A sawbone based biomechanical study to compare compression force and osseous area of contact of two screws for foot and ankle joint arthrodesis

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Introduction:

Arthrodesis of the ankle joint is commonly performed in the operative treatment of symptomatic, end stage osteoarthritis and/or acquired flatfoot deformity. One frequent complication following ankle arthrodesis is the lack of bony joint fusion (non-union). In current literature, variable union rates in ankle arthrodesis following open or arthroscopic approaches with different fixation techniques have been reported [1]. When non-union occurs, it may be due to a number of factors, including failure to obtain and maintain compression across this joint during the healing process [2]. We compared headless compression screws (HCS, DePuy Synthes, Zuchwil, Switzerland) to the IOFix device (Extremity medical, Parsippany, NJ, USA) biomechanically in regard to fusion stability/force distribution (area of contact) that is created in a sawbone arthrodesis model

Methods:

In an arthrodesis model consisting of two customized artificial bone blocks with a density of PCF 15 (solid foam; personalized blocks; Sawbones® Pacific Research Laboratories, Vashon, WA, USA), the IOFix screws and headless compression screws were inserted pairwise parallel to each other (after pre drilling K-wirers using a template for standardized drilling pattern) with a predefined torque of 0.5 Nm, while pressure transducers (K-Scan 4000, Tekscan, Inc., Boston, MA, USA) between the two sawbone blocks were compressed for the measurement of peak compressive force and the compression distribution (contact area).

Results:

IOFix screws distributed the compressive force over significantly larger areas compared to the area of contact created by headless compression screws, showing a more uniform contact area across the arthrodesis. Peak compression force showed no significant difference.

Discussion:

The IOFix fusion system distributes compressive forces across a significantly greater surface area than HCS screws do, making the compression at arthrodesis-site more uniform.

Ideally, there is moderate compression with uniform distribution across co-apted bone-surfaces in an arthrodesis, in order to minimize stress at areas of high peak contact, as well as neutralize shear and bending forces. By avoiding uneven compression across imperfectly co-apted surfaces, areas of high peak contact stress are minimized, reducing the risk of bone resorption by osteoclasis, failure of fixation and non-union

In current literature, there is are several studies that investigate the clinical outcome and biomechanical properties of the IOFix device on the first metatarsophalangeal joint, however, there is only one biomechanical study performed on cadaveric ankle joints by Parker et al. [3,4,5], comparing the IOFix device to a single conventional lag screw.

Literature:

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