

## **Fracture toughness of femoral head cancellous bone material in relation to noninvasive bone assessment measurements**

R Cook<sup>1</sup>, P Zioupos<sup>1\*</sup>, C Curwen<sup>2</sup>, T Tasker<sup>2</sup>

<sup>1</sup> Dept of Materials and Medical Sciences, Cranfield University, Shrivvenham, UK

<sup>2</sup> Gloucestershire Royal Hospital and Cranfield University Postgraduate Medical School, Gloucester, UK

### **Abstract**

There have been a number of studies relating the biomechanical properties of human bone cancellous and cortical (mainly stiffness and strength) to quantitative non-invasive ultrasound (QUS). The best correlations are obtained when mechanical tests are compared vs. contact QUS in-vitro. Few studies attempted to relate noninvasive QUS on cadavers against excised material of the same donors. This study aims to assess the fracture toughness, in addition to stiffness and strength, of cancellous femoral head bone of donors that have gone QUS investigations in-vivo. Both the in-vivo aspect and the toughness measurements of bone are elements that have never been examined before.

Heads of femurs were collected from osteoporotic and osteoarthritic patients. QUS was performed by 2 different peripheral scanners on 4 different sites. Disc and bar-shaped samples were prepared from the femoral heads to material standards for fracture toughness measurements. The densities of samples have been measured to allow minimization of scatter due to varying density. The bar specimens were broken in 3-point bending and the disc shaped one in tension, in both the crack mouth opening displacement was measured. The aim of the study was to investigate whether reliable toughness measurements can be made on cancellous bone (a material capable of large elastoplastic deformations), their dependence on trabecular type and architecture, sample density and the relationship to QUS in-vivo. Such data is currently lacking in the literature.

\* Corresponding author: Dr Peter Zioupos,

Senior Lecturer, Dept of Materials & Medical Sciences, Cranfield University, Shrivvenham SN6 8LA, UK

tel: +44(0)1793-785932; fax: +44(0)1793-783076; mobile: +44(0)7754-772803

email: p.zioupos@cranfield.ac.uk

<http://www.rmcs.cranfield.ac.uk/dmms/cmse/pZioupos>