The Kinematics, Structure and Function of the Infrapatellar Plica, Fat Pad, and Central Body – a New Enthesis Organ Linked to Anterior Knee Pain.

Purpose

Release of the infrapatellar plica (IPP) relieves anterior knee pain. An index case demonstrated mechanical behavior of the plica, and inflammation in the femoral notch. We asked two questions. What is the physiology of this? And, what is the correlating morphology? Our hypothesis is that the IPP, central body, and fat pad collectively act as a highly innervated, deformable, force attenuating enthesis organ, rotating about the IPP femoral origin with knee motion. The IPP tethers the fat pad inducing stretch and deformation because the organ is not isometric; release of the IPP ablates this behavior.

Methods

Fluoroscopy of knee motion was recorded after tantalum beads were placed in the IPP in one knee, then radiographic contrast in another, demonstrating the kinematics pre- and post release of the IPP in cadavers. In nine volunteers undergoing arthroscopy the contrast experiment was repeated, pre- and post-release of the plica. Passive and active motion and a quads set manoeuver were observed. Twelve knees were dissected, gross anatomy assessed, and representative samples of the origin, central zone, central body, and fat pad taken for histologic examination.

Results

The cadaver study videos demonstrate: rotation of the enthesis organ around the femoral origin of the IPP; and, a sequence of dynamic, non-isometric mechanical behavior with stretch and deformity of the IPP and central body approaching end-flexion and extension, none in mid arc; IPP release ablated this. The volunteer study confirmed the sequence for the entire enthesis organ: stretch and distortion in full flexion; then relaxation throughout mid arc followed by remarkable increasing stretch and distortion approaching full extension; IPP release eliminated this. Voluntary quadriceps setting perturbed the enthesis organ. Anatomically, each knee was unique; notch anatomy was variable. Histologic examination shows that the femoral attachment of the IPP is a classic enthesis. The central zone histology is ligamentous, variably composed of loose and dense connective tissue, elastin and fat. Capacity for stretch correlates with: elastin staining throughout; crimping of collagen; and redundancy of connective tissue, vessels and nerves. S100 staining demonstrates nerves in the substance of the IPP. The central body is unique: dense connective tissue of the central body splays out in finger-like septa which merge with those of the fat pad; lobulated collections of mature adipose tissue sit between septa, containing abundant small peripheral nerves and vessels (most showing crimping and redundancy).

Conclusions

We demonstrate the kinematics and structure of a highly innervated, non-isometric, deformable enthesis organ filling the anterior compartment of the knee. Its mechanical task is force attenuation. Release at the IPP origin ablated the observed relaxation, stretch and deformity. Structure and function are linked in that: the IPP origin is an enthesis; the central zone is a non-isometric ligament; elastase staining, redundancy of vessels and nerves, crimping and redundancy of the collagen all reflect the requirement to deform. The fat pad is tethered at the femoral IPP attachment. The IPP, containing nerves, merges with the fat pad at the unique, deformable central body. Release of the IPP eliminates the stretch and distortion, and may be considered as initial treatment of anterior knee pain of all types. These findings alter basic concepts of knee physiology.