INTRODUCTION:
Hip resurfacing arthroplasty (HRA) is increasingly carried out as an alternative to total hip arthroplasty (THA) in young, active patients. The primary indication for this surgery is osteoarthritis. It is favoured over THA as it preserves bone stock and it is claimed not to cause stress shielding. However, fractures of the femoral neck result in short term failure of the procedure in approximately 0.75 - 2% of patients [1,2]. Furthermore, to reduce the potential for femoral neck fracture, it is recommended that femoral neck notching be avoided/minimized [1].

Previous finite element (FE) analyses have employed over-simplified material parameters to define the femoral bone and non-physiological loading conditions [3,4]. In this study an experimentally validated FE model of a cadaveric femur before and after HRA surgery [5] was analysed. The implanted femoral geometry included an anterior notch on the femoral neck. These models were analysed to determine the change in femoral bone mechanics and included physiological loading conditions and more accurate multiple material parameters to represent the nonhomogeneous bone distribution in the femur.

METHODS
Material properties were assigned to the femoral bone using the data from a detailed CT of a cadaveric femur [5]. Intact and implanted FE models were validated using experimentally measured strains compared with model calculated strains. The models were analysed using ANSYS 9.0 (Ansys Inc., Canonsburg, USA). A physiological load case representing the muscle and hip contact forces at an instant 10% through the walking gait cycle was applied to the intact and implanted models.

Von Mises stresses were compared between the two models at three cross-sections through the neck of the femur (Figure 1a). Neck section A included bone in the anterior notch and was level with the inferior rim of the implant. To determine the potential for femoral bone fracture under this physiological loading condition, a risk of fracture (RF) scalar was calculated as the ratio between the Von Mises stress and the ultimate strength of bone. A value greater than one indicated a potential failure.

DISCUSSION:
A multiple material property model more closely simulates real bone mechanical properties than a 2 material model. This is the first fully validated FE model of a femur implanted with an HRA. A limitation of this study was the use of the same loading conditions before and after surgery, which did not account for the dividing of muscles during the procedure.

Taking into consideration that these models were not developed using fracture damage modelling techniques, the analysis results under physiological loading conditions showed minimal change in femoral neck bone stress post-HRA surgery. This appears to support the claims that HRA does not result in stress shielding in the femoral neck. Furthermore, the calculated bone stress in the femoral neck was not sufficient to be a potential cause of fracture when an anterior notch is present.

REFERENCES