



Relationship of scapular neck length to scapular notching after reverse total shoulder arthroplasty by use of plain radiographs

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Background: Scapular notching in reverse shoulder arthroplasty appears to be a multifactorial problem related to both implant and patient factors. There are well-established guidelines for implant position. Recent cadaveric studies have illustrated anatomic factors that need further consideration. Scapular neck length and inferior glenoid tubercle morphology may be major factors predicting scapular notching.

Methods: From 2 institutions, we reviewed 3 years of patient radiographs for reverse shoulder arthroplasty, including all reverse shoulder arthroplasties at least 12 months from surgery. We used true anterior-posterior radiographs, both preoperatively and postoperatively, and focused on the “ideal” positioning of the glenosphere: at or below the inferior margin of the glenoid, and neutral or slight inferior tilt. Radiographs were reviewed by 2 independent surgeons. Glenoid articular surface height was measured along with scapular neck length and notching presence.

Results: Of 64 sets of radiographs reviewed, 50 met inclusion criteria. Notching was present in only 25 (50%) of the sets. The mean scapular neck length was 8.9 mm with a neck:surface ratio of 0.23 in the notching present group and 12.1 mm with a neck:surface ratio of 0.32 in the notching absent group. Significance was reached with both scapular neck length and neck:surface ratio ($P = .0012$ and $P = .0006$, respectively).

Conclusions: There is a high degree of significance that patient anatomy does play a role in the occurrence of notching. Surgeons may consider lateralizing the glenosphere in patients with a scapular neck length of less than 9 mm measured on a true anteroposterior radiograph.

Level of evidence: Anatomy Study, Imaging.

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Keywords: Scapular notching; arthroplasty; reverse shoulder arthroplasty; scapular neck length; radiographs; glenoid articular surface

IRB approval: University of Missouri Institutional Review Board #1156257.

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Reverse total shoulder arthroplasty has a proven track record of improving pain and function, most notably in rotator cuff tear arthropathy, with indications continually expanding.^{3,10,22,26,27} One of the most commonly used reverse prostheses today is the semiconstrained Grammont

style prosthesis. This prosthesis medializes and lowers the glenohumeral center of rotation to reduce the torque of the glenoid-implant interface and concomitantly recruits additional anterior and posterior deltoid fibers to act as abductors.²

This medialization has been associated with notching of the inferior aspect of the scapular neck, presumably because of contact of the humeral component with the lateral scapular margin in adduction. Radiographic findings of notching are common after reverse total shoulder arthroplasty, ranging from 44% to 96%.^{2,4,11,14,15,21,22,25,27} This prosthesis has undergone extensive evaluation since its inception by Paul Grammont in 1985,² with the first report of scapular notching 12 years later by Sirveaux in 1997.¹⁴ Scapular notching is believed to be due to mechanical impingement of the medial rim of the humeral cup against the scapular neck in adduction and the local osteolysis from polyethylene wear created from this impingement.^{14,19,20} Although the radiologic evidence of scapular notching is apparent, the clinical significance is still debated. It has been postulated that scapular notching may ultimately lead to glenoid component loosening; some studies have been able to show poorer clinical outcomes,^{15,20-22} whereas others have not.^{14,16,27}

Patient-specific issues must also be considered. Recent cadaveric studies have illustrated anatomic factors that should be considered further. Scapular neck anatomy^{23,24} and inferior glenoid tubercle morphology^{6,17} as well as body mass index and glenoid inclination⁸ may be major factors in predicting scapular notching. The aim of this study was to evaluate the distance between the lateral scapular body and the articular surface (scapular neck length) and to determine its relationship to the radiographic incidence of notching in reverse total shoulder arthroplasty.

Materials and methods

This is a retrospective review of plain radiographs of shoulders treated with the Grammont style reverse total shoulder arthroplasty during 2 years. In all cases reviewed, the neck-shaft angle of the humeral prosthesis used was 155°. Standard anterior-posterior shoulder radiographs were collected from 2 institutions on consecutive patients returning to clinic for routine follow-up. Two of the investigators independently reviewed 64 shoulder sets in all. After 14 shoulders were excluded, 50 shoulders were included in this investigation. Inclusion criteria were optimal radiographs, a minimum of 12 months after implantation when notching was not present or sooner once notching was present, appropriate glenosphere positioning, preoperative Grashey view radiographs including a native glenoid, and postoperative Grashey view radiographs to assess positioning of the glenosphere and notching. Grashey view is defined as an anterior-posterior radiograph taken in neutral rotation (tangential to glenohumeral joint). Radiographs were excluded on the basis of quality of radiographs leading to inability to identify critical landmarks or suboptimal glenosphere placement defined by lack of neutral or downward slope and glenosphere not at or below the inferior glenoid.

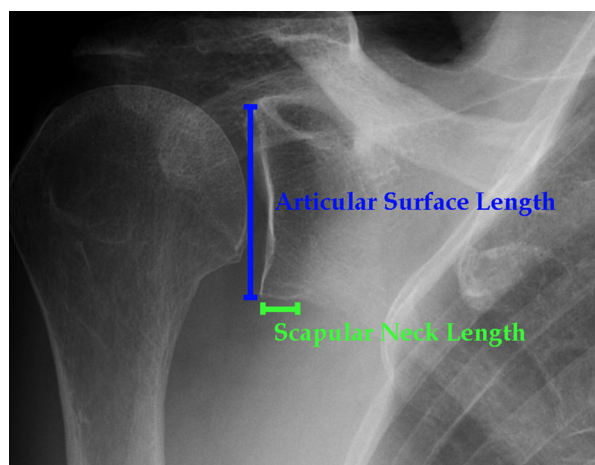


Figure 1 Radiograph showing short scapular neck length.

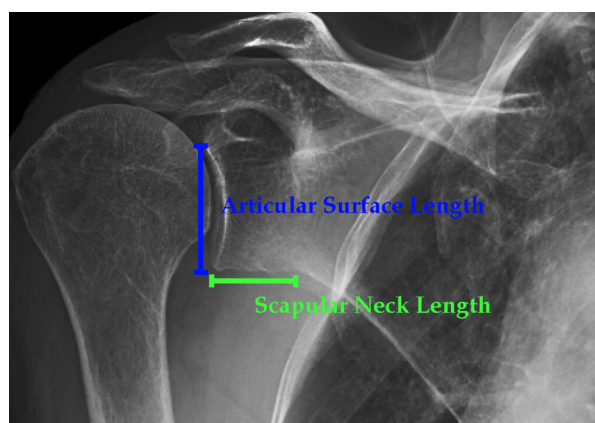


Figure 2 Radiograph showing long scapular neck length.

On standard calibrated picture archiving and communication system (PACS) machines, the investigators independently measured scapular neck length as well as glenoid height for all radiographs and determined if notching was present. Scapular neck length was defined by the distance between the lateral column of the scapula and the articular surface of the glenoid. In situations in which there was a prominent inferior glenoid tubercle, we used this as the medial point in our measurement as this anatomy is known to affect notching.¹⁷ Notching was considered to be present if it was able to be classified according to Sirveaux (grade 1-4).²² Glenoid height was used to calculate a ratio of scapular neck length to glenoid height to account for possible differences in patient size and potential magnification of the radiographs. In addition, scapular neck length and glenoid height ratio provided an additional variable for predictability and for further assessment of interobserver reliability (Figs. 1 and 2).

Results

In total, the included 50 sets of radiographs were analyzed for scapular neck length as well as for glenoid height to obtain a neck:height ratio. The 2-sample *t*-test was used to compare the means of the groups in which notching was

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