



Anterior knee pain as a functional problem of complex dynamic inter-play of living structures

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The knee is the largest and most complex joint of the musculoskeletal system. Compared to the other joints of the lower limb, the knee has the least inherent stability, secondary to the minimal congruence between the distal cam-shaped femur and the relatively flat, proximal tibia.

The stability of the knee is mainly provided by soft tissues: e.g., the cruciate, the menisci and the lateral and medial collateral ligaments, along with the help of the reflex-guided neuromuscular dynamic control mechanisms.

The decelerator-extensor system of the quadriceps with its inbuilt patellofemoral joint is the most powerful and most important active stabilizer, of the knee. In the internally-rotated knee the m. vastus lateralis together with the ilio tibial tract (ITT) tend to pull the patella laterally because of their insertion on lateral retinaculum, and lateral edge of the patella.

The vastus medialis obliquus (VMO), alternatively, inserts in the proximal medial corner of the patella and also on the medial patellofemoral ligament (MPFL), and pulls with the VM and the longitudinal medial retinaculum parallel to the patellar tendon directly onto the tibia.

The MPFL because of its thin anatomy towards its femoral insertion seems to act primarily as an adjusting sensor.

Biedert (1) has shown the dense concentration of proprioceptive nerve endings especially in the areas of the quad-tendons around the patella. This reflects the importance of the guidance function for active muscular stabilization.

What are the characteristics of the anatomy that provide stability of the patella in the anterior aspect of the knee during active loading?

Quadrupeds walk with a flexed knee and their patella is located in a stable configuration—the intercondylar groove (trochlea—L. pulley). This is the same for the human knee in more than 20 degrees of flexion.

But Bear, Elephant and Man walk with a fully extended knee.

Our human patella is therefore less stable between 20 and 0 degrees of flexion articulating with the proximal, flatter trochlea with less bone congruence. Between the 20 to 0 degrees an automatic end-rotation occurs due to the longer medial condyle with the additive anterior circular 60° segment.

By this automatic rotation the femoral condyle turns in relative to the tibia, and as a consequence the Q-angle aligns more with the Quad forces over the patella, providing additional dynamic stability.

The patellar plicae, with a meniscal-like effect close the gaps between the less congruent bone cartilage surfaces and may have a role in reducing the shear forces, when the patella is pulled laterally and medially.

The highly innervated fat pad and the mobile plicae fill all the open spaces between the joint surfaces, and therefore the knee can function with only a few drops (thin film) of synovial liquid. Due to mechanically induced shear forces impinging on vulnerable, innervated soft-tissues—an inflammatory response can provoke effusions and irritated thickened plicae. Additionally, swelling of the fat pad with its falciform (L. sickle-shape) plica, (the so-called ligamentum mucosum), which is an integral proximal part of Hoffa's fat pad can also induce pain.

This ligamentum mucosum runs from the distal patellar pole, following the intercondylar notch up to the proximal

insertion of the anterior cruciate ligament. By this anatomic fact, the pain from the swollen, inflamed fat pad and the connected synovial plicae, rich in sensitive nerve endings is conducted and propagated into the knee and under the patella. The swollen fat pad and the irritated painful plicae around the patella can be readily palpated, for additional clinical information to help manage the patient.

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With all this in mind we have to consider what kind of a treatment can improve the conditions to reestablish joint homeostasis and balanced, pain pain-free knee function.

References

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