Stability of Reverse Shoulder Humeral Implants in a Proximal Humerus Bone Loss Model

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Introduction

The treatment of proximal humeral bone loss with its associated pain and loss of function continues to be a challenge for the orthopaedic surgeon. Current options for this condition include hemiarthroplasty or total shoulder arthroplasty with the addition of bone grafting. Unfortunately, due to residual instability, these options have not given the desired results. Reverse shoulder arthroplasty is becoming a viable option for these difficult cases, although it has yet to be tested biomechanically in a proximal humeral bone loss model. The purpose of this study was to determine the effect of proximal humeral bone loss on the fixation of reverse shoulder humeral implants.

Methods

Three reverse shoulder humeral designs (2 modular and one non-modular) were cemented into eighteen fourth generation Sawbones humeri that were prepared to simulate intact humeri and humeri with proximal humeral bone loss (Figure 1). Torque was cyclically applied (x100) in increments of 2.5 N-m (up to 25 N-m or failure) to the distal end of the humerus while the implant was rigidly attached proximally. Rotational micromotion was measured at a fixed point on the implant (Figure 2).

Results

Rotational micromotion in intact humeri (n=12) was 0.13 radians and in those with bone loss (n=12) was 0.60 radians (p < 0.05). Modular implants failed at lower loads than non-modular implants (13.6 N-m and 20.8 N-m respectively, p < 0.05). Rotational micromotion was greater in non-modular implants compared to modular implants (0.41 radians and 0.17 radians respectively, p < 0.05) due to the earlier failure observed in the modular designs. In addition, failure occurred at the component interface in modular implants and at the bone-cement interface in non-modular implants.

Discussion

Proximal humeral bone loss, in a rotator cuff deficient setting, remains a challenging problem. Reverse shoulder arthroplasty has been shown to be a viable option for these circumstances. Figure 3 illustrates the increased survivability of non-modular and intact constructs. The increased survivability of the intact construct was due to the increased stability imparted by the proximal humeral tuberosities. The non-modular construct was able to survive to higher torsional forces because of a failure of the attachment of the modular constructs. The use of a non-modular humeral implant can provide additional rotational stability in the setting of proximal humeral bone loss.