

Contact Stresses in a Fixed-Bearing Total Ankle Replacement: A Finite Element Analysis

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Introduction/Purpose: Third-generation ankle implants with good clinical results continued to increase the popularity of total ankle arthroplasty (TAA) to address end-stage ankle osteoarthritis preserving joint movement. Newer TAA used fixed-bearing designs, with a theoretical increase of contact stresses leading to a higher polyethylene wear. The purpose of this study was to investigate the contact stresses in the polyethylene component of a new third-generation TAA, with a fixed-bearing design, using 3D finite element analysis.

Methods: A three-dimensional finite element model was developed based on the Zimmer Trabecular Metal Total Ankle (ZTMTA) and a finite element analysis was employed to evaluate the contact pressure, contact area and Von Mises stress in the polyethylene articular surface in the stance phase of the gait cycle.

Results: The peak values were found at the anterior regions of the articulating surface, where reached 19.8 MPa at 40% of gait cycle. The average contact pressure during the stance phase of gait was 6.9 MPa. The maximum von Mises stress of 14.1 MPa in the anterior section was reached at 40 % of the gait cycle. For the central section the maximum von Mises stress of 10.8 MPa was reached at 37 % of the gait cycle, whereas for posterior section the maximum of 5.4 MPa was reached at the end of the stance phase (60 % of the gait cycle).

Conclusion: Although, the average von Mises stress was less than 10 MPa, high peak pressure values were recorded. Advanced models to quantitatively estimate the wear are needed to assess polyethylene and metal component survivorship.

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