Depth related changes in aging bone
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Introduction
Injury and musculoskeletal disorders, such as osteoarthritis (OA), are the cause of 56% of Army medical discharges [1]. Excessive loading can cause damage to the hip and knee joints, as can aging. Microstructure of bone changes significantly with age affecting the strength of the bone [2]. Bone remodels with mechanical stimulus, leading to its heterogeneous structure, this suggests that structure may change as a function of depth [3].

The aim of this study was to (i) evaluate the hypothesis that the structure of the femoral head changes significantly with age; (ii) to determine how the structure changes with depth and (iii) determine how the structure differs between sexes.

Materials and Methods
Femoral head samples, from 18 males and 17 females, were collected from cadavers from the Melbourne Femur Collection (donors ages ranged from 20-93 years old). The donors had no known diseases. Trabecular bone cores were taken along the principle compressive trabeculae of the femoral head. The specimens were scanned using a μCT scanner (XT H 225, X-Tek Systems Ltd.). Cores were sectioned into 10 x 2mm slices and the average greyscale of each section was measured – allowing for the calculation of volumetric tissue mineral density (vTMD) via a hydroxyapatite calibration phantom. Microarchitectural parameters, including bone volume fraction (BV/TV), trabecular thickness (Tb.Th) and trabecular spacing (Tb.Sp) were calculated for each 2mm slice. Volumetric bone mineral density (vBMD) was calculated using vTMD and BV/TV.

Results
The microarchitecture of the femoral head changes significantly with age and is dependent on sex and depth [4]. The subchondral bone is in direct contact with the basal layers of the articular cartilage and is therefore in a different biochemical and mechanical environment to the underlying trabecular bone [4]. It is proposed that discrepancies between sexes are a result of hormonal differences which can influence bone remodelling. Depth, sex and age should all be considered when designing a patient’s joint replacement or osteochondral implant.

Discussion
• The microarchitecture of the femoral head changes significantly with age and is dependent on sex and depth
• The subchondral bone is in direct contact with the basal layers of the articular cartilage and is therefore in a different biochemical and mechanical environment to the underlying trabecular bone [4]
• It is proposed that discrepancies between sexes are a result of hormonal differences which can influence bone remodelling
• Depth, sex and age should all be considered when designing a patient’s joint replacement or osteochondral implant

Conclusion
The structure of the femoral head changes significantly with age, sex and depth. This knowledge can be used to improve implant integration for OA treatment.

References