INTRODUCTION:

The new generation of metal-on-metal hip resurfacing is becoming an increasingly popular alternative to total hip replacement in the younger and more active patient. Mid-term survivorship figures for osteoarthritic patients are comparable to that of patients receiving a total hip arthroplasty. However, individuals receiving a hip resurfacing for aetiologies other than OA, such as avascular necrosis, experience poorer outcomes and higher revision rates (1-2). The Birmingham Mid-Head Resection (BMHR, Orthopaedics, Warwick, United Kingdom) (Figure 1) is designed as a short-stem alternative to hip resurfacing for patients presenting with compromised or unsuitable femoral head anatomy. The BMHR shares the same advantages of proximal femoral bone conservation and ease of revision as that of a standard hip resurfacing. However, retention of the femoral neck bears with it the risk of femoral neck fracture. Several risk factors for femoral neck fracture with traditional hip resurfacing have been identified including femoral neck notching and varus implant alignment. It is not known however, if these fracture risks pose the same hazard to a mid-head resection arthroplasty. The purpose of the current study was to investigate the effect of superior femoral neck notching with the BMHR.

METHODS:

Twenty-four Generation Composite Femurs (Model 3306, Pacific Research Labs, Vashon, WA, USA) were implanted with the BMHR prosthesis and tested in axial compression using a mechanical testing machine. Prior to implantation, intact femurs were first stiffness tested and then again following implantation. Six specimens each were prepared with notches in the superior cortex of the femoral neck, one approximating a sub-cortical thickness notch (2 mm) and one with a full-cortical thickness notch (5 mm). A 2 mm notch size was chosen as this signified a breach in the superior cortex that may not be visible intra-operatively, while a 5 mm notch was chosen as this would most certainly be detected intra-operatively. These groups were compared to a control group prepared without a superior notch in the neck of the femur. All components were positioned in the same coronal alignment with a stem-shaft angle of 125 degrees. To investigate the effect of valgus alignment on a superior neck notch, six specimens were prepared and tested with a 5 mm superior neck notch with the implant aligned in an additional 10 degrees of relative valgus alignment (5 mm + 10 Valgus) or an absolute stem-shaft angle of 135 degrees. Imageless computer navigation (Vector Vision SR1.0, BrainLAB, Heimstetten, Germany) was used to position the initial guide wire during femoral head preparation. Femurs were prepared according to the method described by McMinn (3). A size 3 stem with a 46 mm head was impacted into each synthetic femur. Digital anteroposterior radiographs of the femurs were taken to ensure that accurate alignment was achieved and that no initial fractures were evident.

RESULTS:

Coronal implant alignment accuracy, as verified by AP radiographs, was 1.1 degrees (SD 2.1 degrees). The mean stiffness of the intact femurs was 1376.6 N/m (SD 61.6 N/m) and this was not significantly different from the implanted femurs (Mean 1346.5 N/m, SD 156.6 N/m, p=0.398). The mean load-to-failure for the intact group was 5002.0 N (SD 614.3 N), for the 2 mm notch group was 4367.3 N (SD 291.3 N), for the 5 mm notch group was 4060.3 N (SD 641.3 N), and for the 5 mm + 10 Valgus group was 4469.0 N (SD 614.7 N), (Figure 2). Introduction of a 2 mm notch resulted in a reduction in proximal femoral strength of 19% (p=0.027) compared to femurs prepared without a femoral neck notch. Additional valgus alignment had a protective effect on a 5 mm superior neck notch and this was not significantly different from the no-notch group (p=0.405). Catastrophic failure patterns observed were consistent within each test group. Failure of the proximal femur appeared the result of buckling or crushing of the medial calcar with transcervical fractures originating at the bone-implant interface superiorly and propagating toward the lesser trochanter.

DISCUSSION:

Mid-head resection arthroplasty is an alternative to hip resurfacing for patients presenting with unsuitable femoral head anatomy such as the case with avascular necrosis. Previous work has demonstrated that superior femoral neck notching with hip resurfacing significantly reduces the load bearing strength of the proximal femur with as little as a 2 mm notch. In such cases, it may be prudent to abort a hip resurfacing for a standard total hip arthroplasty. This study appears to provide biomechanical evidence that preparation of the femoral head for a BMHR may be more forgiving to minor preparatory errors such as a 2 mm superior femoral neck notch, however, a full cortical thickness notch resulted in a significant reduction in the load bearing capacity of the proximal femur. Relative valgus alignment of the metaphyseal stem may have a protective effect if superior neck notching occurs. The Birmingham Mid-head Resection may be more forgiving to minor preparatory errors than a typical hip resurfacing arthroplasty.

REFERENCES: