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EVALUATION OF RESULT OF PROXIMAL FEMORAL NAIL ANTIROTATION IN RESPECT OF HELICAL BLADE POSITION IN FEMORAL HEAD IN DRY FEMORAL BONES

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ABSTRACT The purpose of this study was to investigate the biomechanically stability of this device in relation to two common position of helical blade in femoral head in unstable trochanteric fractures. In human femurs bone helical blade of PFNA fixed randomly in central position both in anteroposterior and lateral view in one group(C-C group) while the other group was fixed in inferior one third position in antero-posterior and central in lateral view (I-C group). Unstable intertrochenteric fracture was created and after fixation with PFNA

The position of helical blade is statistically different between groups. Angular and rotational displacements were significantly higher within the C-C group on compared to I-C group in both unloaded and loaded condition .Loading to failure were higher in the I-C group compared to the C-C group. No statistical significance was found for this parameter. Correlations between TAD, femoral head displacement and load to failure showed a significant positive relationship.

The I-C group superior to C-C group and provide better biomechanical stability for angular and rotational displacement. .

KEYWORDS : Biomechanical study, unstable trochanteric fracture, PFNA-II, helical blade position

INTRODUCTION

Unstable intertrochanteric femoral fractures are very common in the elderly, and the incidence of these fractures continuously increases. Intramedullary devices are superior to traditional extramedullary devices for these fractures. Among the intramedullary device proximal femur nailing antirotation (PFNA) is a standard device in the treatment of unstable intertrochanteric femoral fractures. This device combines the biomechanically favorable characteristics of an intramedullary nail with a minimally invasive surgical procedure.

This device has helical shaped blade concepts which has been biomechanically proved significantly higher cut out resistence.. Clinical complications like cutout are still continuing with biomechanically proved better implants like PFNA(up to 3.6% are documented in literature). Apart from patient's factors like osteoporosis, surgeon factors like suboptimal positioning of the device plays a major role in the fixation failure.

The cutout of the lag screw had related to various factors; however cutout failure is mainly due to mal-positioning of the lag screw in the femoral head.. There is no single reason regarding optimal position of lag screw in femoral head. Center-center, posterior-inferior or inferior-center placement of the lag screw was recommended by different studies. But there are very few studies so far which evaluated the performance of the newer device PFNA in relation to different position of helical blade in femoral head.

The aim of our study was biomechanical evaluation of stability of this device in relation to center-center versus the inferior-center position of helical blade in cadaveric femoral head in unstable trochanteric femoral fractures. our hypothesis is there is no significant difference between the two blade position with respect to angular (varus) and rotational displacement after loading and ultimate load to failure.

Methods

Eight paired (N=16 femurs) dry human femoral bone were taken for study. For each specimen anthropometric measurements were performed. Radiographs of each bone were taken to ensure the absence of deformity, prior fracture and any pathological condition. bones were clamped in a cutting template and the osteotomy was created using a hand saw. First cut was an oblique at an angle of 30˚ to the femoral shaft. The second cut was then performed to simulate posteromedial comminution by removing the lesser trochanter with a 30˚ wedge. The lateral wedge was then cut perpendicular from the tip of the greater trochanter with a length of 20 mm until reaching the osteotomy .The Proximal Femoral Nail Antirotation II with helical blade fixed in central position both in anteroposterior and lateral view in one group(C-C group) while the other group was fixed with helical blade in inferior one third position in anteroposterior and central in lateral view (I-C group).

After instrumentation radiographs were taken to ensure correct placement of tip of helical blade at subchondral area and tip-apex distances (TAD) being measured .The three metal markers which were not located collinearly were attached closely to the blade tip inserted in the femoral head (Stereophotogrammetry). The Each specimen was initially loaded with 750 N .Next, each specimen was cyclically loaded, with 750 N vertical loads applied at a rate of 3 Hz for 10, 100, 1000cycles. Failure was defined as a visible collapse of the device that was always evident as the first and irreversible negative slope of the load–displacement curve.

Descriptive analysis was performed using SPSS by calculating the mean and standard deviation for specimens of both groups implant. Data analysis between the groups was done using ANOVA to evaluate the relationship between fragment displacement and load to failure data for the two treatment groups, and fragment displacement and the number of loading cycles. Pearson correlations were performed between bone mineral density, tip apex distance and load to failure. A p-value of <0.05 was considered to be statistically significant for all analyses.

The femoral head fragment got displaced in all specimens in the same direction (varus and external rotation). The mean TAD was 22 mm \ in the I-C group and 18.14 mm in the C-C group. The position of helical blade is statistically different between groups. Angular displacements in the varus direction were significantly higher within the C-C group on compared to I-C group after initial loading with 750 N and after each cyclic loading. There was significantly more permanent Angular displacements in the varus direction in the C-C group compared with the I-C group implant after each cyclic loading. Rotational displacement (external rotation) were slightly higher within the C-C group on compared to I-C group in both unloaded and loaded condition after 1000 and 10000 cycle (Table 2). There was significantly more permanent rotational displacement (external rotation) in the C-C group compared with the I-C group after 1000 and 10000 cycle.No trends of angular displacements in the anterior direction were seen in each specimen. No statistical significance was found for this parameter . The majority of the fracture fragment displacement occurred after the initial load, with continuation of displacement as the number of loading cycles increased, but at a decreasing rate of displacement.

Discussion

The fixation failure of intramedullary device in unstable intertrochanteric fractures is divided into two major groups. First, Patient related factors like Ostoporotic bone is one of the main reasons for fixation failure in aging population. To overcome this, newer device with new technique are described like PFNA with cement augmentation to increase the anchorage in osteoporotic bone. Second, the most important preventable factors are surgical technique like suboptimal positioning of the implant. However till today there is no clear consensus about that. Very few study was performed with PNFA device in term of optimal position of helical blade in femoral head. In the present study, the biomechanical comparison of the stability of a PFNA device in term of two position of helical blade in femoral head revealed statistically significantly more stability in I-C group then C-C group. Load to failure was higher in the I-C group compared to the C-C group but statistically significant difference was not found.

In unstable fracture the lesser trochenter and part of calcar femoral are missing from mechanical load transmission system and because of the lack of bony support over the medial aspect of femur the proximal fragment easily collapse (varus) and internally rotates under the physiologic loads. The inferior placements of helical blade in the frontal plane and centrally in the sagittal plane, inherently support the communited posteromedial cortex and allow compaction of fracture suface, shortening the lever arm, decreasing the bending moment thus avoiding cut out of screw from femoral head . The inferior placements of helical blade achieve the medial most position in the subchondral area and thus stress-bearing surface area of the helical blade increased. In this way the inferior placed helical blade withstand more force than central place helical blade for angular displacement in varus position and load to failure. The central location of a helical blade on the antero-posterior view has no resultant force to affect the femoral head for internal or external rotation. However, inferior location of a helical blade has the effect to externally rotate the femoral head. Consequently, inferior insertion of a helical blade can withstand the deforming force which are responsible for rotational displacement and achieves a better result

The inferior central placements of screw help in better control of proximal fragment because of bone architecture pattern which is formed by decussation of compression and tensile trabeculae provide strong anchorage. This peripheral placement of the helical blade though increases the tip-apex distance but tip apex distance was not related with cutout failure. In our study the mean TAD in the inferior-center group was more than the center-center group and TAD had positive linear correlation with fracture displacement and load to failure.

This study has several limitations. the significant morphological change resulting from fracture healing like bone callus formation, remodeling, subtle malreduction, femoral neck shortening could not be studied.. This study requires large number of specimens for better relevant statistical data evaluation. In this study we choose the relatively simple reproducible loading protocol, though we acknowledge that physiologic loading during activity is more complex because of because of various forces acting on proximal femur. biomechanical study of PFNA device in term of two common position of helical blade in femoral head suggest that inferior position of the helical blade in the frontal plane and central position in the sagittal plane is superior to the center-center position and provide better biomechanical stability for angular and rotational displacement in unstable fractures.

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