Quantitative comparison of exposure for the posterior Judet approach to the scapula with and without deltoid takedown

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Background: The purposes of this study are to quantify the extent of the scapula exposed and to describe the osseous landmarks within the dissection of a posterior Judet approach with and without takedown of the posterior deltoid muscle.

Methods: The posterior Judet approach using the muscular interval between the teres minor and infraspinatus muscle with and without takedown of the deltoid muscle was performed on 10 fresh-frozen cadaveric shoulders. Retractors with 2 kg of force were used at the wound margins for retraction. Upon completion of the exposure, a calibrated digital image was taken from the surgeon’s perspective and specific anatomic landmarks were identified. The digital images were then analyzed with a computer software program, ImageJ (National Institutes of Health, Bethesda, MD, USA), to calculate the area (in square centimeters) of bone exposed.

Results: The mean area of posterior scapula exposed by the traditional Judet approach with takedown of the deltoid muscle was 30.2 cm² (95% confidence interval, 27.7-32.7 cm²) compared with 27.3 cm² (95% confidence interval, 24.8-29.9 cm²) when the deltoid was not detached (P < .0001). In all 10 cadaveric shoulders, the posterior Judet approach without takedown of the deltoid muscle allowed access to the posterior glenoid, lateral scapula border, and spinoglenoid notch.

Conclusions: Although takedown of the deltoid muscle improves exposure, the posterior Judet approach without takedown of the posterior deltoid muscle allows for safe exposure to 91% of the bony scapula obtained by removing the deltoid muscle and access to the critical osseous fixation points of the posterior scapula.

Level of evidence: Basic Science, Anatomy, Surgical Technique.

Keywords: Scapula surgery; surgical exposure; quantitative anatomy; posterior approach; cadaveric study

As interest and understanding of the surgical treatment of scapular fractures increase, the description of more soft tissue–friendly surgical techniques has emerged as well. Certainly, an understanding of common scapular fracture patterns has allowed surgeons to become more strategic and better able to spare the soft tissues during access to these fractures. Recent variations to Judet’s initial posterior surgical dissection, in which the rotator cuff and posterior deltoid are stripped off the posterior scapula, have given surgeons new surgical access windows to fix several different types of scapular fracture patterns.
Before the introduction of a new approach or variation to an existing approach, it is important to understand and describe the anatomy of the vulnerable neurovascular structures and osseous landscape.\textsuperscript{11,25} We believe that adequate exposure to critical reduction and fixation points for the most common scapular fracture patterns can be accomplished, through a posterior Judet incision, without detaching the posterior deltoid, teres minor, or infraspinatus origins. By limiting muscular takedown, patients may be spared unnecessary postoperative restrictions and potential dysfunction, possibly expediting and improving functional outcomes.

The purposes of this study are (1) to describe a modification of the posterior Judet approach using a muscular interval without detachment of the deltoid muscle, (2) to compare and quantify the amount of osseous exposure with this technique versus the traditional exposure with a deltoid takedown, and (3) to describe the anatomic landmarks and vulnerable neurovasculature with methods of protection useful to the surgeon.

Materials and methods

For this study, 10 paired shoulders from 5 unpreserved whole-body cadaveric specimens were used (Table I). None of the specimens had any evidence of previous injury or surgery to the shoulder girdle. The surgical exposures were performed by a single postgraduate year 4–level orthopaedic resident physician (T.E.S.) after hands-on instruction and a hands-on demonstration by a fellowship-trained orthopaedic traumatologist and expert in the treatment of scapular fractures (P.A.C.). The dissections were performed in the University of Minnesota Anatomy Bequest Program Laboratory from August to October 2012.

Surgical procedure

The specimens were placed in the lateral decubitus position, “flopping” slightly forward with an axillary roll and bump as would be done in a live patient surgery. The approach was drawn out with a permanent marker in an inverted lazy L fashion as for a classic Judet skin incision, beginning with the posterosuperior edge of the acromion, extending medially along the scapular spine, and then coursing caudally along the vertebral border.\textsuperscript{10,15,19} The skin incision was made, and a full-thickness subcutaneous tissue flap was reflected off the posterior muscular fascia overlying the deltoid and infraspinatus/teres minor (Fig. 1, A and B). The deltoid was identified by visualizing the muscle fascia orientation and distinctive bulge of the deltoid, and the interval between the posterior deltoid and underlying rotator cuff was developed to allow the posterior deltoid to be retracted cephalad. Retraction was performed with a medium Richardson retractor, which was attached to a strain gauge that did not exceed 2 kg of force (Fig. 2, A and B). The interval between the infraspinatus and teres minor muscles was then developed to access the lateral scapula border, posterior glenoid rim, and scapula neck and body. The circumflex scapular artery was visualized in this interval. The origins of both muscles were left intact. To ensure that the posterior glenoid was visualized, a 12-gauge needle was inserted into the glenohumeral joint directly over the posterior labrum (Fig. 2, C). The suprascapular nerve and artery were both identified in each case at the base of the acromion in the spinoglenoid notch and were protected. The edges of the exposure were retracted with 2 kg of force, and then the exposed bony outline was demarcated with a K-wire drill perpendicular to the scapula.

Once the first outline was completed with the drill, the deltoid origin was reflected from the scapular spine beginning at the medial superior border, and the muscle was secured with stay sutures. Again, the peripheral borders of the exposure were demarcated with the drill and K-wire by use of a retractor with a 2-kg force being applied (Fig. 2, D). Three anatomic landmarks (posterior glenoid, lateral scapula border, and spinoglenoid notch) were analyzed after each dissection to determine whether the landmark was clearly visible and palpable (accessible).

Data collection and analysis

The scapula was stripped of its muscular attachments, and multiple photographs were taken of the exposed scapula from the surgeon’s perspective with a 10-cm metric ruler placed flush against the posterior aspect of the shoulder girdle. To measure the amount of exposure gained by each surgical approach, a calibrated digital photograph of the exposed scapula was captured from directly above the dissection (Fig. 2, E). The digital images were analyzed with a public domain Java image processing and analysis computer software program, ImageJ (National Institutes of Health, Bethesda, MD, USA)\textsuperscript{24} that has been used in several orthopaedic publications for quantification through an image capture.\textsuperscript{4,5,14,23} ImageJ uses a known distance (ie, the metric ruler in each image) with the actual number of pixels in the digital photograph. The software then uses a polygon lasso tool to outline the exposed bone and calculate the area (in square centimeters). Because the scapula is a flat bone, the area inside the outlined surface area of each specimen can be easily measured and calculated.

A descriptive analysis was performed for purposes of reporting sample characteristics. This included age, gender, and body mass index being reported as means or simple proportions. The exposed area of the scapula for each approach was compared by the 2-tailed Student \( t \) test, and Fisher exact testing was used to compare visualization of anatomic landmarks for both exposures. A Wilcoxon rank sum test was used to determine whether there was a correlation between the exposed area and cadaveric variables (gender, age, and so on). Statistical significance was set at \( P = .05 \), and we used an \( \alpha \) of 5% for confidence interval (CI) calculations.

Results

The mean area of scapula exposed by the traditional Judet approach with detachment of the deltoid muscle was
The mean area of scapula exposed by the Judet approach without detachment of the deltoid muscle was 27.3 cm² (95% CI, 24.8-29.9 cm²), or 91% of that obtained by removing the deltoid muscle ($P < .0001$). The mean total area of the exposed bony scapula after it was stripped of all muscular attachments for all 10 shoulders was 59.00 cm² (95% CI, 54.26-63.74 cm²). In all 10 cadaveric shoulders, the posterior Judet approach without detachment of the deltoid muscle allowed access to the posterior glenoid, lateral scapula border, and spinoglenoid notch ($P > .05$) (Fig. 3). For the measurements obtained, there was no correlation between the exposure and gender, age, height, weight, body mass index, or side dissected (right or left shoulder).

**Discussion**

Since the initial description of the extensile Judet approach for the surgical treatment of scapular fractures in 1964, numerous surgical exposures have been described as the understanding of the operative management of scapular fractures has increased. The posterior approach remains the predominant exposure for most surgically treated scapular fractures. The benefits of the Judet approach include adequate exposure for fractures of the inferior glenoid and those extending into the body. On the basis of a mapping study using 3-dimensional computed tomography, 84% of the 61 inferior glenoid fractures included in the study extended to the superior medial angle. Both the extensile Judet approach and modified Judet approach require detachment of the deltoid muscle. A less invasive approach without detachment of the deltoid muscle, which still allows adequate exposure for open reduction–internal fixation of the majority of scapular fractures, could be beneficial to scapular fracture surgeons.

The purposes of this study were to describe and quantify the amount of scapula exposed using a modification to the Judet approach that uses muscular intervals and to identify critical neurovascular structures within the dissection.

The data presented suggest that this less invasive dissection without detachment of the deltoid origin allows access to 91% of the bony scapula exposed with the addition of posterior deltoid takedown. Despite this quantitative difference, there remains little clinical difference between the two approaches because the surgeon has visual access to the posterior glenoid, lateral scapula border, and spinoglenoid notch. These bony landmarks have previously been identified as the regions of superior scapula thickness appropriate for internal fixation of scapular fractures. With retraction of the overlying skin flap, tactile access to the medial scapula border is possible. A more extensile Judet approach may be required for reconstructive cases. Multiple modifications of the original Judet approach have been described in the literature, all of which involve takedown of some portion of the posterior rotator cuff musculature and/or the posterior deltoid origin. Ebraheim et al described their approach using a skin incision along the scapular spine with a vertical extension at the lateral border of the scapula, essentially creating a “reverse” Judet skin incision. Alternatively, Obremskey and Lyman described their modification of the Judet approach using a classic Judet skin incision, developing intermuscular planes similar to those we describe, with their approach taking down the posterior deltoid origin from the scapular spine as originally described by Judet. Our modification of the approach also uses the classic skin incision that is most...
Figure 2  (A) The first exposure was with the deltoid retracted cephalad, allowing the posterior glenoid and lateral border of the scapula to be visualized between the interval of the infraspinatus and teres minor. (B) Moderate retraction force (2 kg) was standardized with a Richardson retractor and strain gauge. (C) The exposure was demarcated by drill holes in the perimeter of the exposed scapula. (D) The posterior deltoid was detached, and the processes outlined in B and C were repeated. (E) Each scapula was stripped of its muscular attachments, and the perimeters of the surgical exposures were outlined and measured for each surgical approach. The area within the blue dashed line represents the exposure attained when the deltoid remains intact. The area within the black dotted line represents the additional exposure gained by detaching the origin of the posterior deltoid.
familiar to orthopaedic surgeons; however, in addition to limiting dissection of the posterior rotator cuff musculature, we advocate preservation of the posterior deltoid origin on the scapular spine. We have shown that little is lost in terms of visualization and bony access for fracture reduction and fixation of the scapular body and glenoid neck with the preservation of the deltoid origin, and we propose that preservation of all muscular origins on the scapular body also limits the morbidity of the approach. Brodsky et al described an intramuscular dissection similar to that which we describe, with preservation of the posterior deltoid insertion, accessed through a vertical incision starting at the posterior border of the acromion. Although this approach allows for similar access to the posterior glenoid, access to the scapular spine and body is limited.6

There are a few weaknesses to this study that merit discussion. First, we used advanced imaging software with 2-dimensional images attempting to represent a 3-dimensional surface for the quantitative analysis. The photographs were taken from a surgeon’s view, directly above and perpendicular to the exposure. Although there may be minimal distortion, the scapula is a relatively flat bone that yields itself to this type of analysis. In addition, the boundaries of the exposure were demarcated by use of perpendicular drill holes with a modest 2 kg of retraction force. If needed, a greater exposure could most likely be obtained with increased traction force. Another limitation of this study is the fact that it relied on a small number of cadaveric specimens. We acknowledge that this may not fully represent the dynamic anatomic relations in vivo, but we used fresh-frozen cadavers in an attempt to limit this variability. Furthermore, the mean age of the cadavers used in this study was 59 years. On the basis of data from 2 systematic reviews, this is much older than the typical trauma patient (38 years or 35.4 years) who presents with a scapular fracture.20,27 The muscle mass of the deltoid is most likely greater in a 38-year-old man compared with a 59-year-old woman, potentially limiting the amount of exposure; however, younger cadavers were not available for our study.

**Table II** Osseous exposure with and without deltoid takedown for each specimen

<table>
<thead>
<tr>
<th>Shoulder</th>
<th>Exposure without deltoid detachment (cm²)</th>
<th>Exposure with deltoid detachment (cm²)</th>
<th>Total scapula area * (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen 1 Left</td>
<td>29.9 (43% of total)</td>
<td>30.3 (43% of total)</td>
<td>70.4</td>
</tr>
<tr>
<td>Right</td>
<td>30.0 (45% of total)</td>
<td>32.7 (49% of total)</td>
<td>66.8</td>
</tr>
<tr>
<td>Specimen 2 Left</td>
<td>31.0 (57% of total)</td>
<td>34.0 (62% of total)</td>
<td>54.4</td>
</tr>
<tr>
<td>Right</td>
<td>28.0 (58% of total)</td>
<td>31.5 (66% of total)</td>
<td>48.1</td>
</tr>
<tr>
<td>Specimen 3 Left</td>
<td>19.7 (37% of total)</td>
<td>22.7 (43% of total)</td>
<td>52.7</td>
</tr>
<tr>
<td>Right</td>
<td>22.8 (46% of total)</td>
<td>25.0 (51% of total)</td>
<td>49.3</td>
</tr>
<tr>
<td>Specimen 4 Left</td>
<td>23.9 (38% of total)</td>
<td>28.3 (45% of total)</td>
<td>62.8</td>
</tr>
<tr>
<td>Right</td>
<td>33.0 (51% of total)</td>
<td>36.0 (56% of total)</td>
<td>64.7</td>
</tr>
<tr>
<td>Specimen 5 Left</td>
<td>28.7 (46% of total)</td>
<td>31.9 (51% of total)</td>
<td>62.9</td>
</tr>
<tr>
<td>Right</td>
<td>26.3 (45% of total)</td>
<td>30.0 (51% of total)</td>
<td>58.1</td>
</tr>
<tr>
<td>Mean</td>
<td>27.3 (47% of total)</td>
<td>30.2 (52% of total)</td>
<td>59.0</td>
</tr>
<tr>
<td>SD</td>
<td>4.12</td>
<td>4.03</td>
<td>7.65</td>
</tr>
<tr>
<td>95% CI</td>
<td>24.8-29.9</td>
<td>27.7-32.7</td>
<td>54.3-63.7</td>
</tr>
</tbody>
</table>

* Total scapula area equals total square area of exposed bony scapula after it was stripped of all muscular attachments.

**Figure 3** After the scapula was stripped of its muscular attachments, the perimeters of the surgical exposures were outlined and the area was measured for each surgical approach.
the exposure in scapular fracture repair with the deltoid origin left intact and only proceed with takedown if additional exposure is needed. By avoiding detachment of the posterior deltoid and infraspinatus muscle insertions, many of the postoperative restrictions after surgical fixation may be avoided. Future clinical studies are needed to determine whether use of this technique expedites and improves patients’ functional outcomes.

Disclaimer

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References