**Introduction:** Infrapatellar Contracture Syndrome (IPCS) [1] describes a post-operative complication in which there is a vertical lowering of the patella relative to the knee joint. This condition, often referred to as patella baja, is induced via patella tendon (PT) adhesion formation and/or irreversible PT contracture, which can have dire implications for both anterior knee pain [2] and mobility [3,4]. The aim of our experiment was to verify and quantify changes (if any) in patellar and tibial kinematics resulting from controlled reductions in the length of the PT.

**Materials and Methods:** Six intact un-paired sheep hind-legs were obtained for this study. The rectus femoris muscle was transacted in the axial plane approximately mid-way along its length during specimen preparation. The femur was rigidly fixed to a knee loading frame by clamping of the femoral head and 50N load was applied along the line of action of the rectus femoris muscle using a weight/cable/pulley system sutured to the belly of this muscle. Knee kinematics were continuously measured throughout the range of motion of the knee using a magnetic tracking system, 3Space IsoTrack II (Polhemus, Colchester, VT) linked to a laptop computer. The systems’ source was fixed to a PVC frame and suspended above the knee, where custom-made bone screws were used to attach the systems’ receivers to the patella and tibia. The patellar receiver was transferred to a third screw implanted in the femur before and after each test to register the spatial location of the femur. After an initial ‘control’ tracking pattern was obtained the fat pad was excised and a second tracking pattern recorded. Incremental 1mm reductions in the length of the PT, up to a total of 6mm, were then simulated using a custom manufactured shortening device (SD) attached to the PT (Figure 1).

The SD was machined from acetal so as not to provide a source for magnetic interference and, fixation required removal of the fat pad. The SD consisted of two clamps linked together by two screws running parallel to the PT which were used to draw the two clamps of the device together, thereby emulating PT contracture. An initial tracking pattern was taken with the two clamps of the SD attached to the PT but not engaged by the shortening screws. Another was taken with the device engaged but no shortening simulated. This was done to ensure that the SD alone did not alter knee kinematics and in all other tests the clamps were engaged. For each testing condition the knee was taken through its entire range of motion a total of three times and the results averaged.

Each leg was then dis-articulated and indentations drilled into the bones. The receivers were re-attached to the bones and a third sensor (stylus pen) used to digitise the indentations. Each bone was then CT-scanned (0.5mm) and the DICOM outputs used to create 3D models of the bones. The surfaces were subsequently imported into a 3D-modelling software package (ProEngineer, PTC, MA) where body-fixed coordinate systems were created using bony landmarks in accordance with the Joint Coordinate System (JCS) of Grood and Suntay [5]. Post-processing (Matlab, MathWorks, MA) involved transformation of the raw data into clinical translations and rotations as per the JCS. Statistical analysis was performed using SPSS (SPSS, IL) with significance set at P<0.05.

**Results:**

![Figure 2. External Rotation and Lateral Shift of the tibia with a 10% contracture in the PT](image)

Removal of the fat pad had no effect on patella tracking or tibial kinematics. In all knees tested, a 6mm reduction in PT length represented a contracture of approximately 10%. Only patellar spin was significantly affected at this level of contracture, all other patella tracking parameters being unaffected. At this level there was a significant increase in external rotation of the tibia (Figure 2), although this effect was only significant post 100 degrees of knee flexion, corresponding to full engagement of the patella with the femoral trochlea. In all knees there was a significant lateral shift of the tibia throughout the entire range of flexion at the 10% contracture level (Figure 2). Patellar flexion lagged tibial flexion in all knees by approximately 30%, a result similar to that observed in the human knee.

**Discussion:** While the geometry of the sheep knee differs from the human, the sheep allowed a simple and cost effective model for experimentation as well as a baseline for future surgical manipulation. Clinically, a 10% reduction in the apparent length of the human PT is classified as patella baja. Our results show that in the in-vitro sheep model, patella tracking - with the exception of patellar spin - is largely unaffected by a 10% reduction in PT length. Our results suggests that tibial kinematics are more sensitive to changes in the length of the PT.

**References:**

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