

## Patellofemoral Research Excellence Award

### The Geometry and Function of the Patellofemoral Joint

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#### Abstract:

##### Purpose:

The purpose of this study was to explore the patellofemoral joint in 3 dimensions, looking at its geometry, motion and stability. This work aimed to establish a relationship between this joint and the tibio-femoral joint.

##### Method:

CT scans of 40 normal knees were analysed using custom designed 3D imaging software. A frame of reference was defined, the flexion and extension facets were described in terms of spheres, and the offset of the extension facet sphere centres was measured relative to predefined landmarks. The locations and orientations of the groove and the trochlear axis were examined in relation to the conventional axes of the femur. As for the patella the relationships of various patellar dimensions were studied.

In the next part of this study, the kinematics and stability of the patellofemoral joint were measured in 14 fresh frozen cadaveric knees using a Polaris tracking system and an Instron material testing machine after physiologically loading the quadriceps muscles. Then the relationship between these measurements and the femoral trochlear geometry was examined.

##### Results:

It was found that the flexion facets of the femoral condyles were spherical. The medial extension facet could be reproducibly described as part of a larger sphere. However, this was not found to be the case laterally. The trochlear groove was circular and positioned laterally in relation to the mechanical, anatomical, and trans-condylar axes of the femur. It was not co-planar with any of the three axes. The trochlear axis was defined as a line joining the centres of two spheres fitted to the trochlear surfaces, lateral and medial to the trochlear groove. When viewed after aligning the femur to this new axis, the trochlear groove appeared more linear than when other axes were used. The thickness of a patella was on average half of its measured width (correlation coefficient 0.89,  $p < 0.001$ ). The path of the centre of the patella was circular and uniplanar from full flexion to approximately 16° flexion, after which it deviated laterally towards full knee extension. This path was perpendicular to a newly-defined trochlear axis. There were significant correlations between the sulcus angle and the medial facet angle with medial stability ( $r = 0.78$ ,  $p < 0.0001$ ).

##### Conclusion:

The knowledge of the shapes of the surfaces and motion of different compartments of the knee joint and their relationships may help to identify and explain the aetiology of knee joint pathologies. It may also be of use in planning and performing joint reconstruction. These relationships also have implications for the design of unicompartmental and total knee replacements and the rules governing their position.