The Ideal Position of Hip Lag Screw Within the Femoral Head: Based on Micro-CT Analysis of the Trabecular Structure of the Femoral Head

INTRODUCTION:
The outcome of lag screw fixation of proximal femoral fracture is highly dependent on its purchase strength within the femoral head and therefore its appropriate positioning is of critical importance. Many authors have favored a center-center position and an inferior position. A tip-apex distance (TAD) of less than 25 mm is also recommended to lower the risk of fixation failure. However, to the best of our knowledge, there is no consensus in the literature regarding which position within the femoral head is definitively ideal for the fixation of proximal femoral fractures. Bone mineral density (BMD) is not the only determinant to represent the bone strength. In addition, current BMD measurements provide a regionally averaged value and would not differentiate regional heterogeneity. This would be misleading for evaluating the trabecular bone strength of the femoral head resulting in consideration of bone quality such as micro-architecture. Therefore, center-center position within the head in both the AP and lateral views could be claimed as an ideal position from the viewpoint of TAD to place the lag screw as close as possible to the center of the head in both the AP and lateral planes.

However, cutting out of the hip screw almost always occurs superiorly, supero-anteriortly, or supero-posteriorly out of the femoral head and buttressing the hip screw against these cutting out action is of utmost importance. Outcome of our study showed that the ideal position of hip screw within the femoral head (particularly in osteoporosis) should be inferior-center position rather than center-center position because the strongest trabecular bone segment (center-center segment, no.5) of the femoral head can more effectively buttress the hip lag screw. Hip lag screw insertion into the center-center position in the femoral head results in removing the strongest trabecular bone parts of the femoral head because most commonly used diameter of hip lag screw is more than 10 mm (usually 12 mm). Our results also suggested that inverted triangle pattern can lead to a more stable fixation rather than triangle pattern when performing parallel cancellous lag screw fixation for femoral neck fractures.

In conclusion, this is the first study using micro-CT analysis of the femoral head microarchitecture, describing the density-mechanical property relationship. Based on the “microstructural score”, the center-center segment (no.5) is the strongest part of the femoral head. Hence hip lag screw should be placed in the inferior (AP view)-center (lateral view) segment which can be buttressed by the strongest center (AP view)-center (lateral view) segment to prevent cutout of screw.

RESULTS:
All parameters, except DOA, showed that center-center segment (no.5) distinctively had the strongest bone quality. Based on our microstructural scoring system, 9 segments can be arrayed in the increasing order of their relative bone strength: no.5 (51 points), no.6 (43), no.2 (42), no.4 (42), no.8 (27), no.3 (22), no.1 (19), no.7 (14), and no.9 (10).

The bone quality of nine segments were further divided into 3 categories for easy understanding and clinical application, taking account of microstructural bone strength score and the inclusion of central components in AP or lateral planes: strongest (no.5 [including 2 central components]), relatively strong (no.2, 4, 6, 8 [including 1 central component]), and weak (no.1, 3, 7, 9 [including no central component]).

DISCUSSION:
This would be the first study using micro-CT analysis of the trabecular structure of the femoral head to find out the optimal position of the hip lag screw using micro-CT analysis. It is widely accepted that the density value from BMD and the structural parameters from micro-CT represent the mechanical properties of the trabecular bone.

The risk of lag screw cutout has been shown to increase dramatically in intertrochanteric fractures if TAD exceeds a threshold of 25 mm. Therefore center-center position within the head in both the AP and lateral views could be claimed as an ideal position from the viewpoint of TAD to place the lag screw as close as possible to the center of the head in both the AP and lateral planes.

REFERENCES: