pt connection
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Patellofemoral Joint

INTRODUCTION

Patellofemoral joint research has increased greatly over the past fifteen years. A great deal of research has been done in the areas of clinical evaluation, surgical procedures, and biomechanics. The one area that has received little attention is the rehabilitation of patellofemoral joint dysfunction.

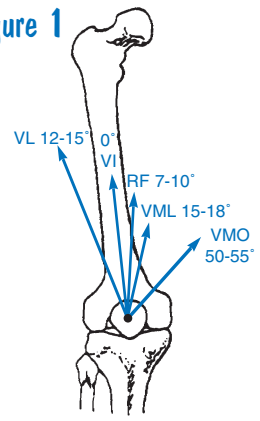
Patellofemoral joint anatomy, biomechanics, and evaluation will be presented. A subsequent newsletter will focus on current rehabilitation guidelines for conservative management of patellofemoral pathology.

ANATOMY

The patella is the largest sesamoid bone in the body. It is embedded within the quadriceps tendon. When viewed from the anterior and superior planes, the patella is seen as a triangularly shaped bone. The actual shape of the patella can vary from one individual to another. In fact, six different shapes have been identified. The posterior surface of the patella is composed of a medial and lateral facet divided by a central ridge. A third facet can be found on the medial aspect and is referred to as the odd facet. The patella is lined with aneural articular cartilage that is approximately 4 to 6mm thick. The thickest portion of articular cartilage can be found on both femoral sulci and condyles.

There are several other structures that are related to the patellofemoral joint. The quadriceps extension mechanism is composed of the following: the vastus intermedius, vastus lateralis, vastus medialis, and rectus femoris; the medial and lateral capsular retinaculum, the medial and

figure 1



Fiber orientation of the quadriceps musculature in relation to the femur.

VL = Vastus lateralis
VI = Vastus intermedius
RF = Rectus femoris
VML = Vastus medialis longus
VMO = Vastus medialis oblique

lateral patellofemoral ligaments, the patellar tendon, the fat pad, and the iliotibial band. When examining a patient with patellofemoral pain, one must keep in mind that all of these structures may be involved.

The position of the patella is maintained by a balance between its medial and lateral restraints. The stabilization of the patella involves both static (noncontractile) and dynamic (contractile) structures. The medial restraints consist of the static medial retinaculum and the dynamic vastus medialis longus and oblique muscles. Contraction of the quadriceps tends to laterally displace the patella. Along with the medial static stabilizers, the vastus medialis oblique muscle counters this lateral displacement (Figure 1).

The lateral retinaculum provides a static restraint, while the vastus lateralis and iliotibial band act as dynamic stabilizers.

BIOMECHANICS

When treating the patellofemoral joint, it is important to understand its anatomical alignment. Biomechanical malalignments are often a predisposing factor in patients that complain of patellofemoral pain and dysfunction. When determining a malalignment, the Q angle can be measured. This is performed by drawing a straight line from the tibial tubercle to the center of the patella. A second line is drawn from the anterior superior iliac spine to the center of the patella. The resultant angle can then be measured. Due to a wider pelvis and increased knee valgus, the Q angle is greater in females than males. The normal Q angle for males is 10-15 degrees and for females 15-20 degrees. An angle greater than 20 degrees is considered abnormal.

A change in patellar tendon length with respect to height of the patella can also alter the biomechanics of the joint. This is determined by taking a lateral radiograph with the knee flexed 30 degrees. The normal ration of patellar tendon length to patellar height is 1:1. A patella that is seated lower is termed patella baja, while the higher patella is called patella alta. Patella alta reduces the efficiency of the quadriceps mechanism, requiring a greater force to extend the knee. This increased force places greater stress on the patellar tendon and can result in overuse injuries.

The patellofemoral joint performs several functions. Acting as fulcrum, the patella provides the quadriceps with a distinct mechanical advantage. The patella also acts as a barrier for the internal knee structures against direct trauma, and has a cosmetic function by giving the anterior knee a rounded appearance.

During knee flexion, the patella glides inferiorly and its contact surface area increases. At 90 degrees, the total contact area is twice that at 30 degrees.

Patellofemoral joint reaction force is the measurement of compression of the patella against the femur and is dependent upon the angle of knee flexion, as well as muscle tension. When the knee is in full extension, the compression forces on the patella are negligible. At 30 degrees, a ratio of 1:1 patellofemoral compression to body weight is present, while at 60 degrees, compression is nearly four times body weight. With normal daily activities, the patellofemoral compression forces vary (Figure 2). Studies have shown that during exercise there is specific range of motion which is optimal to maintain low patellofemoral compression forces (Figure 2).

Figure 2

Compression Forces

Walking:	1.5 x body weight
Stairs:	3 x body weight
Squatting:	8 x body weight

Exercises

Closed chain:	0 - 30 degrees
Open chain:	90 - 60 degrees

ETIOLOGY

Patellofemoral pain syndrome occurs more commonly in females and adolescents. Various predisposing factors lead to patellar pain syndrome. Dysplasia of the trochlea, patella, and excessive subtalar pronation can lead to patellofemoral pain. An increased Q angle, tight lateral retinacular structures, muscle imbalances, and changes in training programs can also contribute to patellofemoral pain.

EVALUATION

A comprehensive history is necessary when evaluating patellofemoral pain. During the history, the patient may complain of diffuse aching in the anterior knee, which is increased by stair ambulation, squatting, kneeling, and prolonged sitting (movie sign). Crepitus, "buckling" or "giving way" of the knee may also be present.

During the standing evaluation, lower extremity alignment is examined for the presence of genu varum or valgum; patella malposition (squinting, alta, or baja); increased Q angle; and excessive subtalar pronation.

In the supine position, inspection should note whether there is atrophy of the vastus medialis oblique muscle. Patellar tracking is assessed by placing the knee through a range of motion. During flexion, a "J" sign may be observed when a laterally subluxed patella centralizes itself in the trochlear groove.

Patellar glide tests evaluate the integrity of the medial and lateral restraints, and should be performed at 20 degrees of knee flexion. Lateral translation greater that 50% of the width of the patella is suggestive of medial restraint laxity.

Lateral patellar tilt is characterized by shortening of the lateral structures, and can restrict passive elevation of the lateral margin of the patella. Lateral patellar tilt is associated with increased lateral facet loading.

The Apprehension test can assist in determining a subluxating patella. It is performed by laterally displacing the patella at 20-30 degrees of knee flexion. A positive sign would elicit pain and a quadricep muscle contraction to prevent the unwanted movement.

Two tests may reproduce articular pain. The Patellar Grind test is performed with the knee in 20 degrees of flexion. The examiner compresses the patella against the femoral sulcus, while having the patient actively contract his quadricep muscle.

Resisted knee extension through the full range of motion may also elicit pain. Reproduction of the patient's symptoms with these tests could indicate articular involvement.

Palpation of the soft tissue structures is performed. Lateral retinacular tenderness is common due to increased tension. Tenderness of the vastus medialis oblique may be noted due to overuse while attempting to balance patellar valgus forces.

The final component of the evaluation is assessment of lower extremity flexibility. ITB (Ober), hamstring, gastroc-soleus, quadricep and hip flexor (Thomas test) flexibility tests are performed to determine whether tightness is present.

After completing the examination, a treatment plan can be formulated based on a summary of the evaluation (See Table 1). Most patellofemoral problems respond to a well designed nonoperative therapy program. The next edition of the PT Connection will be devoted to the conservative management of patellofemoral pathology.

Table 1

History
Diffuse anterior knee pain
Pain with stairs, squatting
Movie sign

Inspection
VMO atrophy
Q angle > 20 degrees
Excessive subtalar pronation
Genu varus/valgum
Patella malposition:
- Squinting
- Patella Alta/Baja

Special Tests
Patellar glides
- Medial
  - Tight lateral structures
- Lateral
  - >50% translation = medial laxity

Patellar lateral tilt
- Tight lateral structures
- Increase lateral facet loading

Articular involvement
- Patellar Grind
- Resisted knee extension

Apprehension test
- Subluxating patella

Palpation
- Lateral retinaculum
- VMO
- Patellar facets

Flexibility
- ITB
- Hamstrings
- Gastroc-soleus
- Hip flexors
- Quadriceps