Orthop Muscular Syst 2015, 4:4
http://dx.doi.org/10.4172/2161-0533.S1.022

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International Conference and Expo on

# Biomechanics & Implant Design

July 27-29, 2015 Orlando, USA

## Comparative stability of different osteosynthesis fixations of open wedge high tibial osteotomy: A finite element analysis

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**Background:** Open wedge high tibial osteotomy is a well-established procedure for the treatment of unicompartmental osteoarthrosis and symptomatic varus malaligned knees. Several modes of osteosynthesic fixation exist, but data on comparative quantitative implant stability is very rare. The following study aimed at quantitative comparison between the most frequently used systems with different fixation characteristics based on the method of finite elements.

**Methods:** Four types of plates were considered: 1) the old Puddu plate, 2) the new Puddu plate with locking head screws, 3) TomoFix plate with locking head screws with and 4) without bone grafting. Finite elements analysis was applied using ANSYS and geometric plane of symmetry for the four fixation types. Cortical and cancellous bone was modeled. Cancellous bone was divided into three parts with the averaged elastic properties of the real tibial bone between E=200 MPa, 500 MPa, and 800 MPa. The Poisson's ratio was ν=0.3. Five wedge opening sizes were studied for each model. In order to identify the reasons for potential screws failure the stresses acting along the screw channels were also studied.

**Results:** The highest load in all investigated fixation types acts in the plate axis. The distribution of stresses in the plates was close to uniform except for zones of stress concentrations, which were related to the design characteristics of the plates. With an increasing wedge opening for the Puddu plates the displacements of proximal and distal tibia were decreasing, but the relative displacement was increasing. For the TomoFix plates with bone grafting the displacement of the distal tibia was decreasing, and without bone grafting the displacement of the distal tibia fragment was increasing and the relative displacement of both tibia fragments decreasing. In all plate models the occurring tension at the screw contact areas pulls the screws and exceeds the allowable values of 1.2 MPa. The stress excess for the TomoFix with bone grafting plate occurs at one, and without bone grafting at five one out of 12 surfaces of 6 screws. In the case of Puddu plates a stress excess occurs in almost all screws surfaces.

**Discussion:** Based on the computational simulations, none of the studied osteosynthesis fixation types allows an early full weight bearing after high open wedge tibial osteotomy. The highest stability was observed when using the TomoFix plate with bone grafting, and the lowest stability was seen for the Puddu plate without locking head screws. Partial weight bearing can reduce the stresses acting along the osteosynthesic fixation. In this case, the TomoFix plate with bone grafting of the defect can be recommended.

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**Notes:**