METAPHYSEAL VOIDS IN PLATED PROXIMAL HUMERUS FRACTURES TREATED WITH A NOVEL TECHNIQUE – A BIOMECHANICAL STUDY

Ivan Zderic (1), Daniel Zhelev (1,2), Stoyan Hristov (2), Asen Baltov (3), Simeon Ribagin (4), Geoff Richards (1), Peter Varga (1), Boyko Gueorguiev (1)

1. AO Research Institute Davos, Switzerland; 2. University Multiprofile Hospital for Active Treatment, Bulgaria; 3. University Multiprofile Hospital for Active Treatment and Emergency Medicine 'N. I. Pirogov', Bulgaria; 4. University 'Prof. Dr. Asen Zlatarov', Bulgaria

Introduction

The treatment of unstable proximal humerus fractures with metaphyseal defects – weakening the osteosynthesis construct – is challenging. A novel technique for cement augmentation of plated complex proximal humerus fractures with metaphyseal voids was recently developed.

The aim of this biomechanical study was to assess the stability of plated complex humerus fractures augmented according to the novel technique versus no augmentation.

Methods

Three-part unstable proximal humerus fractures with posttraumatic voids type AO/OTA 11-B1 were reproduced in 16 paired human cadaveric humeri with 76 years average age of donors (range 66–92), assigned pairwise to 2 groups for locked plating with identical screw configuration. In one of the groups, 6 mL PMMA-based partially cured bone cement of medium viscosity (7 min after mixing) was manually placed through the traumatic lateral window into the void of the humeral head prior to screw insertion. Biomechanical testing was performed in 20° adduction of the specimens under applied progressively increasing cyclic loading at 2 Hz until failure (Fig. 1). Interfragmentary and bone-implant movements were captured by means of motion tracking and triggered x-ray imaging.

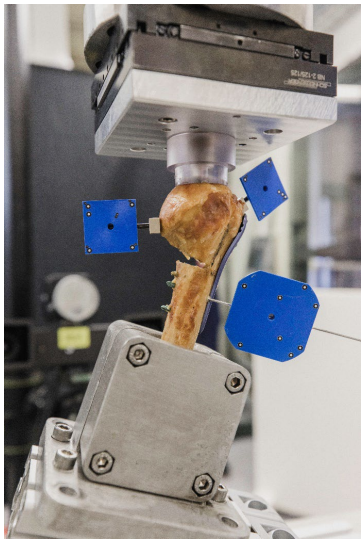

Figure 1: Test setup with a specimen mounted for biomechanical testing.

Results

Initial stiffness was not significantly different between the groups, $p = 0.47$. Varus deformation (Fig.2a), fracture displacement at the medial aspect of the humeral head, cut-out (Fig.2b) and migration of the proximal plate screws were all significantly smaller in the augmented group after 2000, 4000, 6000, 8000 and 10000 cycles, $p < 0.01$. Number of cycles to 2 mm fracture displacement at the medial aspect of the humeral head was significantly higher in the augmented group, $p = 0.02$.

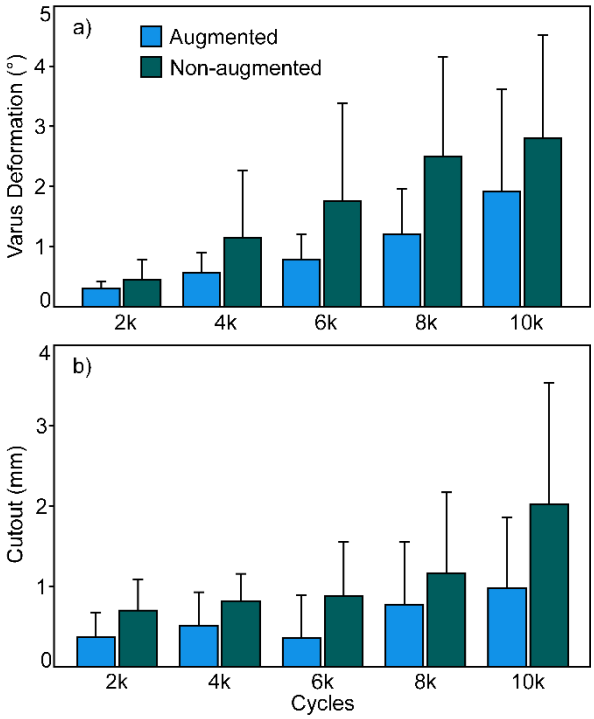

Figure 2: Varus deformation (a) and cut-out of the proximal screws (b) shown over the first 10000 cycles in equidistant steps every 2000 cycles for augmented and non-augmented technique separately in terms of mean and standard deviation values.

Discussion

From a biomechanical perspective, augmentation with PMMA-based bone cement placed in the posttraumatic void of the humeral head during locked plating of unstable proximal humerus fractures considerably increases fixation stability and can reduce the risk of postoperative biomechanically related complications.