

Patellofemoral Tracking Disorder:
Diagnosis and Treatment

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Abstract

Patellofemoral tracking disorder is a common cause of knee pain. It has many etiologies that have been divided into categories. This classification system includes patellar compression syndrome, patellar instability, biomechanical dysfunction, direct patellar trauma, soft tissue lesions, overuse syndromes, osteochondritis diseases, and neurological disorders. The diagnosis of patellofemoral tracking abnormality is well documented however, the treatment of this disorder is unclear. Most clinicians use conservative treatment which includes physical therapy, adjustments, and rehabilitation exercises. However, using the correct treatment for the appropriate cause is often not utilized. This paper will review the literature on the causes and treatments of patellofemoral tracking abnormalities in order to help clinicians select the appropriate treatment.

INTRODUCTION:

The most common knee problem presenting in a physicians office is the Patellofemoral Pain Syndrome (PFPS), in fact 25%-36% of the general population is affected by this syndrome, half of which have abnormal tracking of the patella(10,2). This pain syndrome is most common in athletes, especially runners. There are many articles pertaining to the diagnosis, this involves a careful history, physical (including specific orthopedic tests) and radiographic examination. A key factor in a thorough physical examination is the proper evaluation of the PF joint and inspection of the patella and lower extremity alignment and patellar tracking through the knee range of motion.

Although there are similar protocols for diagnosing patellar tracking disorders there are many discrepancies between authors regarding the treatment. There are obviously management differences between chiropractors, physical therapists, and medical doctors; but there are even differences within each of these models. Conservative management is used most often by all of these disciplines as the first phase of treatment, however if this is not effective, the next phase may include a surgical consultation.

The patient's history of knee pain is the main consideration during the initial consultation. The knee is a very complex joint and many different tissues can cause patellofemoral pain. In fact a classification system has been developed for clinicians to use for determining the source of pain. The classification system divides the patellofemoral disorders into eight groups, including patellar compression syndromes, patellar instability, biomechanical dysfunction, direct patellar trauma, soft tissue lesions,

overuse syndromes, osteochondritis diseases, and neurological disorders. Lateral patellar tracking is mentioned in most of these categories as a contributor to the dysfunction. The authors who developed this classification system (15) have included treatment suggestions for each category. However, not all authors agree on the methods of treatment for these disorders.

Most clinicians agree that the first phase of care for patellar pain and tracking abnormalities is to relieve the pain. This is typically done by using some form of physical therapy including cryotherapy, ultrasound, diathermy, electrical stimulation, or moist heat. If these methods do not work the use of NAIDs are employed for pain management. The next phase of care usually identifies the tissues involved. Rehabilitation of the leg muscles is the last phase of treatment.

Since a classification system and diagnosis criteria has been established for patellar pain and tracking disorders, the diagnosis is not a problem. The current problem deals with the treatment. In order to come up with an effective treatment, the cause of each patients problem needs to be precisely determined. The treatment itself also needs to be accurate and supported by the research that has been done; and not by anecdotal methods of the past.

The purpose of this study is to investigate the literature on the different causes of patellar tracking disorders. The various treatments will also be investigated and evaluated for their effectiveness in treating patellar tracking abnormalities.

Limitations are present in any study, the limits in this particular review is the amount of research relevant to the tracking disorder that is published. This topic is

controversial in its research because many authors contradict each other due to the methods in which it is researched. This study will provide a conservative approach to treating a very common disorder among the general population.

METHODOLOGY:

The literature reviewed was based on the diagnosis and treatment for abnormal patellar tracking and PFPS. A literature search using the Chiropractic Index at the Logan College of Chiropractic library was done first. The key words were patellofemoral pain with no limitations. This produced 30 articles, of those 30 10 abstracts that were relevant to diagnosing and treatment were used.

A second search was conducted in the computer lab at Logan College using the Pubmed medline. The key words this time were patellofemoral tracking. This search revealed 67 articles in peer reviewed journals, of these 67, 25 abstracts were printed and reviewed. Of these 25 abstracts, 22 articles were chosen to be further evaluated. I was also given 7 peer reviewed articles by Dr. Skaggs. These articles were chosen from medical, physical therapy, and chiropractic journals not older than 15 years. During the final evaluation process I selected 16 articles that pertained to the purpose of this literature review.

RESULTS:

The physical examination of patients with PFPS is key in diagnosing a tracking disorder, 50% of patients with knee pain have a tracking problem. During the physical exam usually there is no swelling, but typically there is slight atrophy of the quadriceps (most often vastus medialis), in addition to the following positive tests: patellar inhibition, compression, vastus medialis coordination test, and patellar tracking jitters. Orthopedic tests for internal derangement are typically negative. Patients usually have tight hamstrings and iliotibial bands as well as subtalar joint hyperpronation (10). Observation of the patients gait and measurement of the Q angle are also helpful. These are general findings for a tracking disorder but these alone will not tell you what is causing the problem, however, this is where the classification system becomes useful. It is necessary for the clinician to look at the knee joint and determine which tissues are causing the problem.

In a compression syndrome the patella is over constrained by the surrounding soft tissue, grossly restricting patellar mobility. This can occur on one side (usually lateral) or both sides of the patella called global compression syndrome which can lead to worn articular cartilage.

Patients with lateral compression syndrome often complain of pain (where vastus lateralis inserts into the proximal lateral retinaculum) upon stair climbing, squatting, or stooping down (15). As the condition worsens, crepitation with passive and active motion often develops. Upon physical examination the most important finding is whether or not the patella is tilted laterally with excessive tightness of the lateral

retinaculum when compared to the medial side. Also with lateral compression syndrome patellar mobility will be decreased in the medial direction. If this is not treated it will lead to chronic lateral patellar facet overload resulting in loss of lateral facet cartilage (15).

In global patellar pressure syndrome both retinaculum are excessively tight and the patella is restricted in both lateral and medial directions. This condition usually occurs secondary to trauma or immobilization of the patella causing the patient to complain of anterior knee pain.

Patellar instability is also called patellar subluxation which generally describes the transient lateral movement of the patella during early knee flexion (15). However, the clinician should not confuse this with the normal lateral tracking of the patella that occurs during full extension and flexion. Subluxation may result from congenital deficiency of the femoral trochlea, malalignment of the lower extremity, excessive hip anteversion, external tibial torsion, excessive pronation of the foot, or soft tissue and muscular imbalances. Patients often complain of snapping of the patella, episodes of giving way, and joint effusion with these episodes is commonly present. Additional physical findings may be patellar hypermobility, patella alta, and a laterally displaced patella. The clinician should be suspicious of patellar instability if greater than 50% of the total patella can be displaced laterally over the edge of the femoral condyle (15). Also special attention to the tracking of the patella during full extension to full flexion and back again. According to Wilks et al. it is especially important to observe the entrance and exit into the trochlea during flexion between 10 and 25 degrees.

Frequently, an abrupt lateral movement of the patella at terminal knee extension is observed and is referred to as an extension subluxation.

Lower extremity biomechanical dysfunction such as subtalar pronation can aggravate or cause patellofemoral pain and dysfunction as mentioned earlier. Other biomechanical changes in the lower extremity such as limb length discrepancy can have a significant affect on the patellofemoral joint. Loss of flexibility of the lower extremity muscles can also have a profound effect on the biomechanics of the patellofemoral joint (15).

Radiographic examination in addition to the physical exam is an excellent tool for diagnosing patellofemoral tracking disorders. The minimum views taken would be: the anterior posterior, lateral and sunrise view. The anteriorposterior view is used to rule out congenital anomalies, such as bipartite patella. The lateral and sunrise views are the most useful in the diagnosis. The lateral view is used to find patella alta or infra, this is done by specific set of measurements developed by Insal and Salvati (2). The pole to pole patella length and the distance between the inferior pole and the tibial tubercle is divided by the patellar tendon length and is termed the Insall ratio. This ratio should be 1:1, but a ratio <0.80 or greater than 20% difference bilateral is considered to be indicative of patella alta. This high placement of the patella in the femur sulcus decreases the surface area of the contact thereby applying the same pressure to a smaller surface area and also changes the resultant force vectors from the quadriceps mechanism (2). Patella infra is defined by an Insall ratio of >1.20 or greater than 20% difference bilateral and this also produces the same effect as described above. The most popular

radiograph used to evaluate patellar tracking is the sunrise view. The method of mensuration developed by Merchant et al. is probably the most functional assessment of this view. This involves a measurement of the depth of the femoral sulcus termed the sulcus angle and a measurement of the medial and lateral position of the patella in the femoral sulcus is termed the congruence angle. The sulcus angle should be about 138 degrees and an increased angle predisposes to excessive lateral patellar movement. The congruence angle was found to be -6 degrees in normal knees and +16 degrees in those with PF disorders (2,3). It was found by Moller et al. that a bilateral difference in these angles is more indicative of PF pain rather than the angles by themselves due to the fact that abnormal angles didn't always mean PF pain was present.

Inoue et al (9) found that patellar subluxation can be detected more accurately by using computed tomography with the knee in full extension than by using conventional axial roentgeograms. They took 50 patients who had patellar subluxation and thirty control subjects and examined them using both axial radiographs of the patellofemoral joint with the knee in 30 and 45 degrees of flexion, as well as computed tomography with the knee in full extension. They assessed the amount of lateral patellar tilt using the lateral patellofemoral angle described by Laurin et al., and the congruence angle as described by Merchant et al. The average congruence angle was found to be 5 degrees in patients with subluxation, which is less than previously reported. However, the sensitivity and specificity of the CT scans were higher than the values attained by using axial radiographs. This study is useful for the clinician when determining if a patient with patellofemoral pain has normal radiographs and still is symptomatic.

The use of MR imaging has also been used to evaluate patella tracking abnormalities. A study done by Shellock et al (14) found that MR imaging is just as useful as CT scans, and actually can give more information on the surrounding tissues like the patellar tendon, lateral retinaculum, quadriceps muscle, and patellar cartilage. As previously stated these tissues are important in determining the source of the patellofemoral tracking abnormality.

EMG studies are also used to evaluate muscle contraction during exercise involving the knee joint. Many authors have used the findings of these EMG studies to determine what muscles are best used to rehabilitate the knee joint. However, these studies are hard to compare due to the inconsistent EMG techniques used therefore, more research is needed in this area.

DISCUSSION:

The key to treating patellofemoral tracking disorders is to know what tissues are causing the problem. This should be established during a thorough history and physical exam as stated earlier. Many authors agree that there are numerous treatments and some are not supported by research. This is mainly due to the lack of proper research in the treatment of tracking abnormalities. Understanding the cause was the main concern of most researchers, but now the focus is on the proper treatment methods.

The variety of treatment applications that have been indicated are as follows: cryotherapy, moist heat, electrical stimulation, ultrasound, diathermy, patellar taping, braces, foot orthotics, quadriceps straightening, hamstring and iliotibial band stretches, mobilization of the surrounding tissues, NSAIDs, and surgery. Each of therapies have

their own benefits, but which should a clinician choose when a patient presents with a tracking disorder? The research has shown that exercise is one of the most beneficial treatments. Therefore, the foundation of any treatment plan should involve a comprehensive exercise program designed to target the large muscle groups of the lower extremity. Patient compliance in this area is essential in order to balance these muscles.

In a study by Doucette et al (5) of patients with lateral compression syndrome, exercise that involved training of the VMO (Vastus Medialis Oblique) was found to improve patellar tracking. The patients in this study also received iliotibial band stretching and mobilization of the surrounding tissues. Another study that involved VMO training showed that there are no significant differences in normalized EMG between the VMO and VL (Vastus Lateralis) in patients with or without PFPS. The VMO:VL proportion was shown to be the highest when medial tibial rotation and knee extension were resisted simultaneously. This study also revealed that there was not preferential recruitment of the VMO versus the VL during maximal hip adduction effort and simultaneous maximal knee extension. Medial rotation of the tibia alone also did not result in increased VMO activity when compared with the VL in this study (11). While some authors have found significant differences in VMO and VL activity in patients with patellofemoral tracking disorders, other have not. Direct comparisons of these studies are difficult because of differences in experimental technique and methods of assessing EMG data.

The reason that researchers have implicated the VMO as the primary medial stabilizer of the patella is due to the work of Lieb and Peery who identified the distal

fibers of the vastus medialis to be angled at approximately 55 degrees from the longitudinal axis of the femur. This makes that portion of the muscle most likely to prevent lateral subluxation of the patella (12). A lack of equilibrium between the VMO and VL is widely accepted as a contributing factor to the lateral subluxation of the patella. Unfortunately the evidence is lacking that shows the VMO is a contributor to patellar malalignment. Exercises attempting to isolate the VMO most likely result in a general straightening of the quadriceps, however, the mechanism by which quadriceps strengthening reduces symptoms is not known.

Since patellofemoral pain is typically reproduced with activities that are associated with high patellofemoral joint reaction forces, it is important that an exercise program be designed to enhance quadriceps strengthening while keeping joint stress to a minimum. During an open chain exercise (knee extension with the weight applied at the ankle), the amount of quadriceps force required to extend the knee steadily increases as the knee moves from 90 degrees to full extension. In addition to the increase in quadriceps force, the patellofemoral joint contact area steadily decreases. However during closed chain exercise (squatting), the quadriceps force is relatively minimal as the knee is extended and steadily decreases as the knee flexes(11). This increase in force is distributed over a larger surface area as the contact area increases as the knee flexes. Since both forms of exercise can be used to promote quadriceps hypertrophy, it is suggested that a strengthening program should consist of both open and closed chain exercises so that strengthening can be performed throughout a large arc of motion (7). Another factor in quadriceps training is eccentric versus concentric weight training. A

study by Godard et al (7) evaluated if accentuated eccentric resistance training would result in increased concentric strength. They found that there is no significant enhancement of maximal concentric torque from training with an accentuated eccentric resistance than without an accentuated eccentric resistance. The authors of this study suggest a balance between eccentric and concentric contractions during an exercise program.

The iliotibial band has also been implicated in the dysfunction of patellar tracking. A study of 17 patients with lateral tracking of the patella was evaluated. In that study the medial glide of the patella was tested manually and Ober's test was performed to test the flexibility of the iliotibial band. Twelve of the 17 patients exhibited a tight iliotibial band with hypomobility of medial glide of the patella. This study demonstrated a strong relationship between iliotibial band tightness and decreased medial glide of the patella (13). Therefore when developing a treatment plan, stretching of the iliotibial band along with manual stripping of the muscle is likely to decrease the laterality of the patella.

Patellar taping has also been shown to correct patellar malalignment during activity. McConnell reports a 92% success rate in a group of patients with PF pain, using a combination of taping, stretching and muscle training (4). The taping may address the specific needs of a patient as it can be used to correct lateral tilt, lateral displacement, rotation, and/or anterior-posterior tilt. The tape is applied as only a temporary measure to facilitate the muscle training and mobility exercises(4).

Excessive subtalar pronation has been implicated in the lateral position of the patella in tracking abnormalities. This is due to the fact that excessive pronation increases medial tibial rotation as a result of the talus articulation with the tibia and fibula at the talocrural joint (10). This leads to lateral deviation of the patella. A study by Klingman et al (10) evaluated patellar alignment by radiographic analysis pre and post placement of orthotic posting in patients with excessive rearfoot pronation. The study revealed a significant change in the medial glide of the patella.

The chiropractic treatment of patellofemoral tracking abnormalities also includes adjustments to the lumbar spine, pelvis, hips, knees, and ankle when indicated (16). The most important aspect of this treatment is to restore normal joint function and prevent abnormal biomechanics in any of these areas. Patellar mobility must be restored and this is done by lateral to medial glide, superior and inferior glide, and circumduction of the patella. The tibiofibula joint should also be addressed if indicated.

CONCLUSION:

A variety of etiologic factors can cause or contribute to patellar tracking disorders. The first step is to identify the tissue(s) that is causing the tracking disorder by using proper and thorough diagnostic methods. Then an appropriate treatment plan can be established. The most effective treatments that have been established are quadriceps exercises, iliotibial and hamstring stretches, patellar taping/bracing, activity modification, orthotics, and the physical therapy modalities (ice, heat, electrical stimulation and ultrasound).

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