



The Effects of Partial Meniscectomies on Knee Joint Contact Stresses: A Finite Element Study

Diagarajen Carpanen

email: diagarajen.carpanen@anglia.ac.uk



Background

The meniscus is a C-shaped cartilage located at the periphery of the knee joint. It helps in the load bearing and stabilisation functions of the knee. Meniscal injuries arise in the young population, following trauma or sports injury, as well as in the older population. Meniscus tears (Figure 1) have an incidence as high as 70 per 100,000 people. Partial meniscectomy, whereby part of the torn meniscus is excised, is a common surgical practice for treating the torn meniscus.

The effects of resecting specific sizes and locations of meniscus on knee joint contact pressures and the risk of osteoarthritis onset is not clear. Our aim is to investigate this unknown link by finite element (FE) method. We hypothesise that the size and location of the resected meniscus during a partial meniscectomy influence the percentage increase in knee joint contact pressures compared to those of pre-injury on the same knee.

Method

We created a three dimensional (3D) model of the knee (Figure 2) from computer tomography (CT) scans and magnetic resonance images (MRI) of a cadaveric knee, using Mimics imaging software v14 (Materialise, Belgium). The 3D model was exported to FE package ANSYS v12.1 (ANSYS, Pennsylvania) for stress analysis, where loading conditions, simulating the standing posture, were applied.

As a first step to answering our research question, we carried out a comparison study on the contact stresses in the tibiofemoral joint of an intact knee and one with a total meniscectomy, whereby the meniscus was completely removed.

Results

Stress analyses (Figure 3) show that peak compressive stresses in the tibial cartilage were 2.14 times higher in the simulated meniscectomised knee. These results are consistent with those published by Pena and co-workers (2006).

Conclusion

Preliminary findings show the importance of the meniscus in reducing knee joint contact stresses and is a first step towards understanding the safe location and proportion of partial meniscectomy.

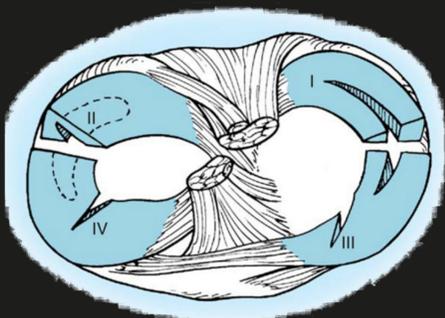


Figure 1: Four Basic Tears of the Meniscus (blue) : I, longitudinal; II, horizontal; III, oblique; and IV, radial (Source: Operative Orthopaedics, 2007)

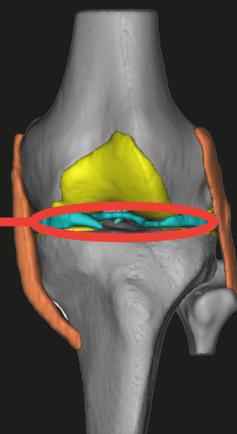


Figure 2: An Accurate Three Dimensional Model of the Healthy Knee, Created from CT Scan Dataset

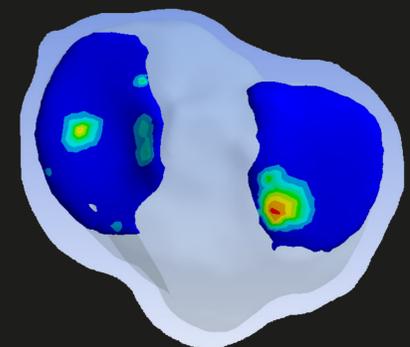


Figure 3: Stress Results in the Knee Tibial Cartilage - axial view

Acknowledgements

Supervisory Team: Dr. Rajshree Mootanah, Dr. Robert Walker, Prof. Kevin Cheah & Dr. Howard Hillstrom
The Higher Education Funding Council for England