INTRODUCTION:

Hip resurfacing provides a viable bone-sparing alternative to traditional total hip arthroplasty. Strong medium-term results have been demonstrated for patients presenting with idiopathic osteoarthritis (OA); however, patients with avascular necrosis of the femoral head (AVN) and OA second to childhood disorders such as developmental dysplasia of the hip (DDH) and slipped capital femoral epiphysis (SCFE), have typically fared poorer specifically in the longevity of the femoral component (1-2).

Traditionally, there have been few effective options for the treatment of AVN and secondary OA outside of a total hip replacement. Preservation of proximal femoral bone stock, however, is desirable, specifically in young patients likely to require revision surgery in the future. To this end, the Birmingham Mid-Head Resection device (BMHR, Smith & Nephew Orthopaedics, Warwick, United Kingdom) (Figure 1) was developed as an alternative to hip resurfacing for patients who would otherwise benefit from a conservative hip arthroplasty.

The BMHR is a bone-conserving, short-stem femoral prosthesis designed for patients with compromised femoral head anatomy unsuitable for a hip resurfacing arthroplasty. Similar to hip resurfacing, the BMHR preserves the femoral neck and does not violate the femoral medullary canal; however, it is not known if the femoral neck fracture risks associated with hip resurfacing pose the same risk to a mid-head resection arthroplasty. The aim of the current investigation was to examine the effect of coronal implant alignment on proximal femoral strength with the BMHR.

METHODS:

Institutional review board approval was granted to obtain sixteen pairs of fresh-frozen cadaveric femurs. The mean age of the donors was 71.1 years (range 46-90 years); 12 donors were male and 4 were female. Each pair was from the same donor and pairs were divided randomly into two equal alignment groups. Individual pairs within each alignment group were divided with left femurs as a control and right femurs as an experimental specimen. The first alignment group prepared experimental specimens in 10 degrees of relative varus alignment while the second group prepared experimental femurs in 10 degrees of relative valgus. All control specimens were prepared with the implant aligned with the native neck-shaft angle of the femur.

Pre-preparation scaled digital radiographs were taken of all specimens to determine anatomical parameters and Dual X-ray Absorptiometry (DEXA, Hologic, Bedford, MA) scans were performed to determine the bone mineral densities (BMD) of each femur. Imageless computer navigation (VectorVision SR, BrainLAB, Heimstetten, Germany) was used to insert the initial femoral guidewire in the appropriate coronal alignment and in neutral version for preparation of the femoral head.

Femurs were prepared according to the surgical protocol established by McMinn (3). Initially, femurs were prepared in a similar fashion to a standard hip resurfacing. However, with the mid-head resection, the femoral head is planed down an additional depth compared in order to remove all non-viable epiphysial bone. A conical shaped reamer is then used to ream the metaphyseal bone of the neck to accept the prosthesis. Once prepared, the appropriate BMHR component was impacted into the prepared femur. Prepared femurs were potted, placed in single-leg stance position and tested in axial loading to failure. Load-displacement values were recorded for each test.

RESULTS:

There was no significant difference between matched paired femurs prepared in varus alignment (Mean 4623, SD 1608) and matched paired control specimens (Mean 4761, SD 1290, p=0.999). Femoral Neck BMD (R=0.860, p<0.001) correlated best with peak failure load (Figure 2). Failure of the proximal femur appeared the result of buckling of the medial calcar with fractures originating at the bone-implant interface superiority and propagating distally toward the lesser trochanter.

DISCUSSION:

This biomechanical investigation appears to be the first to investigate the risk of femoral neck fracture associated with the Birmingham Mid-Head Resection. The findings of the current study are in contrast to previous studies investigating implant alignment in hip resurfacing. Clinically relevant variations of stem alignment did not appear to impact proximal femoral strength with a BMHR in place. A valgus aligned implant did not appear to strengthen, nor a varus implant weaken, proximal femoral strength compared to a neutrally aligned implant. Failure of the proximal femur implanted with a BMHR appears less sensitive to variations in implant alignment than a typical hip resurfacing.

REFERENCES: