

Parallel Trajectory of Cannulated Screws Is Biomechanically Advantageous to Diverging Trajectory in Moderate Pauwels Angle Femoral Neck Fractures

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Purpose: Femoral neck fractures are significant injuries with a high morbidity and mortality rate in the geriatric population. Surgical treatment is recommended for improved mobilization. The current gold standard includes internal fixation with three screws in a parallel trajectory and inverted triangle formation. The purpose of this study is to determine if parallel or diverging screw trajectories have a biomechanical advantage in treating moderate Pauwel's angle transcervical femoral neck fractures.

Methods: This study used 32 identical femur models; one-half were assigned to the parallel trajectory group and the rest to diverging trajectory. A 3D printed guide was used to make femoral neck cuts and insert K-wires for both screw trajectories. The fractures were made at a Pauwel's angle of 40° before fixation with 6.5 mm partially threaded, cannulated, stainless steel screws in an inverted triangle arrangement. To test torsional stiffness, torque was applied in a vertical axis through the femoral head. Axial stiffness and load to failure (LTF) involved vertical axial loads applied through the center of the femoral head. Models were examined for anatomic points of failure.

Results: Thirty femurs were included for final analysis. One model from each group exceeded the testing machine's limits and were excluded. Parallel screws demonstrated significantly greater axial stiffness compared to the diverging screws (431 N/mm $\pm$ 45 N/mm vs 367 N/mm $\pm$ 104 N/mm respectively, $p = 0.032$). No significant difference was found for torsional stiffness (6.36 Nmm/deg $\pm$ 2.46 Nmm/deg vs 6.69 Nmm/deg $\pm$ 2.14 Nmm/deg respectively, $p = 0.691$). The parallel screw group was able to withstand more load than the divergent group and approached statistical significance (4461 N $\pm$ 402 N vs 4095 N $\pm$ 601 N respectively, $p = 0.063$). No significant differences were found in modes of failure ($P > 0.05$).

Conclusion: Parallel screws provide greater axial stiffness values and are noninferior with regard to torsional stiffness and axial LTF when compared to diverging screws for moderate Pauwel's angle femoral neck fractures. The diverging screws presented a challenge in consistent placement and reproducibility of trajectory.