Pre-operative Metaphyseal Cancellous Bone Density is Associated with Intra-operative Conversion to Stemmed Total Shoulder Arthroplasty

James Matthew Gregory[1], Jacob Siahaan, Manuel URVOY
[1]University of Texas Health Science Center at Houston

INTRODUCTION:

Use of stemless humeral components in anatomic total shoulder arthroplasty is increasingly common. Intra-operative assessment of humeral metaphyseal bone quality has been used to judge whether use of a stemless humeral component is appropriate. Objective pre-operative data regarding metaphyseal bone quality may help guide surgical decision making. This study sought to evaluate pre-operative proximal humeral bone quality and determine whether it is predictive of intra-operative conversion to a stemmed humeral component.

METHODS: Consecutive patients who underwent primary anatomic total shoulder arthroplasty from a single-surgeon practice were enrolled. All patients received a pre-operative CT scan for surgical templating purposes. Exclusion criteria were lack of a pre-operative CT scan, pre-operative plan for a stemmed component, and intra-operative conversion to a stem for a reason other than bone quality (i.e. fracture). Pre-operative CT scans were analyzed with an automated templating software. Cortical index and thickness were calculated, and bone density of the proximal diaphysis, cancellous metaphysis, and cortical metaphysis was obtained by averaging Hounsfield units (HU) across anatomically defined regions using a previously validated technique. The decision to convert to a stemmed humeral component was made intra-operatively, and was based on a lack of stability of the trial stemless component. Pre-operative bone quality measurements were compared between stemless and stemmed groups. Fisher exact tests were used for categorical variables and Mann-Whitney U tests were used for continuous variables. An exact logistic regression was used incorporating gender and age. An exact logistic regression was used incorporating gender and age.

RESULTS:

A total of 79 patients who underwent primary anatomic total shoulder arthroplasty were included in this study. Of these patients, six underwent intra-operative conversion to a stemmed humeral component (7.6%). There was no significant difference between cohorts in terms of cortical index, and bone density within the proximal diaphysis and cortical metaphysis. On univariate analysis, cortical thickness, metaphyseal cancellous bone density, and gender were significantly different between groups (Table 1). Patients receiving a stem had significantly lower metaphyseal cancellous bone density than those receiving stemless components (5.5 ± 11.2 HU vs 47.6 ± 29.4 HU, $p<0.001$). All patients converted to stems were female and had metaphyseal cancellous bone density less than 20 HU. Using an exact logistic regression model, only metaphyseal cancellous bone density remained significant (Table 2). Patients with metaphyseal cancellous bone density less than 20 HU were 17.8 times likely to need intra-operative conversion to a stem ($p=0.001$).

DISCUSSION AND CONCLUSION: Metaphyseal cancellous bone density can be calculated on pre-operative CT scans and is associated with intra-operative conversion to a stemmed humeral component in anatomic shoulder arthroplasty. A threshold of 20 HU can be used to predict which patients are more likely to require stemmed components.

Table 1 – Univariate analysis of significant variables between stemless and stemmed groups

Variable	Stemless (n = 73)	Stem (n = 6)	P-Value
Cortical Thickness	3.8 ± 0.69	3.23 ± 0.27	0.012*
Metaphyseal Cancellous Bone Density			< 0.001*
High (Above 20 HU)	58 (79.5%)	0	
Low (20 HU & Below)	15 (21.5%)	6 (100%)	
Gender			0.010*
Male	41 (56.2%)	0	
Female	32 (43.8%)	6 (100%)	

Table 2 – Exact logistic regression model showing odds ratio of needed a stemmed humeral component

Variable	Odd Ratio	95% Confidence Interval		P-Value
Cortical Thickness	2.7	0.23	47.04	0.48
Low Metaphyseal Cancellous Bone Density	17.8	1.9	Inf	0.001*
Female	4.1	0.44	Inf	0.24