BASEPLATE COMPRESSION SCREW FORCE OF A REVERSED SHOULDER PROSTHESIS

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INTRODUCTION

Reversed shoulder arthroplasty is an accepted treatment for glenohumeral arthritis associated to rotator cuff deficiency. Loosening of the glenoid baseplate have however been reported [1], and analyzed on artificial bone [2], cadaver bone [3], and with numerical methods [4]. The optimal baseplate fixation is obviously related to compression screws force. This force, which is certainly limited by the strength of the surrounding bone, is currently unknown. The goal of this study was to measure the compression screw force and screwing torque to corelate it to the surrounding bone volume.

METHODS

An experimental setup was specifically designed to measure continuously (during the screwing process) the compression force, the screwing torque and the screwing angle of the baseplate compressive screws. The apparatus was a stand composed of a holder (to fix the scapula), a custom baseplate embedded with 3 thin force captors (Tekscan), a torque meter (Andilog) and a digital goniometer. The preparation (reaming) of the glenoid bone was done as recommended by the manufacturer. The Aequalis baseplate was then positioned to drill the hole of the two compression screws. The Aequalis baseplate was removed and the two screws were measured independently with the instrumented baseplate. During the measurement, the time when the surgeon would stop to screw was marked (surgical stop), but the screwing was continued until failure of the screw fixation (bone failure). Force (F_{surg}) and torque (M_{surg}) at surgical stop, and force (F_{max}) and torque (M_{max}) at bone failure were obtained. Bone volume (BV) within a cylindrical region of interested of 8 mm of diameter around the screw was measured with a microCT (SkyScan). The same experimental protocol was done by a senior surgeon with the 2 compression screws on 6 cadaveric scapulas. All statistical tests were performed with P = 0.05.

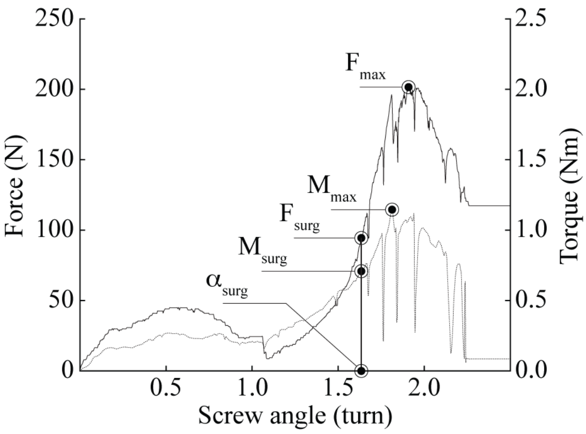

Figure 1: Typical compressive screw force and screwing torque vs. screwing angle during the screwing process.

RESULTS AND DISCUSSION

Each screw presented the same behavior. After a first alignment phase, there was a quasi-linear clamping phase, a post-yield phase and then the failure (Figure 1). The alignment phase required approximately one screwing turn, and the clamping phase (until failure) another turn. F_{max} was statistically correlated with BV (Figure 2). F_{surg} was not statistically correlated to BV. In average, F_{surg} was 51% of F_{max}. M_{max} and M_{surg} were not statistically correlated to BV. In average, M_{surg} was 60% of M_{max}. F_{surg}, M_{surg}, F_{max}, M_{max} and BV were higher for the posterior screw than for the anterior screw.

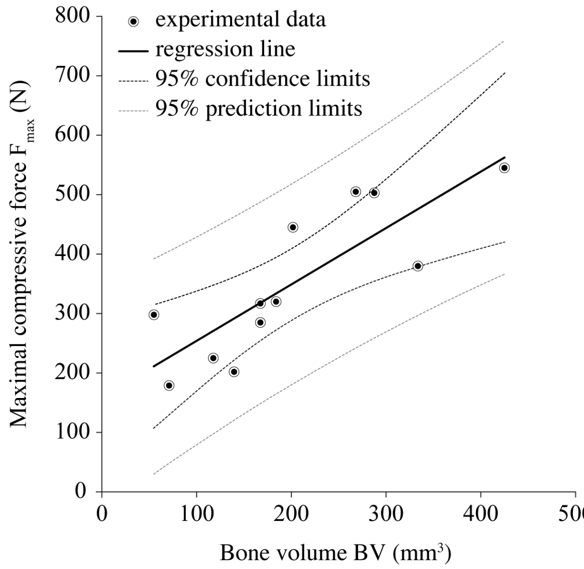

Figure 2: Maximal compressive force vs. bone volume.

CONCLUSIONS

The maximal compressive force of the two compression screws of the Aequalis baseplate was correlated to the surrounding bone volume. The compressive force of the posterior screw, inserted into the spine of the scapula, was nearly two times higher than the anterior screw, inserted in the body of the scapula. These results confirm that the positioning of the posterior nonlocking screw into the spine of the scapula provides a strong fixation of the baseplate. The correlation between maximal compression force and surrounding bone volume will be used to improve the design and fixation of the baseplate of reversed shoulder prostheses.

ACKNOWLEDGEMENTS

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