

**BIOMECHANICAL STUDY IN THE OPTIMIZATION OF DIFFERENT FIXATION MODES FOR A PROXIMAL FEMUR L-OSTEOTOMY- A THREE DIMENSIONAL FINITE ELEMENT SIMULATION**

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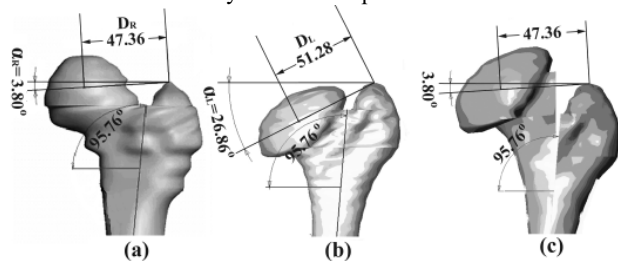
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**INTRODUCTION**

Numerous surgical techniques have been proposed to manage the femoral neck shortening and the greater trochanter overgrowth secondary to retarded growth of the femoral capital epiphysis but with little success [1]. For the reconstruction of residual deformities of the hip, Papavasiliou et al. performed a new type of proximal femur L-osteotomy with hip spica casts, and achieved good results [2]. Although the results were good with this osteotomy, a thorough understanding and study of the biomechanical characteristics will be helpful to improve the technique and aid in preoperative planning. A three dimensional finite element analysis was thus designed to understand the mechanical characteristics of postoperative femur after L-osteotomy.

**METHODS**

A patient with left hip dysplasia was recruited as the study model of L-osteotomy. The normal right hip was used as a guide to perform the corrective surgery. The length and the angle of the intersected line between the femoral head center and the most superior point of the greater trochanter in the normal right femur were considered as the final resultant configuration postoperatively (Figure 1). C-T images were used to create the 3-D finite element models. Four FEA models with the same longitudinal length of osteotomy (126mm) but different fixation screw configurations (P2/D2, P2/D3, P3/D2, P3/D3, P: Proximal fixation; D: Distal fixation) together with four FEA models with the same fixation screw number (P3/D2) but different longitudinal length of osteotomy (116, 126, 136 and 146mm) were created. Analysis was performed on a loading condition simulating single legged stance. The von Mises stress distributions of postoperative femora and displacements of the femoral head were analyzed and compared.

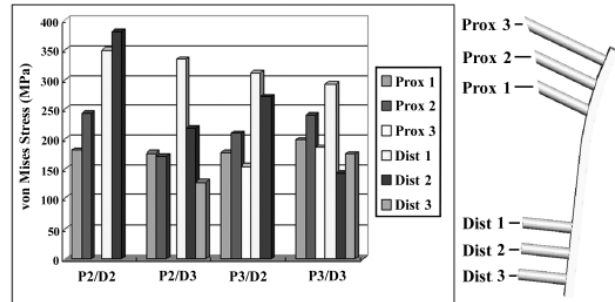


**Figure 1:** (a) normal right femur, (b) left femur with residual deformity, and (c) resultant configuration after L-osteotomy.

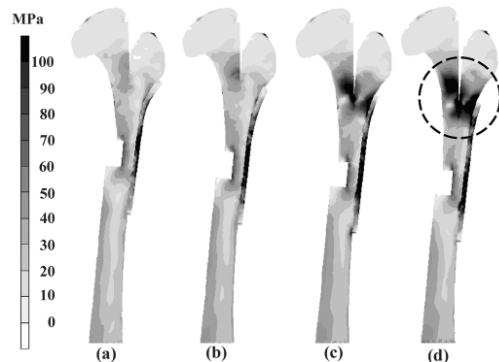
**RESULTS AND DISCUSSION**

This study achieved the following findings: A). The fixation devices (plate and screws) sustained most of the external loading, the peak value of von Mises stress on the fixation screws decreased with increasing screw number (Figure 2). B). More screws placement on the proximal segment would be more beneficial to improve the postoperative stability as compared to

that on the distal segment. C). The extent of osteotomy should be limited because a high local stress concentration might occur around the femoral neck regions with increasing longitudinal length of L-osteotomy (Figure 3).



**Figure 2:** Peak value of Von Mises stress on fixation screws for femora instrumented with four different configurations of screw placement but at the same longitudinal length of osteotomy (126mm). The peak stress of screws increased with decreasing screw number, and the highest value was found on the most distal screw (D2) on condition that the femur was instrumented with four screws (P2/D2).



**Figure 3:** Von Mises stress for femora instrumented with four different longitudinal lengths of osteotomy but the same screw number (P3/D2). (a) 116mm, (b) 126mm, (c) 136mm and (d) 146mm. The von Mises stress around the femoral neck regions progressively increased as the longitudinal length of osteotomy increase from 116 mm to 146 mm.

**CONCLUSIONS**

The results indicate that the more screws placement on the proximal segment the more the stability improvement in the postoperative femur. Therefore, the cobra type plate with more screw holes on the proximal part might be a good alternative for the L-osteotomy.

**REFERENCES**

1. Tauber C, et al. *Acta Orthop Scand* **51**, 661-666, 1980.
2. Papavasiliou VA, et al. *Clin Orthop* **341**, 123-127, 1997.