DIFFERENCES IN THE USE OF PEGS AND SCREWS IN THE FIXATION OF GLENOID COMPONENTS

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INTRODUCTION

The glenoid component failure is the most common complication of TSA and one of its failure modes is related with its initial fixation [1]. Large micromotions are a threat for the fixation of glenoid components and the final clinical outcome. They may produce a progressive weakening of the implant stability until failure. Strength of the component fixation is given mainly by a bone cement layer, a keel, peg(s) and/or screw(s).

This study compares the fixation given by simplified pegs and screws by means of a finite element (FE) model. Our hypothesis is that compression given by the screws will favor a more stable implant fixation. The fixation was evaluated and compared in terms of the bone-implant interface micromotions in an uncemented glenoid component. The risk of fracture due to the torque applied to the screw(s) was evaluated by comparing the maximum and minimum principal bone strains around the glenoid with the yield strain in bone given in previous literature.

METHODS

The glenoid component's position relative to the scapula was verified and approved by an expert surgeon (PMR). Geometry and material properties of the scapula were obtained through the CT data set of a healthy cadaver's scapula (male, 90 years old). The modeled glenoid implant was an uncemented, round-shaped and fully conformed component. This component was chosen due to the fact that the fixation relies exclusively on pegs or screws. They were modeled as solid cylinders (3.5mm diameter and 15mm length) and completely fixed to the glenoid component and the bone. Material properties were specified by the manufacturer. Having an estimation of the ideal torque for screw fixation [2] and the material properties of the screw, it was possible to calculate the prestrain in the modeled screw (0.07%) that would produce the same compression in the surrounding bone than the one given by a real screw.

Four different configurations of fixation were simulated: with only one central peg (PEG1), with a single central screw (SCREW1), with central and inferior pegs (PEG2), and with central and inferior screws (SCREW2). The same four configurations were repeated but with a scapula with reduced material properties in order to resemble a case of rheumatoid arthritis (RA). Muscle and joint reaction forces, during upper arm abduction and forward flexion, were estimated with the Delft Shoulder and Elbow Model (DSEM) [3]. Interface micromotions were evaluated by observing the relative motions of neighboring points located at both sides of the bone-implant interface. Comparisons between all the different studied fixation methods were done through sets made of every point of the interface and its largest micromotion in all the studied arm positions. Statistical analyses were done using a nonparametric one-way analysis of variance.

RESULTS AND DISCUSSION

Fixation of the uncemented glenoid component always improved, i.e. interface micromotions were lower, with the use of a second peg or screw in the inferior side of the component (Figure 1). Interface micromotions were always larger in RA bone. However, no significant difference was found between the fixation given by screws and pegs, neither in healthy or in RA bone (Kruskal-Wallis test, $p<0.01$). In healthy bone, the largest principal strains were 0.38% and 0.52% in tension and compression, respectively. These values are not larger than previously reported yield strains in bone (0.62 and 1.04%) [4]. However, they were larger than those values when RA bone was simulated and the upper arm was above 30 degrees in either abduction or forward flexion (up to 1.9% and 2.2% with one central peg or screw).

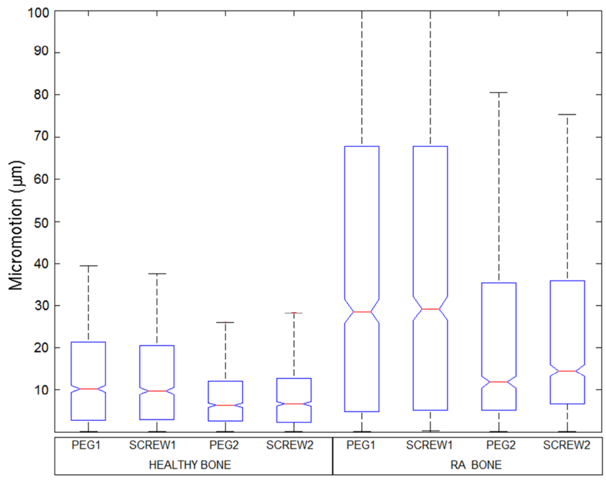

Figure 1: Box plot of the interface micromotions for the different fixation configurations and bone qualities (healthy and RA bone).

CONCLUSIONS

The use of a second peg or screw was a good option for making the implant fixation more stable. Initial fixation, i.e. interface micromotions, was not affected by the choice of using screws or pegs in an uncemented glenoid component. To apply a larger torque to the screws, i.e. a larger prestrain in our models, may make the fixation more stable but it will also increase the risk of bone fracture, especially in presence of weak bone. Regardless of the use of either peg or screws, an uncemented glenoid component may produce bone strains that threat the integrity of weak bone during arm elevation.

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