Introduction: The extended proximal femoral osteotomy has been introduced as a safe and effective means of improving exposure during revision total hip replacement. However, basic science research devoted to this technique and published outcome studies have been limited. Only one basic science study which examines this technique has been published. Under compressive loads, micro-motion of a cemented prosthesis following osteotomy and impaction grafting was not significantly different from controls, but testing loads were less than physiologic to avoid damage to the testing apparatus. Alternatively several smaller studies and case reports have reported few complications; however, Aribindi reported on 122 hips which included 25 iatrogenic fractures at the time of surgery. Twenty-one fractures occurred through the femur at the time of osteotomy or during manipulation of the hip for preparation of the canal and placement of the prosthesis. Consequently, this study was developed to examine the resultant strength of the femur following osteotomy, and in conjunction, to generate awareness regarding the tolerance of the osteotomized femur for manipulation at the time of surgery. The working hypothesis was that the extended proximal femoral osteotomy creates a significant reduction in strength of the residual femur.

Methods: Nine matched pairs of cadaveric femurs (age 30-92) with no significant difference in bone mineral density between paired hips by DEXA scan (Hologic QDR-4500A) were examined in torsion to failure. The osteotomy was created in one of each pair as previously described with care to remove no more than the lateral third of the femoral cortex. The length of the osteotomy and the length of the femur were standardized at 15cm and 30cm from the tip of the greater trochanter respectively. Particular attention was paid to the distal osteotomy site so as to create a smooth bevel as there was historical concern for creating a stress riser at this location. The femoral head remained in continuity with the medial strut and served as the proximal point of loading in a customized jig. Each specimen was then secured distally in methylmethacrylate and mounted on a material testing machine (Instron 1321). Mechanical characteristics were tested by internal rotation of the hip through an arc of 90 degrees over two seconds, a simulation of the action required for dislocation of the hip through a posterior approach. Initial stiffness was calculated from the slope of the torque vs. angular deformation curve. Energy absorption to failure was derived by calculating the area under each curve up to the point of failure. Assessment for statistical difference between intact and osteotomized femora was then made using a paired t-test. Lastly, the fracture pattern was examined.

Results: There was a 72% reduction in torque required for failure (p<0.001) from an average of 128 to 35.7 N-m. Angular deformation was reduced by 49.6% from an average of 34.5 degrees in the intact state to only 17.4 degrees following osteotomy (p<0.002) [Figure 1]. Stiffness was calculated over the first 8 degrees of rotation as the earliest point of failure was 8.7 degrees. Stiffness decreased 63.1% from 211 to 148 N-m (p<0.021). Energy required to result in fracture, a function of torque applied over distance, was reduced by 80% (p<0.0001) [Figure 2]. Lastly, osteotomized specimens consistently failed at the osteotomy site. The fracture occurred posteriorly and distally through the bevel and extended medially and superiorly in a spiral fashion to the anterior osteotomy cut. Intact specimen routinely failed in an explosive nature at the point of distal fixation to the mounting device.

Discussion: The extended proximal femoral osteotomy has a significant effect on the strength of the residual femur. The osteotomy creates an open cortical defect, a defect that communicates with the open end of a cylinder, which allows the remaining medial strut to wrap around itself during torsion. The residual femur is thus more pliable following osteotomy but only through a narrow range of angular rotation prior to failure. This study additionally identifies the distal extent of the osteotomy as a stress riser under torsion. All osteotomized specimens consistently failed at this location. Revision hip surgeons should be made aware of the 70% reduction in torsional strength. This reduction should be considered particularly when osteotomy is performed prior to dislocation of the hip and during manipulation of the femur prior to implantation of a prosthesis and fixation of the osteotomized fragment. The significant weakening of the femur additionally supports a guarded post-operative mobilization and rehabilitation program following hip replacement facilitated by this approach.

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