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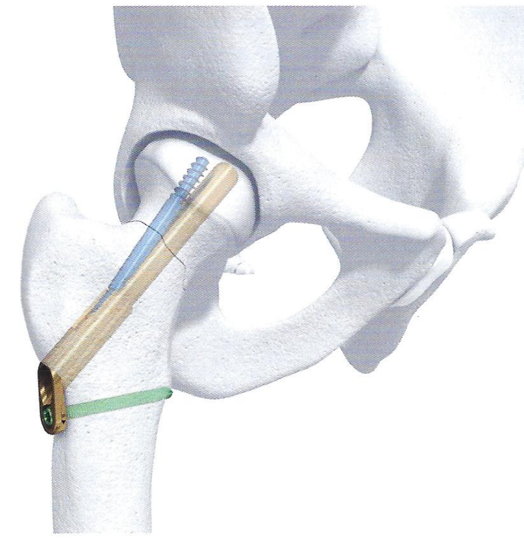


Fig 1
The new Femoral Neck System for femoral neck fracture fixation.

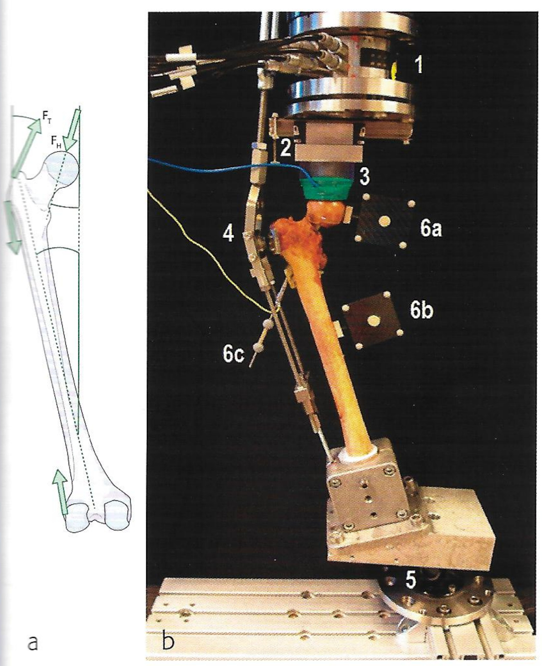
Biomechanical Evaluation of Femoral Neck Fracture Fixation with the new Femoral Neck System: Comparison with DHS-Blade, DHS with Antirotation Screw, and three Cannulated Screws

Clinical Background

The Dynamic Hip Screw (DHS) is considered the gold standard for the fixation of unstable subcapital or transcervical femoral neck fractures type AO/OTA 31–B. However, the prominence of the implant can be painful. As an alternative, three Cannulated Screws (3CS) may be used, however, the fixation might not provide enough stability in cases of displaced fractures. The aim of this project was to evaluate the biomechanical performance of the new less-invasive implant, the Femoral Neck System [1] (FNS) (Fig 1) and compare it to established fixation methods using DHS–Screw, DHS–Blade, and 3CS in a human cadaveric model.

Materials/methods

Twenty pairs of fresh-frozen anatomical specimen femora were instrumented with either DHS–Screw, DHS–Blade, FNS, or 3CS. A reduced unstable femoral neck fracture 70° Pauwels III, AO/OTA 31–B2.3 was set standardized with 30° distal and 15° posterior wedges in respect to the fracture plane using a custom saw-guide. Biomechanical assessment was performed with the specimens mounted on a material testing



a b

Fig 2a–b Biomechanical testing.

a A free body diagram of the femur.
  F_T) Abductor muscle force acting on the greater trochanter.
  F_H) Hip contact force.

b Test setup with a left femur specimen mounted for biomechanical testing and instrumented with FNS.
  1) Load cell.
  2) Linear guide assuring free centre of the femoral head rotation.
  3) PMMA shell simulating the acetabulum.
  4) Bracing attachment to simulate the iliotibial band of the abductor muscles.
  5) Cardan joint preventing displacement and axial rotation of the specimen.
  6a–c) Three retro-reflective marker sets attached to the femoral head, shaft, and implant for optical motion tracking.

machine in 16° femoral shaft lateral angulation (Fig 2). Starting at 500 N, cyclic compression loading along the transducer axis was applied to the femur, with increasing peak force at a rate of 0.1 N/cycle until construct failure. Machine data was used to calculate the axial construct stiffness immediately after test start. Relative interfragmentary movements along the femoral shaft and neck axis were evaluated with optical motion tracking (leg/femoral neck shortening). Statistical analysis was performed at a level of significance set to 0.05.

Results

The highest axial stiffness was observed, on average, using the FNS, followed by the DHS–Screw, DHS–Blade, and 3CS, with no significant differences between the implant systems. Cycles until 15 mm leg shortening were similar for DHS–Screw, DHS–Blade, and FNS, and significantly higher in comparison to 3CS ($p<0.001$). Similarly, cycles until 15 mm femoral neck shortening were comparable between DHS–Screw, DHS–Blade, and FNS, and significantly higher compared to 3CS ($p<0.001$). The results are summarized in Table 1.

Conclusion

The biomechanical performance of the FNS is comparable to either of the DHS implants, and as with them, significantly better than 3CS in terms of resistance to leg and neck shortening under cyclic loading. In addition, FNS is potentially less invasive than DHS, which makes it a competitive product for unstable femoral neck fracture treatment.

Note

[1]Regulatory approval for the Femoral Neck System is pending.

DHS–Screw	DHS–Blade	FNS	3CS
Axial stiffness [N/mm]			
688.8 ± 44.2	629.1 ± 31.4	748.9 ± 66.8	584.1 ± 47.2
Cycles until 15 mm leg shortening			
20,542 ± 2,488	19,161 ± 1,264	17,372 ± 947	7,293 ± 850
Cycles until 15 mm femoral neck shortening			
20,846 ± 2,446	18,974 ± 1,344	18,171 ± 818	8,039 ± 838

Table 1
Parameters of interest for the implant systems (mean ± SEM).