#1926 - Experimental Study / Free Papers

Biomechanical Analysis Of Recently Released Cephalomedullary Nails For Trochanteric Femoral Fracture Fixation In A Human Cadaveric Model

Trauma / Hip & Femur Trauma / Surgical Treatment

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Background
Trochanteric femoral fractures are associated with increasing incidence due to the aging population and represent a serious adverse effect of osteoporosis. Their cephalomedullary nailing in poor bone stock can be a challenging endeavor associated with insufficient implant fixation in the femoral head. Despite the ongoing implant improvements, the rate of mechanical complications in the treatment of unstable trochanteric femoral fractures is still high. Recently, two novel concepts for nailing with the use of a helical blade – with or without bone cement augmentation – or an interlocking screw have demonstrated advantages as compared with single screw systems with regard to rotational stability and cut-out resistance. However, these two concepts have not been subjected to a direct biomechanical comparison so far.

Objectives
The objectives of this study were to investigate in a human cadaveric model with low bone density (1) the biomechanical competence of cephalomedullary nailing with the use of a helical blade versus an interlocking screw, and (2) the effect of bone cement augmentation on the fixation strength of the helical blade.

Study Design & Methods
Twelve osteoporotic and osteopenic human cadaveric femoral pairs were assigned for pairwise implantation using either a short TFN-ADVANCED Proximal Femoral Nailing System (TFNA) with a helical blade head element, offering the option for cement augmentation, or a short TRIGEN INTERTAN Intertrochanteric Antegrade Nail (InterTAN) with an interlocking screw. Following, six osteoporotic femora, classified within the lower DEXA T-score range among the pairs and implanted with TFNA, were augmented with 3 ml TRAUMACEM V+ bone cement. As a result, four study groups were created and combined in two clusters comprising specimens of the same donors each – group 1 (TFNA) paired with group 2 (InterTAN), and group 3 (TFNA augmented) paired with group 4 (InterTAN). An unstable pertrochanteric AO/OTA 31-A2.2 fracture was simulated by means of osteotomies. All specimens were biomechanically tested until failure under progressively increasing cyclic loading featuring a physiologic load trajectory. Interfragmentary movements were monitored by means of optical motion tracking.

Results

T-score of the osteoporotic femoral pairs in groups 3 and 4 (median -2.8, range -4.6 to -2.5) was significantly lower compared with the specimens in groups 1 and 2 (median -1.9, range -2.6 to -1.0), p=0.03. Initial stiffness (N/mm) in groups 1 to 4 was 335.7±65.3, 326.9±62.2, 371.5±63.8 and 301.6±85.9, respectively, being significantly different between groups 3 and 4, p=0.03. Varus deformation (°) and rotation of the femoral head fragment around the neck axis (°) after 10,000 test cycles were 1.9±0.9 and 0.3±0.2 in group 1, 2.2±0.7 and 0.7±0.4 in group 2, 1.5±1.3 and 0.3±0.2 in group 3, and 3.5±2.8 and 0.9±0.6 in group 4, respectively, both with significant difference between groups 3 and 4, p≤0.04. Cycles to failure and failure load (N) at 5° varus deformation were 21428±6020 and 1571.4±301.0 in group 1, 20611±7453 and 1530.6±372.7 in group 2, 21739±4248 and 1587.0±212.4 in group 3, and 18622±6733 and 1431.1±336.7 in group 4, respectively, being significantly different between groups 3 and 4, p=0.04.

Conclusions

From a biomechanical perspective, cephalomedullary nailing of trochanteric femoral fractures with the use of helical blades is comparable to interlocking screw fixation in femoral head fragments with low bone density. Moreover, bone cement augmentation of helical blades considerably improves their fixation strength in poor bone quality.