SURGICAL TREATMENT OF FEMOROACETABULAR IMPINGEMENT: HOW FAR CAN WE GO?

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Introduction:

Impingement of the hip is a condition that has been increasingly recognized among young patients with hip pain. Two different types of impingement have been described in non-dysplastic hips. Over-coverage impingement or "pincer" effect occurs between the anterior wall/labrum of the acetabulum and the femoral head. A "cam-effect" impingement occurs when the femoral head-neck union has an abnormally large radius. Widening of the femoral neck causes a reduction in its concavity creating an impingement over the acetabular rim. Thus, the area is squeezed under the acetabular rim (1).

Patients with a cam impingement demonstrate insufficient femoral-head offset. If in sufficient femoral head offset is a cause of anterior impingement (cam-effect), surgical resection of a femoral neck bump and/or part of the anterolateral neck can be done to improve the femoral head offset. However, a potential risk of this procedure is a femoral neck fracture (2).

Our aim was to evaluate the ultimate failure load after partial resection of the anterior-lateral femoral neck union for the correction of cam-effect impingement to determine the critical point where risk of femoral fracture is unacceptably high.

Material and Methods

15 fresh frozen cadaveric pelvises from the Department of Anatomy at the Mayo Clinic were used (4 Male and 11 Female). The age, height and weight at time of death were in average 79 years (57-98), 167 cm (152-185) and 61.7 kg (43.5-83.0). Bilateral proximal femurs were exposed and isolated. The femoral neck radial circumference was measured. The proximal femurs (15 pairs) were divided into three groups of five. One side (right or left) was randomly assigned to the case group and the other to the control group. Anterior-lateral head/neck quadrant was resected for each case femur. Ten, thirty, and fifty percent of the neck diameter were removed for case groups I, II, and III respectively (Fig. 1). The matched controls were tested intact.

FIGURE 1. Left: Line between point A and B marks the medial lateral distance (diameter) of the neck. In transverse cross section, the femoral neck has been divided in four quadrants. AB is the width of the femoral neck. AD = 10%, 30% or 50% of AB. The field in yellow shows the estimated resection of the femoral neck over the anterolateral quadrant. The length of resection will be 3cms centered on A point.

Offset of the femoral head/neck junction increase with increased percentage of bone resected by the osteotomies (Figure 2).

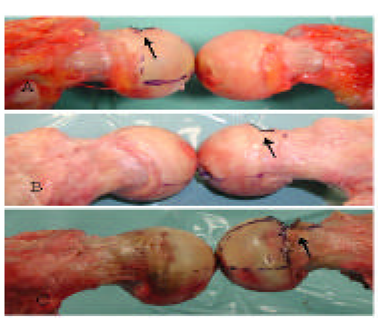

Figure 2: Femoral head/neck junction offset increased among the different percentage of resections. A: 10%. B: 30%. C: 50%

The samples were potted in methyl-methacrylate and clamped in a material testing machine (secured in a vise at 25° adduction in the coronal plane and neutral in the sagittal plane). A material testing system (MTS) servo-hydraulic testing machine was used to apply vertical loads directly to the head with a polished flat applicator. This axial load protocol has been used previously to test femoral neck fracture fixation method devices (3). Loads were applied at 20mm/min until neck fracture occurred.

The peak load before fracture for group I (10% resected), II (30% resected), III (50% resected) were compared. The difference in peak load before fracture between each case and its control were analyzed. The reduction in load bearing capacity was calculated as [(Case-Control)/Control]. The results were used to determine the relationship between amount of resection (10%-30%-50%) and femoral neck peak load that existed at femoral neck fracture. ANOVA was performed to determine if there was significant difference in load bearing capacity for each %resection ($p<0.05$).

Results:

No differences in the peak load were observed between group I (10% of resection) cases and controls. All the fractures observed in this group were at the same area (away from the head neck junction). Group II (30% resection): all cases resulted in fracture at the level of the osteotomy when 90% of the force required to achieve failure in the control (matched) group was applied; controls fractured away from the head neck junction. Group III (50% resection): All cases fractured at the level of the osteotomy. 60% of cases (3/5) fractured at approximately 1,200N of axial load (force applied on the hip when standing on one leg) (3,4). Controls fractured away from the head neck junction

There was a statistically significant difference ($p=0.004$) in load bearing capacity. The 50% resection carried less load compared to the other two resections. There wasn't any statistically significant difference in load bearing capacity between the 10% and 30% resection. (Figure 3)
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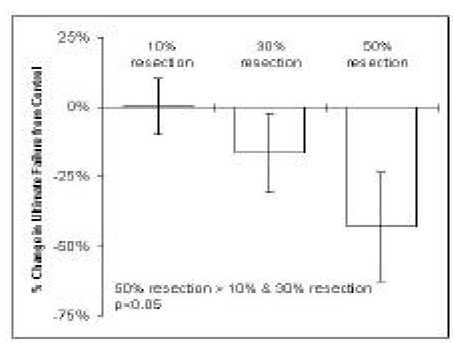

Figure 3: Load bearing capacity for differing amounts of resection.

Discussion

Resection of the anterolateral quadrant of the head neck union to treat hip impingement can be performed safely up to 30% of the diameter of the head neck union. If a fracture occurred with 30% of resection, it will occur at the level of the osteotomy site (femoral head/neck union). 50% resection of the diameter of the head/neck union weakness the bone significantly. Even under physiological loads for the hip (Bregmann et al.[4]: Standing up = 1500N/190%BW; Sitting down = 1300N/156%BW; Walking slow = 2000N/242%BW) a fracture can occur.

References

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