



Deltoid Takedown approach to Ideberg VI/AO F2(4) glenoid fossa fractures



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Scapular fractures account for 1% of all fractures, with 10% of these involving the glenoid.⁸ Glenoid fossa fractures (GFF) were first classified by Ideberg into 5 types.^{8,11} Goss expanded on this and described the rare type VI, defined as severely comminuted (Fig. 1).⁸ In 2013, the Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) International Scapula Classification group reclassified glenoid scapula fractures with the F-B classification.^{3,12,22} F denotes the nature of the articular segment (Fig. 2): F0, extra-articular; F1, simple intra-articular; and F2, multifragmentary intra-articular with 3 or more articular fragments.¹² 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; and g, glenoid-side exit.³

For Ideberg-Goss type I to 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.^{4,8} 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.⁸

Current literature regarding specific treatment for Ideberg-Goss type VI/AO F2 GFF is limited. Goss preferred nonoperative treatment, although his paper did not include outcome data.⁸ Goss acknowledged that even with optimum nonoperative care, type VI fractures of the glenoid fossa posed the greatest risk of late symptomatic degenerative disease or instability of the glenohumeral joint.⁸ There are reported cases of acute reverse 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.^{5,6,18} 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-Goss type I GFF.^{7,17} 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 al² showed that the combined approach could still not access the posterosuperior zone of the glenoid.

We report the results of 2 cases of Ideberg-Goss type VI/AO F2(4) GFFs involving the posterosuperior quadrant treated with an alternative safe “Deltoid Takedown” approach.

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

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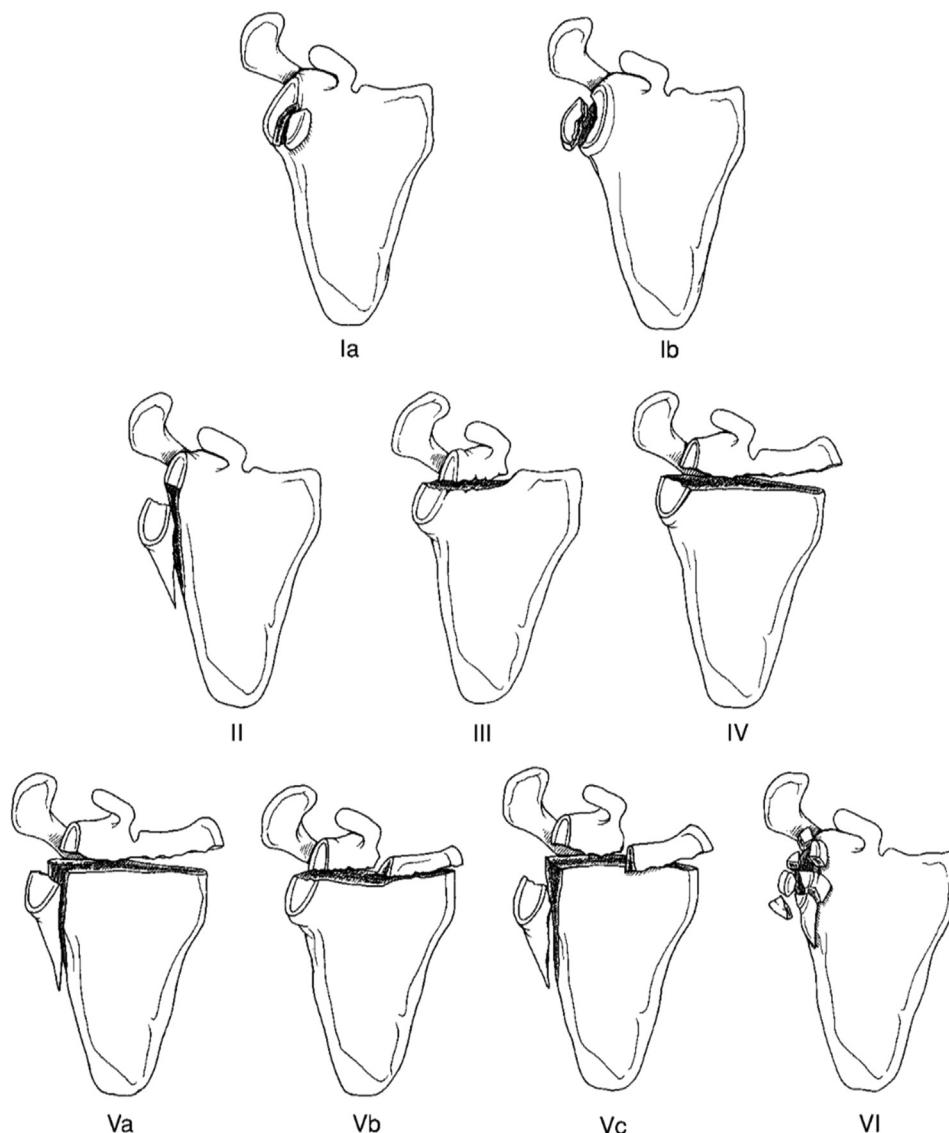


Figure 1 Ideberg-Goss classification. Reprinted from “Scapular fractures and dislocations: diagnosis and treatment” by T. P. Goss, 1995, *Journal of the American Academy of Orthopaedic Surgeons*, 3(1), p. 22-33. Copyright 1995 by the American Academy of Orthopaedic Surgeons.⁹

Case 1

A 49-year-old man fell off his horse and sustained an Ideberg-Goss type VI/AO F2(4) B(gm) glenoid fossa 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 plane to continue into the deltopectoral groove anteriorly (Fig. 5).

After pretemplating with a standard plate and predrilling, the clavicle was osteotomized in a chevron manner—a coronal osteotomy of the anterior ¼ of the clavicle width was performed starting at the anterior deltoid origin until lateral to the coracoid, 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 (inferior branch to infraspinatus). The posterior deltoid medial to the acromion osteotomy was released from the scapular spine (Fig. 6).

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

Reduction and fixation was then done through 4 intervals—the anterior rotator interval (between subscapularis and supraspinatus),

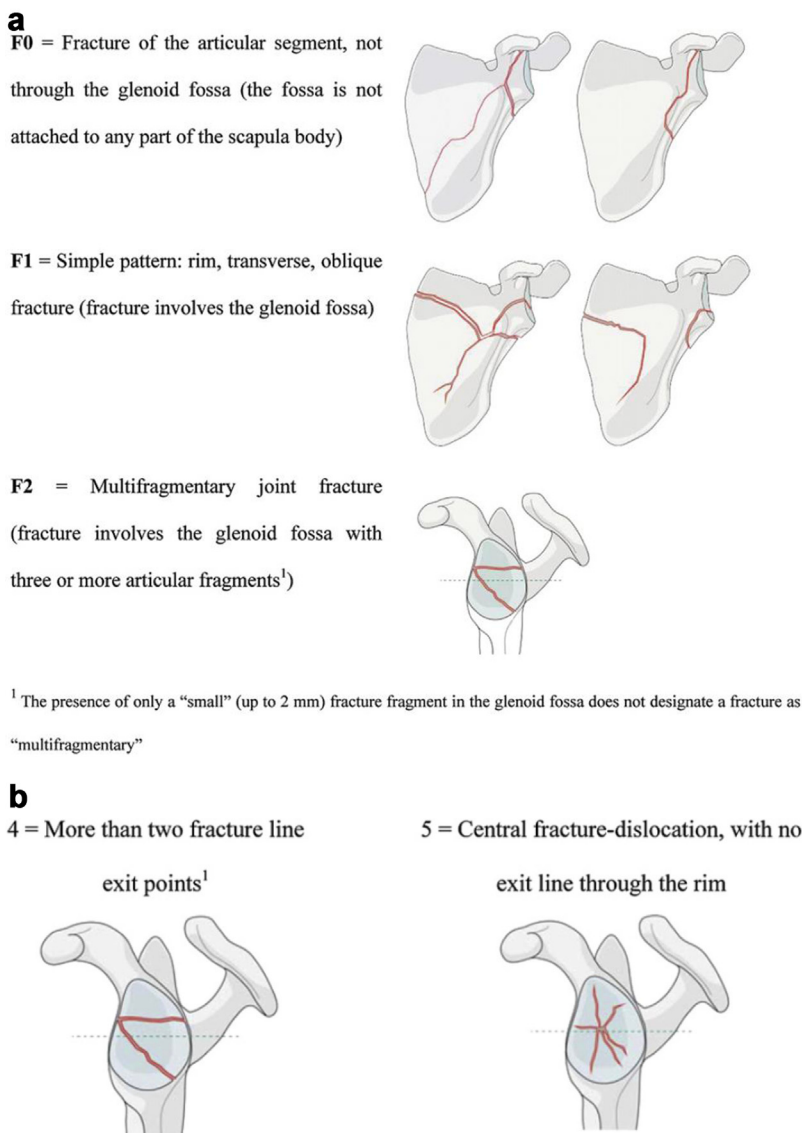


Figure 2 (a, b) Arbeitsgemeinschaft für Osteosynthesefragen (AO) glenoid fracture classification. Reprinted from “The AO Foundation and Orthopaedic Trauma Association (AO/OTA) scapula fracture classification system: focus on glenoid fossa involvement” by Jaeger et al., 2012, *Journal of Shoulder and Elbow Surgery*, 22(4), p. 512-520. Copyright 2013, by the Journal of Shoulder and Elbow Surgery Board of Trustees.¹²

posterior rotator interval (between supraspinatus and infraspinatus), Judet¹⁴ interval (between infraspinatus and teres minor), and inter-teres interval¹³ (between teres minor and teres major).

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

At 7 years, his Constant score is 77 and American Shoulder and Elbow Surgeons (ASES) ASES score is 95.

Sequential X-rays and clinical range of motion at 7 years of follow-up is shown in [Figures 8](#) and [9](#).

Case 2

A 55-year-old man involved in a motorbike accident sustained an Ideberg-Goss type VI/AO F2(4) B(gml) glenoid fossa

fracture-dislocation of his left shoulder with an ipsilateral segmental fracture of his clavicle ([Figs. 10](#) and [11](#)). Multiple other injuries warranted an intensive care unit 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 debridement 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 fixed with an intramedullary screw. The comminution of the GFF necessitated a rim plate in the “nonaccess” posterosuperior quadrant,² therefore the greater tuberosity of the humerus was osteotomized from the bicipital

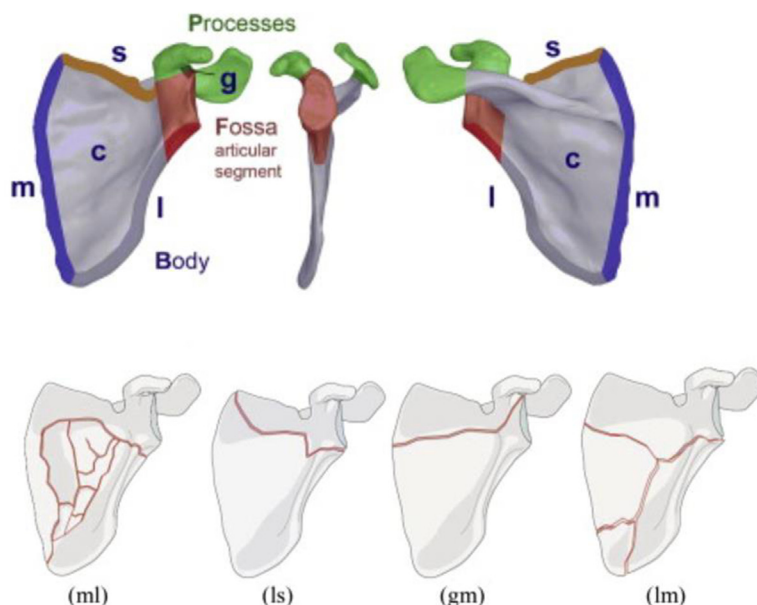


Figure 3 AO glenoid fracture classification. Reprinted from “The AO Foundation and Orthopaedic Trauma Association (AO/OTA) scapula fracture classification system: focus on body involvement” by Audigé et al., 2014, Journal of Shoulder and Elbow Surgery, 23(2), p. 186-196. Copyright 2014, by the Journal of Shoulder and Elbow Surgery Board of Trustees.³

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 supra-scapular 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 maintaining glenohumeral joint stability.

Serial postoperative X-rays are shown in Figure 14.



Figure 4 Case 1: preoperative CT of the right scapula. CT, computed tomography.

At 17 months postsurgery, Case 2 re-presented with a sinus in his posterior scapular scar. Culture grew *Serratia marcescens* and was successfully treated with debridement and removal of the acromion metalware. Computed tomography scans at 3.5 years, after posterior metalware removal, are shown in Figure 15. Active range of motion at 5 years is seen in Figure 16. His Constant score is 77 and at this point in time was 77 and his ASES score was 83.

Discussion

In 1991, Soslowky et al²³ found that the maximal thickness of the glenoid cartilage was 3.81 ± 0.72 mm. Goss therefore recommended that for GFF a relative indication for surgery was an intra-articular step of 5 mm.⁹ We can only find one study on outcomes for nonoperative treatment of GFF, published by Königshausen et al.¹⁶ In their series of 24 patients with Ideberg-Goss type II-VI GFF, they found that patients with intra-articular displacement of >5 mm do significantly poorer than those with less displacement (Constant scores 59 and 88 respectively, $P < .001$).¹⁶ In a case series of 84 scapula fractures with 29 intra-articular GFF, Cole et al⁴ recommended 4 mm intra-articular displacement as the maximal cut-off for nonoperative management.

From our literature search looking at outcomes with various treatments of GFF there are a total of just 16 Ideberg-Goss type VI/AO F2(4) GFF.^{1,4,15-17,20} 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.^{8,9} There were only 2 cases with reported outcomes on nonoperative treatment specific to Ideberg VI/AO F2 GFF in the paper by Königshausen et al.¹⁶ One case developed grade III OA, the other was not commented on.

Other options for management include acute reverse total shoulder replacements, though all studies found relating to this had elderly patients of at least 63 years old.⁶ Our 2 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 nonoperatively, 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 nonunion with chronic humeral dislocation. Hence in these cases, the decision was to proceed to fixation.

Lin et al¹⁷ conducted a retrospective study of ARIF vs. ORIF for GFF and found equivocal results. Two Ideberg-Goss type VI GFFs were in the ARIF group, one was in the ORIF group, no images or subgroup analyses were conducted on these 3 cases. Although the senior author has performed ARIF on Ideberg-Goss type Ia and III GFF, he felt that these 2 cases were beyond his capabilities for ARIF.

Gauger and Cole⁷ conducted a retrospective review which recommended minimally invasive surgery for GFF within 30 days of injury but were of a simple nature only and therefore seemed less applicable to our cases.

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.⁸ Kavanagh et al¹⁵ reported 10 cases of ORIF for GFF (2 of which were a stellate pattern) and described a posterior approach via reflection of the posterior deltoid off the

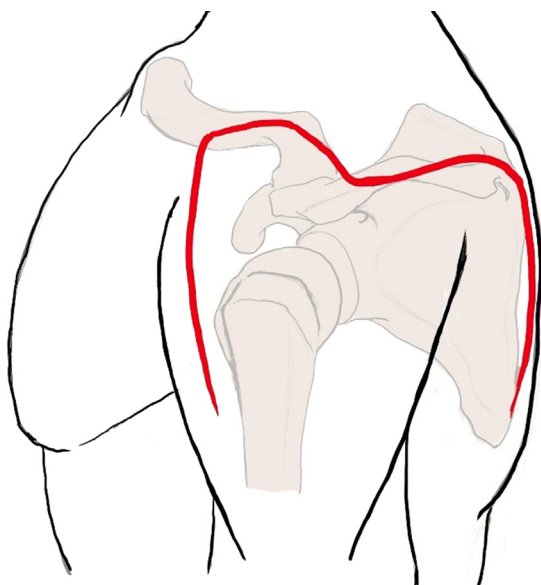


Figure 5 Skin incision for Deltoid Takedown approach.

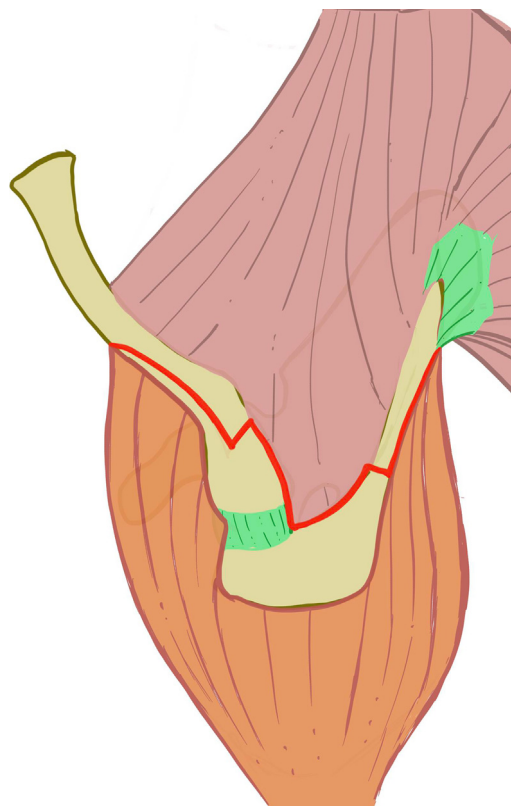


Figure 6 Clavicular and acromion osteotomies.

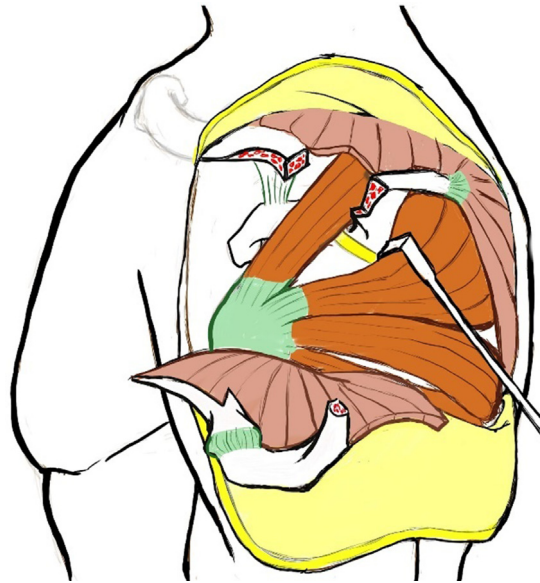


Figure 7 Inferior reflection of deltoid around insertion.

scapular spine, dissecting through the Judet interval with an infraspinatus tenotomy. They reported that the anterior approach to these fractures was exceptionally difficult and would not recommend it. Nork et al²⁰ reported 17 cases of Ideberg-Goss type

IV, V, and VI GFFs (with 5 Ideberg-Goss type VI) treated with a similar posterior approach but without infraspinatus tenotomy and commented that control and reduction of the cephalad/anterior articular segment is most difficult. Even without an Ideberg-Goss

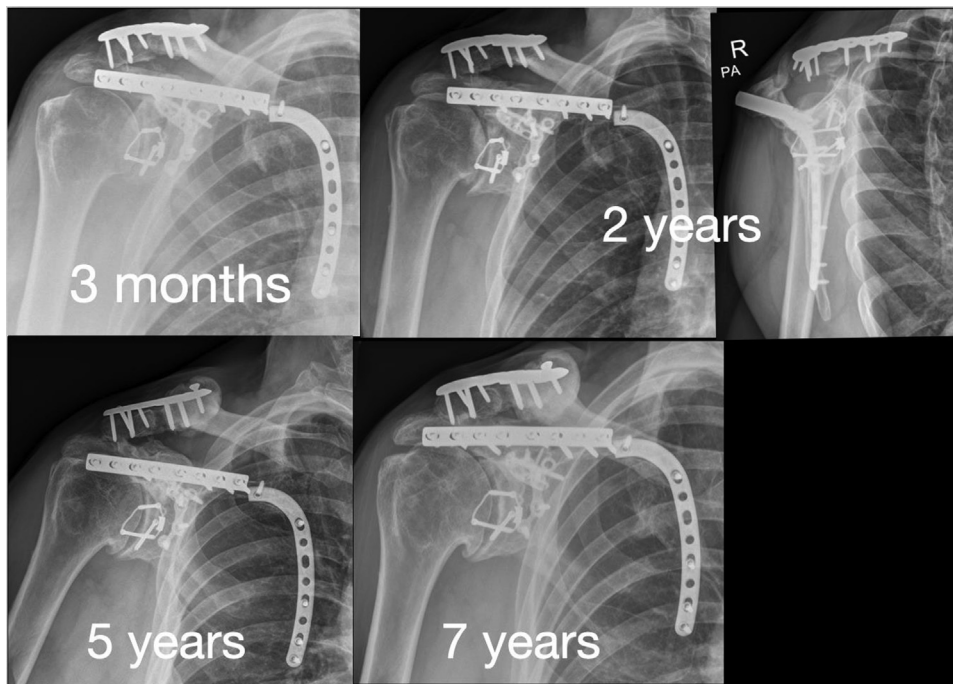


Figure 8 Case 1: serial postoperative X-rays.

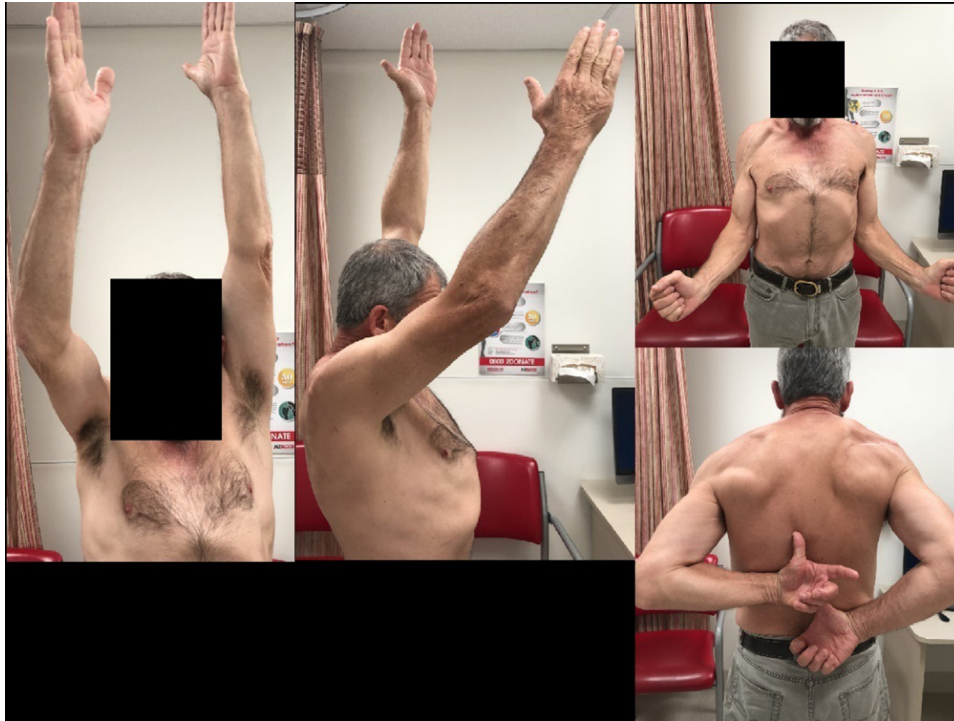


Figure 9 Case 1: clinical range of motion 7 years postop.

type VI within their series of 31 ORIF of GFF, Mayo et al¹⁹ reported 2 of the cases requiring a combined anterior (deltopectoral) and posterior (Judet) approach. 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 al¹ reported on 33 patients with ORIF of GFF, 16 of which had 3 intra-articular fragments and 2 of which had 4 intra-articular fragments and commented that 5 cases needed combined anterior-posterior approach.

Ao et al² identified that even with a combined anterior and posterior (Judet) approach there was a posterosuperior “nonaccess” zone between the coracoid and spinoglenoid notch. The Deltoid Takedown approach described in this text allowed access to all parts of the 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.^{10,15,17,19,21}

Reported complications from ORIF of GFF are few. Schandelmaier et al,²¹ in a series of 22 cases of Ideberg-Goss type II-V



Figure 10 Case 2: preoperative CT of the left scapula. (*) Labels associated with segmental acromial and clavicular fractures. CT, computed tomography.

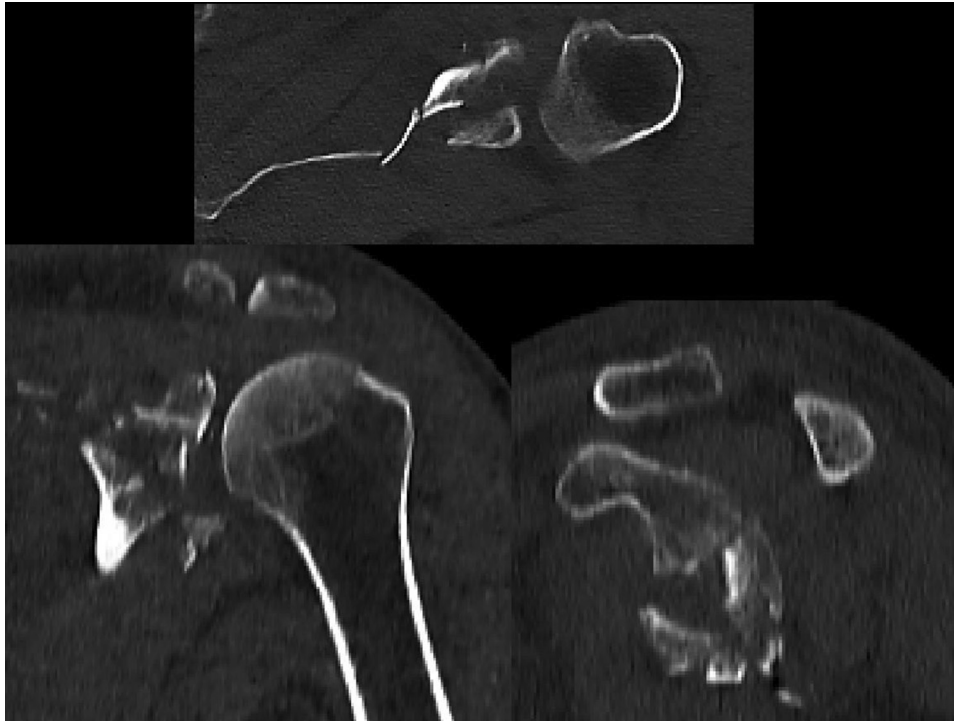


Figure 11 Case 2: preoperative CT of the left scapula. *CT*, computed tomography.

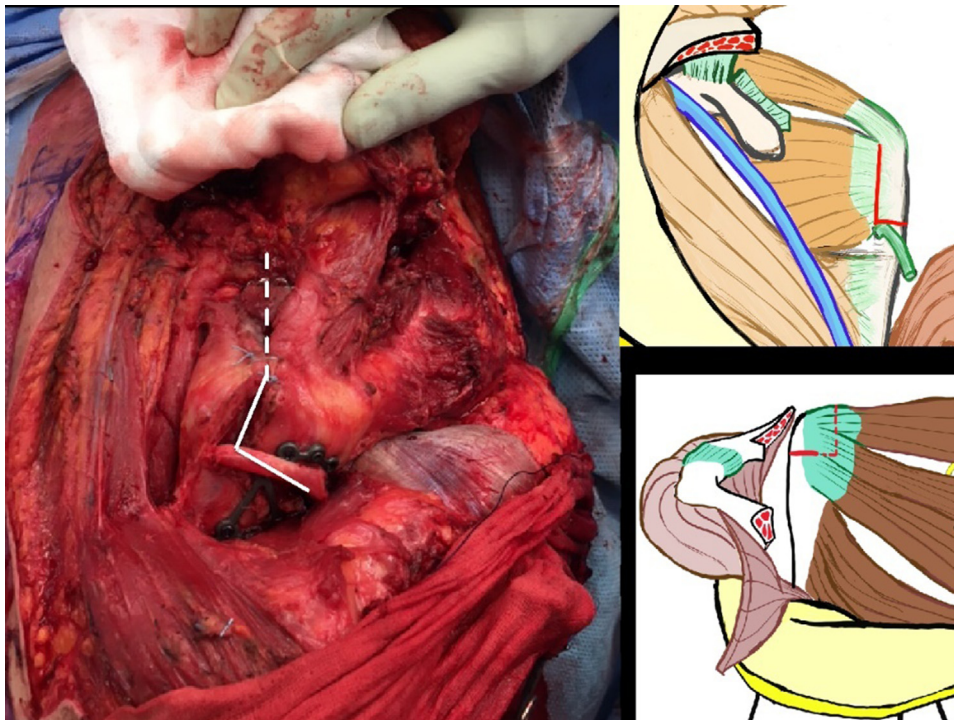


Figure 12 View with the deltoid reflected distally. Greater tuberosity osteotomy from bicipital groove to Judet interval. Dotted line depicts anterior rotator interval. Solid line depicts osteotomy.

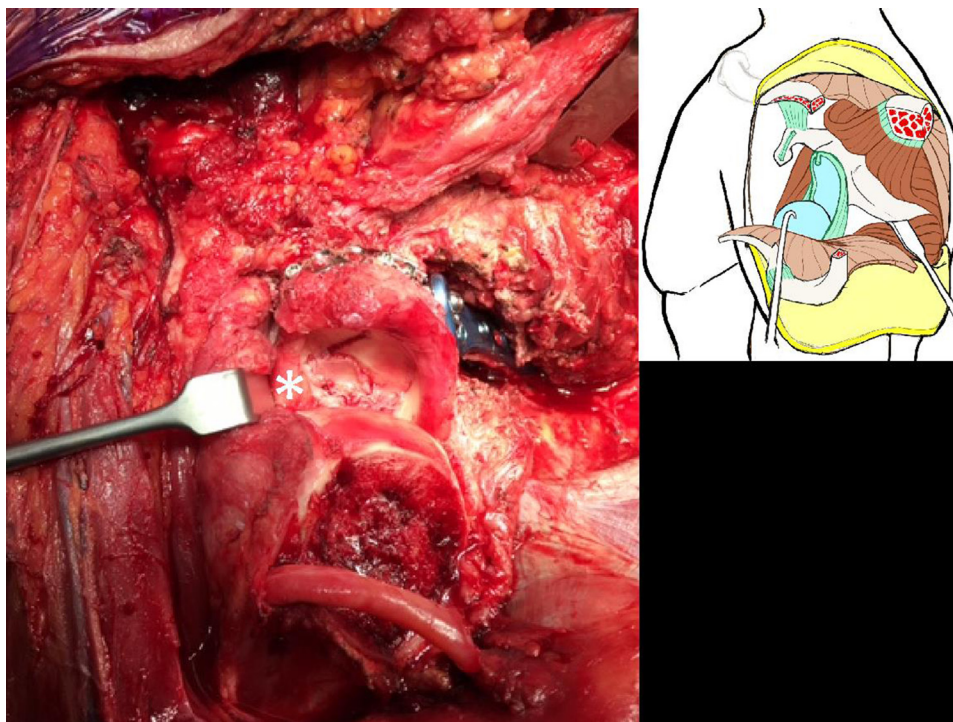


Figure 13 Case 2: view of the glenoid. (*) Labels preserved anterior band of the inferior glenohumeral ligament.

GFF, reported 2 cases (9%) of deep infection. Kavanagh et al¹⁵ reported a single case (10%) of heterotopic ossification in a patient with concurrent closed head injury in a series of 10 patients. Anavian et al¹ in a series of 33 intra-articular GFF who underwent ORIF reported 1 case (3%) of intra-articular screw penetration, 1 case of stiffness requiring postoperative manipulation under anesthesia, and 1 case of symptomatic ectopic bone requiring resection. Mayo et al¹⁹ reported 2 cases of denervation of infraspinatus secondary to inferior branch of the 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 postoperation, likely to have seeded from his ipsilateral open forearm fracture infection while in hospital.

In total, we found 14 cases of ORIF for Ideberg-Goss type VI GFFs mentioned in the English literature.^{1,4,15,17,20} We could not find any published imagery, surgical technique, or 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 access to 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) GFF when these fractures are deemed not suitable for “willful neglect” or acute shoulder replacement. It is particularly useful when the fracture comminution involves the posterosuperior zone, which has previously been described as having poor access even when using a combined anterior-posterior approach.

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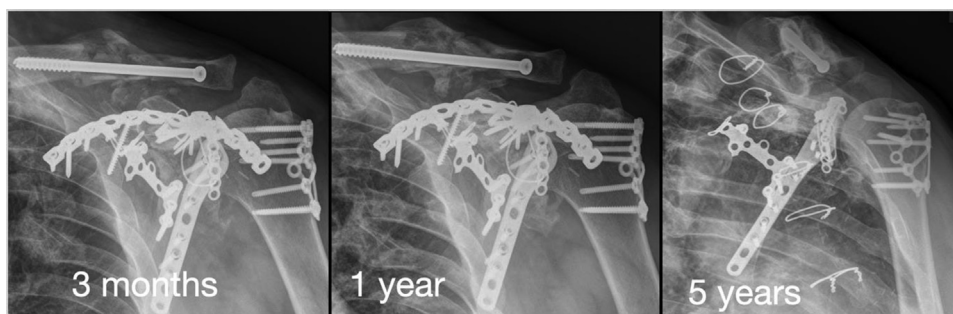


Figure 14 Case 2: serial postoperative X-rays.

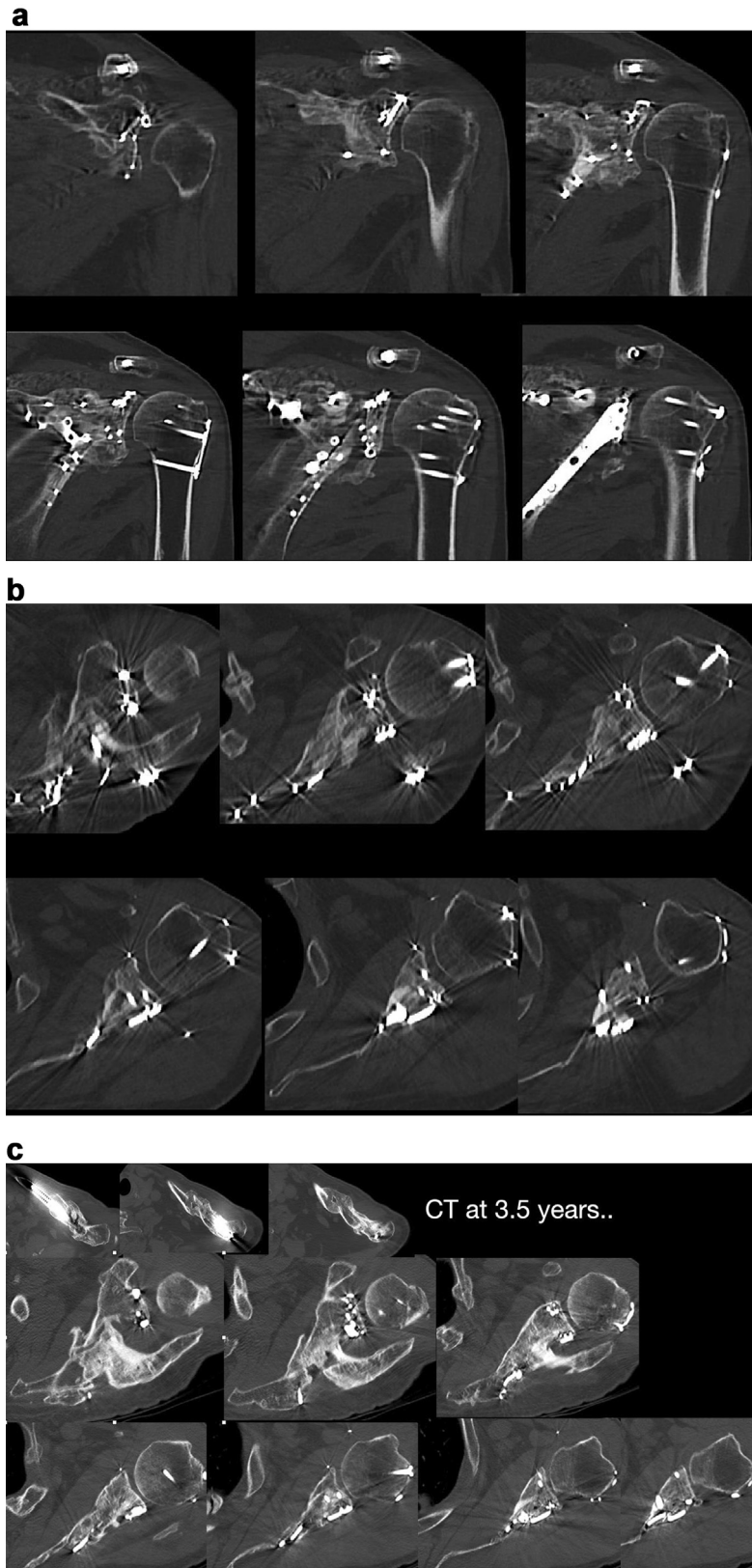


Figure 15 (a-e) Case 2: CT scan at 3.5 years postoperative after removal of posterior metalware. CT, computed tomography.

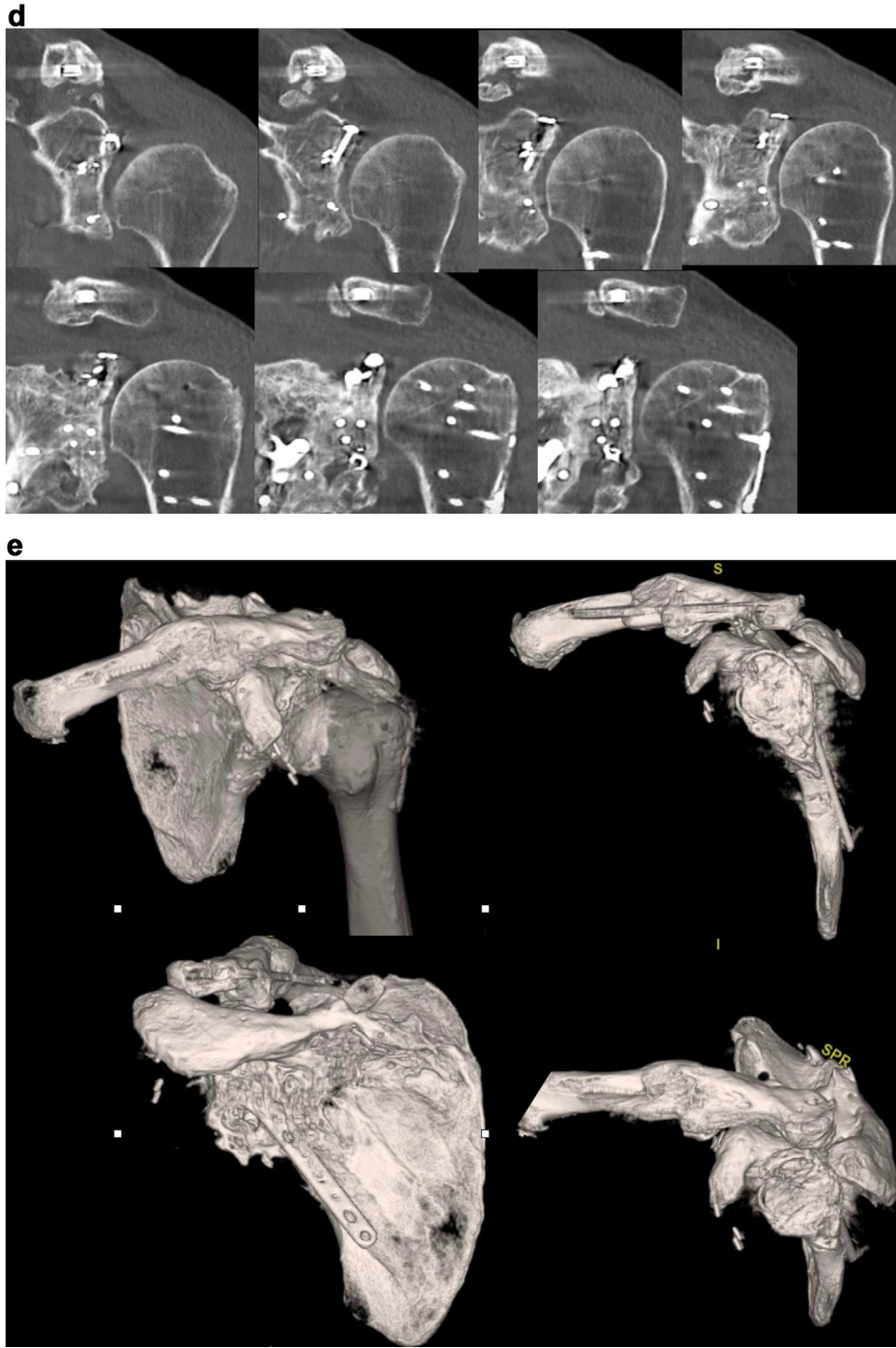


Figure 15 (continued).



Figure 16 Case 2: clinical range of motion 5 years postop.

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