct, as both present strong rationale for their positions, but rather to give the reader a point of reference and an awareness of both.

Proponents of strengthening the VMO[6,10,47,63,64] believe the primary goal of rehabilitation is to develop excellent quadriceps strength with focus on strengthening the VMO.[51] It is proposed that increasing the VMO's strength and endurance may help prevent overuse disorders even when predisposing malalignment is present.[9]

Several sources promote involvement of the hip adductors with simultaneous quadriceps muscles contraction to isolate the VMO.[12,25] The rationale for these exercises involves the supposition that the VMO has its origin on the adductor longus and maximus[59] as discussed in Chapter II. The hip adductors are generally incorporated by having the patient squeeze a pillow between his or her knees while performing closed chain exercises., thus facilitating contraction of the VMO.[30]

No study has shown a significant increase in VMO activity as compared to VL activity in any of the several quadriceps exercise variations.[15,31,58,59] Current evidence indicates that imbalances in VMO:VL magnitude are not critical and that there is no significant difference in the timings of reflex latency in EMG studies.[23] One study comparing five isometric exercises commonly performed by patients with PFPS to elicit VMO activity did not result in selective recruitment of the VMO.[65]

Hamstrings

In a study of 76 athletes with anterior knee pain, a six-week program to strengthen the hamstrings and stretch the quadriceps worked in relieving symptoms and returning the athletes to activity in 91% of the cases.[22] This was unique because an overwhelming majority of articles on PFPS rehabilitation programs stress stretching the hamstrings and strengthening the quadriceps.

Flexibility

Incorporated into the exercise program are stretching exercises to increase flexibility as tightness of the rectus femoris, IT band, the hamstrings,[22] and lateral retinaculum has been implicated in patients with PFPS. It is proposed that patellar tracking can be improved by increasing flexibility of the passive structures around the knee joint.[47]

Tightness of the anterior structures also increases the compressive force on the anterior aspect of the knee.[22] "If the rectus femoris is tight, full excursion of the patella may be inhibited."[6(p561)]

It is suggested that there is a correlation between IT band tightness and PFPS.[57,66,67] Stretching the IT band should be included in the flexibility program.

Tightness of the hamstrings tends to increase flexion of the knee.[38] Patients with PFPS significantly decreased their pain by bringing the hamstrings to normal flexibility.[11]

McConnell contends that the lateral retinaculum can be passively mobilized and advocates a low-load sustained stretch that is achieved by patellar

taping. Other techniques to help loosen the lateral structures include massage and patellar mobilizations.[47]

Other Treatments and Techniques

Other treatment options frequently found in the literature are knee braces,[5,6,12,15,16] patellar taping,[47] and foot orthoses.[15,16,68] These devices are designed to guide the patella in the femoral sulcus to improve patellar tracking. It is suggested that orthotics are not used by themselves, but as part of a comprehensive rehabilitation program.[6]

If conservative treatment is unsuccessful, then surgical intervention may be required. For the less than 10% of PFPS patients who do not respond to conservative treatment, surgery may be necessary to correct malalignment. Typical treatment may consist of a lateral retinacular release, tightening of the medial retinacula, a VMO tendon transfer, or a patellar tendon transfer.[15] Over 100 operations for patellofemoral disorders have been described,[12] but therapy for PFPS with surgery has not been studied.[1] It is suggested that even with operative techniques, recovery involves the same rehabilitation exercises as used to treat PFPS conservatively. The only alterations involve soft tissue healing considerations.[13]

CHAPTER V

CONCLUSION

"Classification of any medical subject is of only academic interest if it fails to help the clinician select the proper treatment plan and fails to provide clearly defined diagnostic categories so that results can be analyzed and compared prospectively and retrospectively."[69(p174)] This statement seems to summarize the problem that patellofemoral pain syndrome presents to the clinician and the frustration of patients afflicted with it. It also exemplifies the need for a thorough examination of the knee to rule out more specific pathologies.

It is ever important to look at the whole person when treatment considerations are made. Activity levels, postures, biomechanics, personality, pain tolerance, and patient compliance will all have a significant bearing on treatment outcomes. The same activities used to evaluate PFPS should be carried through in the treatment program and used as indicators to chart progress. Treating a specific problem in a logical and sequential manner would eliminate a lot of confusion for everyone involved and provide better testing and evaluation techniques, a relatively predictable outcome, and an increase in treatment efficacy.

The mechanisms involved in PFPS must be fully understood to plan for conservative treatment and effective patient education. This will assist in

providing the patient with independent management of his or her diagnosis and long-lasting results.

REFERENCES

1. Arroll B, Ellis-Pegler E, Edwards A, Sutcliffe G. Patellofemoral pain syndrome. A critical review of the clinical trials on nonoperative therapy. Am J Sports Med. 1997;25(2):207-212.
2. Sandow MJ, Goodfellow JW. The natural history of anterior knee pain in adolescents. J Bone Joint Surg. 1985;67:36-38.
3. Insall J. Current concepts review patellar pain. J Bone Joint Surg. 1982;64-A(1):147-152.
4. Thomee R. A comprehensive treatment approach for patellofemoral pain syndrome in young women. Phys The. ;17(12):1690-1703.
5. Tria AJ Jr, Palumbo RC, Alicea JA. Conservative care for patellofemoral pain. Orthop Clin North Am. 1992;23(54):545-554.
6. Zappala FG, Taffel CB, Scuderi GR. Rehabilitation of patellofemoral joint disorders. Orthop Clin North Am. 1992;23:555-556.
7. Hughston JC. Patellar subluxation. A recent history. Clin Sports Med. 1989;8(2):153-162.
8. Maenpaa H, Lehto MU. Patellar dislocation. The long-term results of nonoperative management in 100 patients. Am J Sports Med. 1997;25(2):213-217.

9. Krivikas LS. Anatomical factors associated with overuse sports injuries. Sports Med. 1997;24(2):132-146.
10. Kettelkamp DB. Current concepts review management of patellar malalignment. J Bone Jt Surg. 1991;63-A(8):1344-1347.
11. Walsh WM. Patellofemoral joint. In: DeLee JC, Drez D. Orthopaedic Sports Medicine. Philadelphia, Pa: W. B. Saunders; 1994.
12. LaBrier K, O'Neill DB. Patellofemoral stress syndrome: current concepts. Sports Med. 1993;16(6):449-459.
13. Kannus P, Niittymaki S. Which features predict outcome in the nonoperative treatment of patellofemoral pain syndrome? A prospective follow-up study. Med Sci Sports Exerc. 1994;26(3):289-296.
14. Reider B, Marshall JL, Warren RF. Clinical characteristics of patellar disorders in young athletes. Am J Sports Med. 1981;9(4):270-274.
15. Davidson K. Patellofemoral pain syndrome. Am Fam Phys. 1993;48(7):1254-1262.
16. Reid DC. The myth, mystic, and frustration of anterior knee pain. Clin J Sports Med. 1993;3(3):139-143.
17. Ficat RP, Hungerford DS. Disorders of the Patellofemoral Joint. Baltimore, Md: The Williams and Wilkins Company; 1977.
18. Outerbridge RE, Dunlop JAY. The problem of chondromalacia patellae. Clin Orthop Rel Res. 1975;110:177-196.
19. Huberti HH, Hayes WC. Patellofemoral contact pressures. The influence of Q-angle and tendofemoral contacts. J Bone Jt Surg. 1984;66-A(5):715-724.

20. Grana WA, Kriegshauser LA. Scientific basis of extensor mechanism disorders. Clin Sports Med. 1985;4(2):247-257.

21. Fulkerson JP. The etiology of patellofemoral pain in young, active patients: a prospective study. Clin Orthop Rel Res. 1983;179:129-133.

22. Kibler WB. Strength and flexibility findings in anterior knee pain syndrome in athletes. Am J Sports Med. 1987;15(5):410.

23. Reynolds L, Levin A, Medeiros JM, Adler NS, Hallum A. EMG activity of the vastus medialis oblique and the vastus lateralis and their role in patellar alignment. Am J Phys Med. 1983;62(2):61-70.

24. Karst GM, Willett GM. Onset timing of electromyographic activity in the vastus medialis oblique and vastus lateralis muscles in subjects with and without patellofemoral pain syndrome. Phys Ther. 1995;75(9):813-823.

25. Hanten WP, Schulthies SS. Exercise effect on electromyographic activity of the vastus medialis oblique and vastus lateralis muscles. Phys Ther. 1990;70(9):561-565.

26. Basmajian JV, Harden TP, Regenos EM. Integrated actions of the four heads of quadriceps femoris: an electromyographic study. Anat Rec. 1972;172:15-19.

27. Montgomery JB, Steadman JR. Rehabilitation of the injured knee. Clin Sports Med. 1985;4(2):333-343.

28. Brunet ME, Stewart GW. Patellofemoral rehabilitation. Clin Sports Med. 1989;8(2):319-329.

29. Henry JH. Conservative treatment of patellofemoral subluxation. Clin Sports Med. 1989;8(2):261-278.

30. McConnell J. The management of chondromalacia patella: a long term solution. Aust J Physiother. 1986;32(4):215-223.

31. Hubbard JK, Sampson HW, Elledge JR. The vastus medialis oblique muscle and its relationship to patellofemoral joint deterioration in human cadavers. J Orthop Sports Phys Ther. 1998;28(6):384-391.

32. Fox TA. Dysplasia of the quadriceps mechanism. Hypoplasia of the vastus medialis muscle as related to the hypermobile patella syndrome. Surg Clin North Am. 1975;55(1):199-226.

33. MacIntyre DL, Robertson DG. Quadriceps muscle activity in women runners with and without patellofemoral pain syndrome. Arch Phys Med Rehabil. 1992;73(1):10-14.

34. Fulkerson JP, Tennant R, Jaivin JS, Grunnet M. Histologic evidence of retinacular nerve injury associated with patellofemoral malalignment. Clin Orthop Rel Res. 1985;197:196-205.

35. Rouse SJ. The role of the iliotibial tract in patellofemoral pan and iliotibial band friction syndromes. Physiotherapy. 1992;82(2):199-202.

36. Insall J, Bullough PG, Burstein AH. Proximal "tube" realignment of the patella for chondromalacia patellae. Clin Orthop Rel Res. 1979;144:63-69.

37. Busch MT, DeHaven KE. Pitfalls of the lateral retinacular release. Clin Sports Med. 1989;8(2):279-289.

38. LaBrier K, O'Neill DB. Patellofemoral stress syndrome. Crit Rev Phys Rehabil Med. 1995;7(4):287-298.

39. Harrison E, Magee D, Quinney H. Development of a clinical tool and patient questionnaire for evaluation of patellofemoral pain syndrome patients. Clin J Sports Med. 1996;6(3):163-170.

40. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. J Arthroscopic Rel Surg. 1993;9(2):159-163.

41. Oberg U, Oberg B, Oberg T. Validity and reliability of a new assessment of lower-extremity dysfunction. Phys Ther. 1994;74(9):861-871.

42. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Rel Res. 1985;198:43-49.

43. Kettelkamp DB, Thompson C. Development of a knee scoring scale. Clin Orthop Rel Res. 1975;197:93-99.

44. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med. 1982;10(3):150-154.

45. Flandray F, Hunt JP, Terry GC, Hughston JC. Analysis of subjective knee complaints using visual analog scales. Am J Sports Med. 1991;19(2):112-118.

46. Thomee R, Grimby G, Wright BD, Linacre JM. Rasch analysis of visual analog scale measurements before and after treatment of patellofemoral pain syndrome in women. Scand J Rehab Med. 1995;27:145-151.

47. McConnell J. Management of patellofemoral problems. Manual Therapy. 1996;1(2):60-66.

48. Grelsamer RP, McConnell J. The Patella: A Team Approach. Gaithersburg, Md: Aspen Publishers, Inc; 1998.

49. Fitzgerald GK, McClure PW. Reliability of measurements obtained with four tests for patellofemoral alignment. Phys Ther. 1995;75(2):84-92.

50. Hoppenfeld S. Physical Examination of the Spine and Extremities. Norwalk, Conn: Appleton and Lange; 1976.

51. Paulos L, Rusche K, Johnson C, Noyes FR. Patella malalignment: a treatment rationale. Phys Ther. 1980;60(12):1624-1632.

52. Magee DJ. Orthopedic Physical Assessment. 3rd ed. Philadelphia, Pa: W. B. Saunders Company; 1997.

53. Norkin CC, Levangie PK. Joint Structure and Function. A Comprehensive Analysis. 2nd ed. Philadelphia, Pa: F. A. Davis Company; 1992.

54. Kolowich PA, Paulos LE, Rosenberg TD, Farnsworth S. Lateral release of the patella: indications and contraindications. Am J Sports Med. 1990;18(4):359-365.

55. Papagelopoulos PJ, Sim FH. Patellofemoral pain syndrome: diagnosis and management. Orthopedics. 1997;20(2):148-157.

56. Fulkerson JP. Awareness of the retinaculum in evaluating patellofemoral pain. Am J Sports Med. 1982;10(3):147-149.

57. Puniello MS. Iliotibial band tightness and medial patellar glide in patients with patellofemoral dysfunction. J Orthop Sports Phys Ther. 1993;17(3):144-148.

58. Cerny K. Vastus medialis oblique/vastus lateralis muscle activity ratios for selected exercises in persons with and without patellofemoral pain syndrome. Phys Ther. 1995;75(8):672-683.

59. Callaghan MJ, Oldham JA. The role of quadriceps exercises in the treatment of patellofemoral pain syndrome. Sports Med. 1996;21(5):384-391.

60. Yates C, Grana WA. Patellofemoral pain - a prospective study. Orthopedics. 1986;9(5):663-667.

61. Finestone A, Radin EL, Lev B, Schlamkoirtsch N, Wiener M, Milgrom C. Treatment of overuse patellofemoral pain. Prospective randomized controlled clinical trial in a military setting. Clin Orthop Rel Res. 1993;239:208-210.

62. Fisher RL. Conservative treatment of patellofemoral pain. Orthop Clin North Am,. 1986;17(2):269-272.

63. Schulthies SS, Francis RS, Fisher AG, Van DeGraaff KM. Does the Q-angle reflect the force on the patella in the frontal plane? Phys Ther. 1995;75(1):24-30.

64. Boucher JP, King MA, Lefebvre R, Pepin A. Quadriceps femoris muscle ativity in patellofemoral pain syndrome. Am J Sports Med. 1992;20(5):527-532.

65. Laprade J, Culham E, Brouwer B. Comparison of five isometric exercises in the recruitment of the vastus medialis oblique in persons with and without patellofemoral pain syndrome. J Orthop Sports Phys The. 1998;27(3):197-204.

66. O'Neill DB, Micheli LJ, Warner JP. Patellofemoral stress. A prospective analysis of exercise treatment in adolescents and adults. Am J Sports Med. 1992;20(2):151-156.

67. Winslow J, Yoder E. Patellofemoral pain in female ballet dancers: correlation with iliotibial band tightness and tibial external rotation. JOSPT. 1995;22(1):18-21.

68. Eng JJ, Plerrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. Phys Ther. 1993;73(2):62-70.

69. Merchant AC. Extensor mechanism injuries: classification and diagnosis. In: Scott NW, ed. Ligament and Extensor Mechanism Injuries of the Knee. St. Louis, Mo: Mosby Year Book; 1991.