DELToid TAKEDOWN APPROACH TO IDEBERG VI/AO F2(4) GLENOID FOSSA FRACTURES

RUNNING TITLE: Deltoid Takedown – Approach and Results

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The Health and Disability Ethics Committee approved this case report (2021 EXP 11664).

Disclaimers:
Funding: No funding was disclosed by the authors.

Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Patient consent: Obtained
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FRATURES

ABSTRACT

Ideberg-Goss type VI/AO F2(4) glenoid fossa fractures are a rare and complex injury. Although some advocate non-operative management, grossly displaced glenoid fossa fractures in the young patient may warrant fixation. Current approaches still describe difficulty with access of the entirety of the glenoid, particularly the postero-superior quadrant.

We present 2 cases of Ideberg-Goss type VI/AO F2(4) glenoid fossa fractures treated with fixation through a novel “Deltoid Takedown” approach, which allows safe access to the whole glenoid with satisfactory clinical results at 5 and 7 years respectively.

KEYWORDS: Deltoid Takedown approach; glenoid fracture; scapular fractures; posterior approach to the shoulder; glenoid fixation; Judet approach; modified-Judet approach; glenoid ORIF

Level of Evidence: Level IV; Case Report

Scapular fractures account for 1% of all fractures, with 10% of these involving the glenoid.1 Glenoid fossa fractures (GFF) were first classified by Ideberg into 5 types.2,3 Goss expanded on this and described the rare type VI, defined as severely comminuted (Fig 1).1 In 2013, The AO/OTA International Scapula Classification group reclassified glenoid scapula fractures with the F-B classification.4,5,6 F denotes the nature of the articular segment (Fig. 2 ); F0, extra-articular; F1, simple intra-articular; F2, multi-fragmentary intra-articular with 3 or more
articulat fragments. A further number follows in brackets denoting the location of the fragment, grouped into quadrants of the glenoid. B denotes scapular body involvement and the exit point of the fracture line (Fig. 3); l, inferior lateral; m, medial; s, superior; g, glenoid-side exit.

For Ideberg-Goss type I-V/AO F0-F1 GFF, Open Reduction and Internal Fixation (ORIF) is generally recommended if there is an articular step greater than 4-5 mm, severe separation of glenoid fragments, or instability/subluxation of the humeral head. However for Ideberg-Goss type VI/AO F2 GFF, some literature advises against ORIF due to the extensive comminution and the subsequent disruption of soft tissue if attempted. Current literature regarding specific treatment for Ideberg-Goss type VI/AO F2 GFF is limited. Goss preferred non operative treatment, although no outcome data was reported in his paper. Goss acknowledged that even with optimum non-operative care, type VI fractures of the glenoid fossa posed the greatest risk of late symptomatic degenerative disease or instability of the glenohumeral joint. There are reported cases of acute inverse shoulder replacements as an alternative to ORIF for GFF but these were in older patients, with the youngest of these reported cases being 63 years old. Arthroscopic-assisted reduction and internal fixation (ARIF) and minimally invasive surgery (MIS) have been used for GFF but in the published studies majority of patients treated this way had simpler Ideberg Type I GFF. ORIF has largely utilized a posterior Judet or modified-Judet approach, with concurrent anterior deltopectoral approach as required, however in a cadaveric study Ao et al showed that the combined approach could still not access the postero-superior zone of the glenoid.
We report the results of 2 cases of Ideberg-Goss type VI/AO F2(4) glenoid fossa fractures involving the postero-superior quadrant treated with an alternative safe “Deltoid Takedown” approach.

CASE 1:

49 year-old man fell off his horse and sustained an Ideberg-Goss type VI/AO F2(4) B(gm) fracture dislocation (Fig 4).

During surgery, the patient was placed in the lazy-lateral position. A curvilinear incision was made. The skin incision was started vertically along the medial border of the scapula, then turning 90° horizontally along the scapular spine. At the level of the coracoid, the incision was turned 90° again in the sagittal plan to continue into the deltopectoral groove anteriorly (Fig. 5).

After pre-templating with a standard plate and pre-drilling, the clavicle was osteotomized in a Chevron manner – a coronal osteotomy of anterior ¼ of the clavicle width was performed starting at the anterior deltoid origin until lateral to the coracoid, the osteotomy was then extended posteriorly to include the full width of the clavicle. This chevron osteotomy preserves the osseous origin of the anterior deltoid on the lateral clavicle, preserves the conoid ligament attachment to the medial clavicle and avoids injury to the suprascapular nerve. Posteriorly, the acromion was osteotomized, again in a Chevron manner, superior to the spinoglenoid notch to avoid the suprascapular nerve. The posterior deltoid medial to the acromion osteotomy was released from the scapular spine. (Fig. 6.)

The trapezoid ligament, coraco-acromial ligament and the trapezius were released from the
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osteotomized lateral clavicle and acromion to allow the deltoid to reflect distally on its insertion. (Fig. 7)

Reduction and fixation was then done through 4 intervals – the anterior rotator interval (between subscapularis and supraspinatus), posterior rotator interval (between supraspinatus and infraspinatus), Judet interval (between infraspinatus and teres minor) and Interteres interval (between teres minor and teres major).

Case 1 subsequently fell off his horse 2.5 years later and fractured the clavicle medial to the clavicular plate, treated non-operatively.

At 7 years, his Constant score is 77 and ASES score is 95.

His sequential XR and clinical photograph at 7 years follow-up are shown in Fig 8 and 9.

CASE 2:

55 year old involved in a motorbike accident sustaining an Ideberg-Goss type VI/AOF2(4) B(gml) fracture dislocation of his left shoulder with an ipsilateral segmental fracture of his clavicle (Fig. 10 and 11). Multiple other injuries warranted an ICU admission, including a chest injury that delayed his glenoid fixation until day 18 of admission. Ipsilateral Grade IIIa open forearm fracture with subsequent Serratia Marcescens infection was successfully treated by débridement and soft tissue flap coverage at approximately 4 weeks post injury.

As the clavicle and acromion were both already fractured segmentally, the Deltoid Takedown approach was modified to incorporate these fracture sites. To minimize soft tissue dissection, the clavicle was later fixed with intramedullary screw. The comminution of the GFF necessitated a rim plate in the “non-access” postero-superior quadrant, therefore the greater
tuberosity was osteotomized from the bicipital groove to the Judet interval in continuation with a capsulotomy lateral to the labrum to allow placement of the plate under the supraspinatus (Fig. 12). This allowed safe retraction of the suprascapular nerve away from the glenoid margin, while also allowing access for safe application of the rim plate. The inferior glenohumeral ligament was preserved (Fig. 13), providing protection to the axillary nerve and maintain glenohumeral joint stability.

Serial postop Xrays are shown in Fig. 14.

At 17 months post surgery, Case 2 re-presented with a sinus in his posterior scapular scar. Culture grew Serratia Marcescens and was successfully treated with débridement and removal of the acromion metalware. CT scans at 3.5 years, after posterior metalware removal, are shown in Fig 15. Active range of motion at 5 years is seen in Fig 16. His Constant score is 77 and his ASES score is 83.

**DISCUSSION**

In 1991, Soslowsky et al found that the maximal thickness of the glenoid cartilage was 3.81 +/- 0.72mm.16 Goss therefore recommended that for glenoid fossa fractures (GFF) a relative indication for surgery was the exposure of the subchondral bone at 5 mm of intra-articular displacement.17 We can only find one study on outcomes for non-operative treatment of GFF, by Königshausen et al.18 In their series of 24 patients with Ideberg-Goss type II-VI GFF they found that patients with intra-articular displacement of greater than 5mm do significantly poorer than those with less displacement (Constant scores 59 and 88 respectively , p<0.001).18 In a case series of 84 scapula fractures and 29 intra-articular GFF, Cole et al recommended 4mm as the cut-off for non-operative management.7
From our literature search looking at outcomes with various treatment of GFF there are a total of just 16 Ideberg-Goss type VI/AO F2(4) GFF, reflecting the rarity of this injury. As fixation is complicated and usually these patients have significant concomitant injuries, it can be reasonable to manage some of these fractures with “willful neglect”, to first allow the fracture heal, with plans to perform a shoulder replacement at a later date. Goss did comment that these fractures have the greatest risk of arthritis and instability but there were no specific outcomes reported in his paper. There were only 2 cases with reported outcomes on non-operative treatment specific to Ideberg VI/AO F2 GFF in the paper by Königshausen. One case developed grade III OA, the other was not commented on. Other options for management include acute inverse total shoulder replacements, though all studies found relating to this had elderly patients of at least 63 years old. Our two cases (aged 49 and 55) were felt to be too young and active to consider this a reasonable option. With their high degree of comminution and displacement the senior author felt that if treated non-operatively, the end result was more likely to make subsequent shoulder replacement an equally difficult procedure, with further complication anticipated if the displaced fragments developed into a non-union with a chronic humeral dislocation. Hence in these cases, the decision was to proceed to fixation.

Lin et al conducted a retrospective study of arthroscopic-assisted internal fixation (ARIF) versus open reduction internal fixation (ORIF) for GFF and found equivocal results. Two Ideberg- Goss type VI GFF were in the ARIF group, one was in the ORIF group, no images or sub-group analysis was conducted on these 3 cases. Although the senior author has performed ARIF on Ideberg-Goss type Ia and III GFF, he felt that these two cases were beyond his capabilities for ARIF.
Erich et al conducted a retrospective review which recommended minimally invasive (MIS) for GFF within 30 days on injury for glenoid fractures of a simple nature only and therefore seem less applicable.\textsuperscript{12}

With regard to surgical approaches for ORIF, most glenoid fractures, even those with 3 or more articular fragments, can be fixed with the traditional or modified Judet approach, +/- deltopectoral approach or similar.\textsuperscript{3} Kavanagh et al reported 10 cases of ORIF for GFF (2 of which were a stellate pattern) and described a posterior approach via reflection of the posterior deltopectoral off the scapular spine, dissecting through the Judet interval with an infraspinatus tenotomy.\textsuperscript{19} They reported that the anterior approach to these fractures were exceptionally difficult and would not recommend it. Sean et al reported 17 cases of Ideberg-Goss type IV, V and VI GFF (with 5 Ideberg-Goss type VI) treated with a similar posterior approach but without infraspinatus tenotomy and commented again that control and reduction of the cephalad/anterior articular segment is most difficult.\textsuperscript{20} Even without an Ideberg-Goss type VI within their series of 31 ORIF of GFF, Mayo et al reported two of the cases requiring a combined anterior (deltopectoral) and posterior (Judet) approach.\textsuperscript{21} Mayo et al also described release of the trapezius from the scapula spine in rare cases where exposure of the suprascapular fossa was required but it is not clear if this technique was used in any of the included patients. Anavian et al reported on 33 patients with ORIF of GFF, 16 of which had three intra-articular fragments and 2 of which had 4 intra-articular fragments and commented that 5 cases needed combined anterior-posterior approach.\textsuperscript{22} Ao et al identified that even with a combined anterior and posterior (Judet) approach there was a postero-superior “non-access” zone between the coracoid and spinoglenoid notch.\textsuperscript{13} The Deltoid Takedown approach described in this text allowed access to all parts of glenoid fossa and scapula while protecting the suprascapular neurovascular bundle, axillary nerve and
The circumflex humeral arteries.

Despite the complexities of ORIF for GFF, reported results are encouraging. Reported complications from ORIF of GFF are few. Schandelmaier et al, in a series of 22 cases of Ideberg type II-V GFF, reported 2 cases (9%) of deep infection. Kavanagh et al reported a single case (10%) of heterotopic ossification in a patient with concurrent closed head injury in a series of 10 patients. Anavian et al in a series of 33 intra-articular GFF who underwent ORIF reported one case (3%) of intra-articular screw penetration, one case of stiffness requiring postoperative manipulation under anesthesia and one case of symptomatic ectopic bone requiring resection. Mayo et al reported 2 cases of denervation of infraspinatus secondary to inferior branch suprascapular nerve palsy but could not confirm if they were present pre- or postoperation. There were no other reports of neurological complications post ORIF. In this study, Case 2 had a Serratia Marcescens infection 17 months post operation, likely to have seeded from his open forearm fracture infection while in hospital. In total we found 14 cases of ORIF for Ideberg-Goss type VI GFF mentioned in the English literature. We could not find any published imagery, surgical technique nor reports of results specific to ORIF of this injury. Considering the favorable outcomes of these 2 cases, this paper hopefully provides some useful technical information on ORIF of these rare and complex fractures.

CONCLUSION:

The Deltoid Takedown approach can offer full access to the glenoid and scapula in Ideberg-Goss type VI / AO F2(4) glenoid fossa fractures when these fractures are deemed not suitable for “willful neglect” or acute shoulder replacement. It is particularly useful when the fracture comminution involves the postero-superior zone, which has previously been described as having a poor access even when using a combined anterior-posterior approach.
REFERENCES:


**F0** = Fracture of the articular segment, not through the glenoid fossa (the fossa is not attached to any part of the scapula body)

**F1** = Simple pattern: rim, transverse, oblique fracture (fracture involves the glenoid fossa)

**F2** = Multifragmentary joint fracture (fracture involves the glenoid fossa with three or more articular fragments\(^1\))

\(^1\) The presence of only a “small” (up to 2 mm) fracture fragment in the glenoid fossa does not designate a fracture as “multifragmentary”
4 = More than two fracture line exit points

5 = Central fracture-dislocation, with no exit line through the rim
LEGEND FOR FIGURES


Fig 4. Case 1: Pre-operative CT right scapula

Fig 5. Skin incision for Deltoid Takedown approach

Fig 6. Clavicular and acromion osteotomies

Fig 7. Inferior reflection of deltid around insertion

Fig 8. Case 1: Serial post-op Xrays

Fig 9. Case 1: Clinical range of motion 7 years post-op

Fig 10. Case 2: Pre-operative CT left scapula. * labels associated segmental acromial and clavicular fractures
Fig 11. Case 2: Pre-operative CT left scapula

Fig 12. View with the deltoid reflected distally. Greater tuberosity osteotomy from bicipital groove to Judet interval. Dotted line depicts anterior rotator interval. Solid line depicts osteotomy.

Fig 13. Case 2: View of the glenoid. * labels preserved anterior band of the inferior glenohumeral ligament

Fig 14. Case 2: Serial post-op Xrays

Fig 15a,b,c,d,e. Case 2: CT scan at 3.5 years post-op after removal of posterior metalware

Fig 16. Case 2: Clinical range of motion 5 years post-op