FINAL PROJECT

STRESS DISTRIBUTION OF THE FEMUR IN PRE-TOTAL HIP ARTHROPLASTY (THA) USING THE DIRECT ANTERIOR APPROACH (DAA) WITH FINITE ELEMENT METHOD

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2026

ABSTRACT

The DAA-THA procedure requires specific lower limb positioning combined with mechanical traction using a traction table, which may introduce complex loading conditions on the femur and surrounding structures, potentially leading to stress concentrations that increase the risk of intraoperative fractures. This study aims to determine the stress distribution in the femur and hip joint during DAA procedures under traction table loading conditions using the finite element method. A three-dimensional model of the hip joint was developed from the LibHip database, and six limb position configurations were simulated under fixed distal femur displacement in ANSYS. The simulation results show that limb position significantly affects the reaction force and von Mises stress required to achieve a given magnitude of hip joint distraction. The configuration of 0° hyperextension and 30° abduction was found to be the most mechanically favorable, producing the lowest reaction force (146 N) and the lowest maximum stress (36.51 MPa), while still achieving a joint space widening (5.4 mm) close to the clinically targeted value (5.5 mm). The maximum von Mises stress was consistently located at the distal femur and femoral neck rather than at the hip joint itself, as the frictionless cartilage-to-cartilage contact ceases to transmit force once joint separation occurs. Across all simulated configurations, the maximum stress obtained (up to 62.08 MPa) remained below the reported ultimate tensile strength of cortical bone (approximately 120–150 MPa), suggesting that axial traction alone, within the range of forces and positions considered, is unlikely to be the primary mechanical cause of intraoperative femoral fracture. The findings are anticipated to provide a biomechanical basis for optimizing surgical techniques in DAA-THA and serve as a reference for improving patient safety during orthopedic procedures.

Keywords: Total Hip Arthroplasty (THA), Direct Anterior Approach (DAA), Traction Table, Finite Element Analysis (FEA), Stress Distribution, Hip Joint Mechanics.