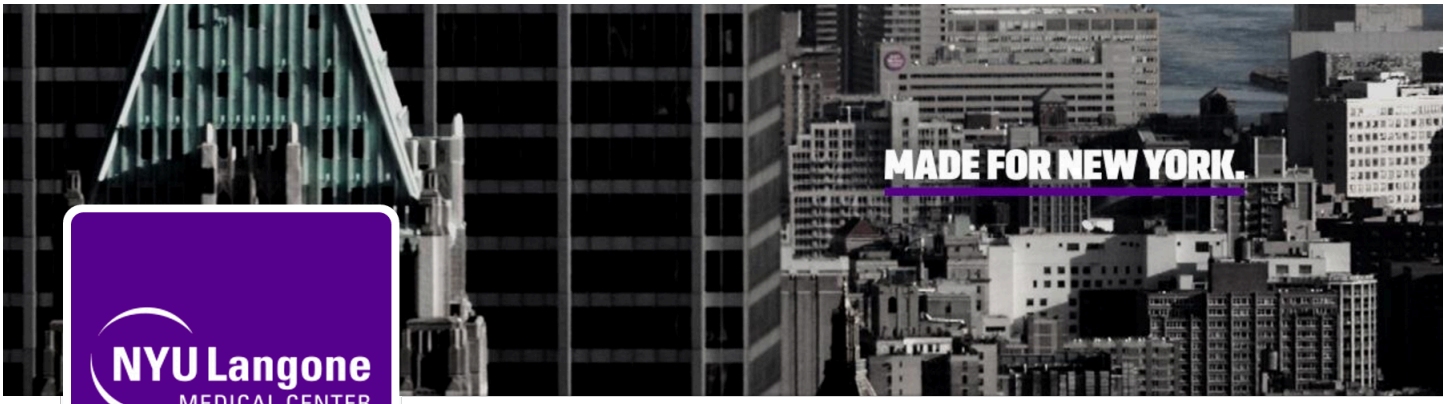

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Rehabilitation Protocol for Patellar Realignment

The knee consists of four bones that form three joints. The femur is the large bone in your thigh, and attaches by ligaments and a capsule to your tibia, the large bone in your shin. Next to the tibia is the fibula, which runs parallel to the tibia. The patella, commonly called the knee cap, is embedded in the quadriceps and patellar tendonand articulates with the front of the femur. This is the patellofemoral joint. The patella acts as a pulley to increase the amount of force that the quadriceps muscle can generate and helps direct the force in the desired upward direction.1 The patella sits in a groove on the end of the femur called the trochlear groove. This groove varies in depth from person to person. While the knee exes (bends), the patella travels down the groove and as the knee extends (straightens) it moves up the groove. As the patella travels up and down in the femoral groove it maintains a congruent boney alignment. This patellar movement in the femoral groove is often referred to as patellar tracking. There are several structures that work together to keep the patella aligned and stabilized in the femoral groove properly, specifically to prevent the patella from excessive lateral movement. The lateral aspect of the trochlear groove is normally about 1 cm higher than the medial which helps to keep the patella in the trochlear groove by providing a buttress on the lateral side (Figure 1).2 This provides the main resistance to lateral patellar translation (which is the most common direction of displacement), especially beyond 20 degrees of knee exion.3 People who have a shallow trochlea are more susceptible to patellar instability.

Proper stabilization of the patella is also affected by the soft tissue structures (ligaments and muscles) surrounding the knee. The medial patellofemoral ligament (MPFL) is a continuation of the deep retinaculum and vastus medialis oblique (VMO) muscle fibers (inner portion of the quadriceps muscle) on the inside of the knee. These structures provide a significant force (near 60% total) against lateral displacement of the patella, as their force is directed inward or medially.2,4 The MPFL is the primary restraint to lateral displacement of the patella during the first 20-30 degrees of knee exion.3 This ligament is a passive stabilizer and extends from the upper inner side of the patella to medial aspect of the femur.

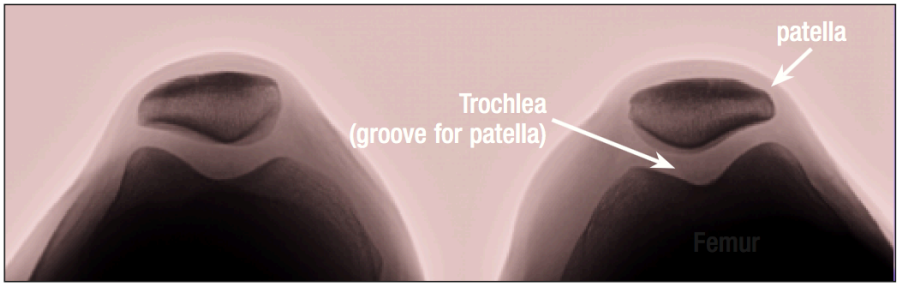

Figure 1 *Radiograph of the patellofemoral joint in slight flexion. The lateral aspect of the trochlear groove is normally about 1 cm higher than the medial.*

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Rehabilitation Protocol for Patellar Realignment

The patellomeniscal ligament and retinaculum also contribute over 20% of the restraining force. These ligaments can be injured and torn with an initial acute traumatic patellar dislocation (knee cap quickly going out of place during a sport related movement). The most common mechanism for an initial dislocation is a forceful inward rotation of the knee on a planted foot. The radiograph below is that of a 12 year old boy in the emergency room after such an injury (Figure 2). Often times the patella will go back in to place (or relocate to the groove) as the knee is gently straightened. In this case the patient was unable to straighten his knee and his patella remained dislocated laterally. Note on the radiograph that there is no overlap of the femur and patella.

An individual can also have a traumatic instability. In this situation the instability is more likely to be a partial dislocation or subluxation and not created by a large forceful one time injury. People with a traumatic instability usually have predisposing factors that alter their normal patellar tracking.

The alignment of the pelvis and femur can affect patellar tracking. The alignment of the pelvis and femur can be structurally altered based on a particular individual's angle of the quadriceps muscle, also known as "Q angle". The "Q angle" is formed by the superior line of the quadriceps pull (from the hip) and the patellar tendon (insertion onto the front of the tibia) as they intersect at the patella (Figure 3).[2]

The alignment of the pelvis and femur can also be functionally altered in a weight bearing position due to hip weakness or pronated (flat) feet.

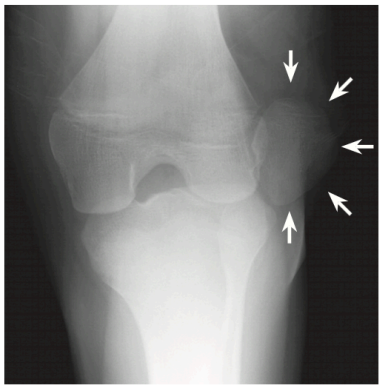
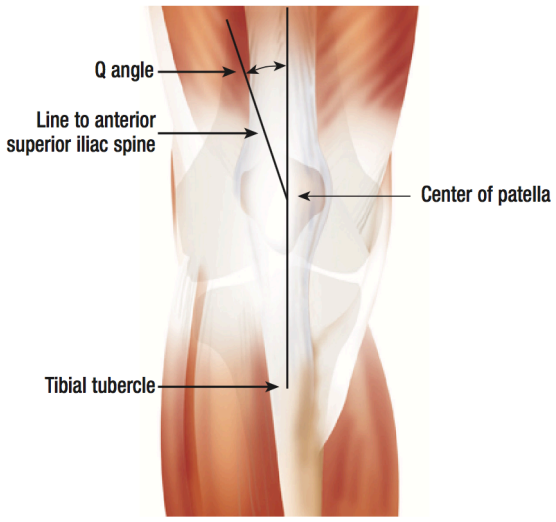


Figure 2 *Radiograph of the knee, arrows show the laterally dislocated patella*



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Patellofemoral stress syndrome (knee cap pain) and patellar instability result from a deviation in the normal tracking of the patella. Most often abnormal tracking results in lateral positioning of the patella (toward the outside of the knee). Lateral displacement can occur from the femur rotating inward or the patella being pulled outward. This can happen as a result of injury or repetitive stress. Instability can occur as a mild subluxation (slight loss of joint alignment), or as a complete dislocation (Figure 2). Patellar dislocation typically involves a strong quadriceps contraction combined with a flexed and valgus knee position and an internally rotated femur relative to the tibia.[2] In sports this often occurs when an athlete plants his/her foot to pivot and the knee turns inward while the upper body and hips are turning outward. Annual incidence of patellar dislocations in people under 16 years of age was found to be 43 per 100,000. This incidence lowers to 31 per 100,000 in the second decade of life, followed by 11 per 100,000 in the third decade, and even further to 1.5-2 per 100,000 in those between 30-59 years of age.[2]

People with recurrent dislocations of the patella often have anatomical variations or malalignment including patella alta or a higher quadriceps "Q angle" (Figure 3), which predispose them to instability.[3,4] Patella alta describes a high-riding patella which engages the trochlea later in flexion than normal, giving the patella less boney stability.[4]

Many options exist for treating patellar instability. Rehabilitation is typically recommended following an initial dislocation; however recurrent dislocation is reported to be as high as 48% with non-operative treatment.[2] Operative treatment is typically performed on those with an underlying, predisposing anatomical variations/ malalignment as noted above. Operative treatment is also performed on people who have had reoccurring dislocations, as these individuals typically have continued apprehension and progressive joint damage. Specific operative treatment is selected based on the particular needs of the individual including: extent of malalignment, individual's age, level of activity, ligamentous injury (MPFL) and joint condition. Examples of procedures used include: proximal realignment, MPFL repair or reconstruction, lateral release, and distal realignment.

Figure 4 *Lateral radiograph of the knee showing a distal realignment to reduce the "Q" angle by moving the tibial tubercle medially.*

Proximal realignment alters the medial- lateral position of the quadriceps muscle to the patella through appropriate manipulation of the tissues at or above the level of the patella. An incision is made over the knee and specific procedures include: lateral retinacular release (lengthening the structures on the outside of the patella), VMO advancement and MPFL repair and reconstruction (shortening the muscle or ligaments on the inside of the patella).[2] This procedure is sometimes done in combination with a distal realignment procedure.

Distal realignment is often done to reduce the "Q angle". This is performed through an incision over the knee in which an instrument to cut the tibial tubercle (the boney prominence on the top of the tibia where the patellar tendon attaches) is used. This is called an oteotomy. The basic purpose of this type of osteotomy is to move the tibial turbercle medially (toward the inside). The type of osteotomy performed will determine how much of this bone will be cut. Because of this difference there will also be subsequent differences in when these patients can begin weight bearing. The patellar tendon and bone which was cut is then moved medially which alters the position of the patella. The bone is reattached in this new position to the tibia with screws (Figure 4).

A quality post-operative rehabilitation program is essential to having a successful outcome from a patellar stabilization procedure. The goals of rehabilitation will initially focus on protection for healing, mobility and range of motion. After this early phase there will be a strong emphasis on strengthening throughout the entire leg and core. In the final stages rehabilitation the focus will be on control of sport specific movements, such as change of direction and rotational movements.