Acromionectomy and Deltoid Deficiency

A Solution

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Abstract Deltoid insufficiency after iatrogenic or traumatic acromionectomy results from separation of the deltoid from its origin and mechanical fulcrum. Subsequent retraction of the tendon and formation of subdeltoid adhesions to the cuff and humerus result in stiffness and pain. We evaluated clinical outcomes of patients treated with autogenous tricortical iliac crest bone graft combined with deltoid reconstruction or deltoidplasty for deltoid insufficiency after acromionectomy. We retrospectively reviewed four patients, three males, and one female treated with deltoidplasty reconstructions as revision surgery. Their mean age was 41 years, and the minimum followup was 41 months (mean, 50 months; range, 41–66 months). There were three work-related injuries. Outcomes evaluated were pain relief (visual analog score), American Shoulder and Elbow Surgeons score, cosmesis, and complications. The mean pain score improved from 8 (range, 3–10) preoperatively to 1 (range, 0–3) postoperatively. The mean American Shoulder and Elbow Surgeons score improved from 31 ± 14 to 68 ± 13 . One patient required revision deltoidplasty for abductor weakness. Three patients underwent hardware removal. One patient who underwent concurrent latissimus dorsi transfer had limited

functional improvement but decreased pain. Two patients had improved cosmesis. All had CT scans with three-dimensional reconstructions documenting union. All patients stated they would undergo the procedure again.

Level of Evidence: Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Deltoid insufficiency in the setting of acromionectomy is a rare condition. The loss of the acromion weakens the deltoid by separating the muscle from its origin and mechanical fulcrum. Retraction of the tendon and formation of subdeltoid adhesions to the cuff and humerus result in stiffness and pain [11]. In 1971, Hammond [6] reported his clinical experience of 90 acromionectomies for chronic tendinitis, emphasizing secure reattachment of the deltoid to the stump of the acromion. With 93% of patients achieving good to excellent results, acromionectomy was accepted as a treatment option for disabling tendinitis. However, in 1981, Neer and Marberry [9] studied 30 patients who had radical acromionectomies performed. Twenty-seven had persistent pain, all had marked weakness of the shoulder, and none could raise their arm above horizontal.

Management of postoperative deltoid muscle deficiencies has received little attention [2, 5, 10, 12]. Furthermore, deltoid insufficiency after iatrogenic or traumatic acromionectomy often has catastrophic consequences for shoulder function; reconstructive procedures for deltoid insufficiency and acromionectomy are seldom described in the literature [1, 8, 9, 12].

In a study of 24 patients who underwent rotational deltoidplasty reconstruction for postoperative deltoid

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disruption, eight had prior lateral acromionectomies performed and they all had uniformly poor results [12]. The need for reconstruction of the deltoid origin thus was suggested. Acromion reconstruction using bone graft has since yielded promising results [1, 8].

The deltoid muscle and rotator cuff work in tandem to produce smooth, coordinated movement of the glenohumeral joint. Reconstruction of the acromion and restoration of the deltoid origin result in restoration of the lever arm by establishing a new origin for the important anterior and middle portions of the deltoid. The purpose of this study was to evaluate the clinical outcomes (pain relief, range of motion [ROM], cosmesis, and complications) of four patients treated with autogenous tricortical iliac crest bone graft combined with deltoidplasty (TID) for deltoid insufficiency after acromionectomy.

Materials and Methods

This study is a retrospective review of four patients who were treated with the TID procedure. All underwent revision surgery for combined acromial and deltoid insufficiency (Figs. 1–4).

Their mean age was 41 years (range, 24–62 years), with three males and one female, and two dominant and two nondominant extremities treated (Table 1). There were three work-related injuries. All patients had their index procedure performed elsewhere. All patients were disabled. One patient had a failed prior open reduction and internal fixation of an acromion fracture. Three patients had extensive therapeutic acromioplasties performed in combination with other procedures (Table 1), which resulted in iatrogenic acromionectomy and deltoid insufficiency. The former was confirmed by preoperative CT scan (Fig. 3). Three patients had open rotator cuff repairs and one patient

had an open Bankart repair in conjunction with failed open reduction and internal fixation of a traumatic acromion fracture.

American Shoulder and Elbow Surgeons (ASES) scores, pain scores, and ROM were obtained preoperatively and postoperatively (Table 2). The mean preoperative ASES score was 31 (range, 15–53). The mean preoperative pain score was 8 on a visual analog scale of 0 to 10 (range, 3–10). The mean preoperative forward elevation, abduction, and external rotation were 61°, 70°, and 25°, respectively.

All index procedures were performed by the principal investigator of this study (JJPW) between May 2002 and July 2004. All patients underwent TID reconstruction with

Fig. 2 A three-dimensional CT scan of the same patient as in Figure 1 shows a traumatic acromionectomy.

Fig. 1 This radiograph shows a traumatic acromionectomy in a 24-year-old man, who had a failed open reduction and internal fixation of the acromion.

Fig. 3 This CT scan illustrates how an extensive acromioplasty may result in iatrogenic acromionectomy and loss of the deltoid's fulcrum (see Figure 4).

Fig. 4 This diagram illustrates loss of the anterior acromion resulting in detachment of the deltoid muscle from its mechanical fulcrum.

a tension band technique (Figs. 5, 6). In one patient, a massive revision rotator cuff repair was performed in addition to a latissimus dorsi tendon transfer for augmentation of the rotator cuff repair as described by Gerber et al. [4]. Fascia lata graft was harvested from the thigh to augment reconstruction of the latissimus transfer. Deltoid reconstruction also was performed in this patient.

Two patients had pain catheters placed intraoperatively. Three patients underwent regional interscalene block with supplemental general anesthesia; one patient had general anesthesia only.

After adequate anesthesia was obtained, patients were placed in the beach chair position so that the anterior and posterior aspects of the shoulder were fully exposed and the ipsilateral hip was elevated and exposed by placing a folded blanket underneath the buttocks. Tricortical iliac crest bone graft was obtained approximately 10 cm posterior to the anterior-superior iliac spine. All grafts measured approximately 3 cm in length and 2 cm in depth. After sharp dissection and exposure of the remaining acromion, the deltoid was split in line with its fibers. The deltoid split was extended, in a subperiosteal fashion, medially and laterally from the superior aspect of the acromion. This subperiosteal dissection extended medially

to the acromioclavicular joint and laterally to the antero-lateral edge of the acromion. Dense adhesions were released from the superficial and deep surfaces of the deltoid. This technique kept the deltoid tissue in continuity. A rongeur was used to freshen the anterior edge of the acromion.

The graft then was shaped and fashioned with a saw (MicroAire Surgical Instruments, Inc, Charlottesville, VA) to obtain a rigid fit against the acromion. Two Kirschner wires from the cannulated 4.0-mm screw set were drilled through the graft on the back table. Drill holes also were placed through the top of the acromion posteriorly, laterally, and anteriorly. The graft then was apposed to the acromion stump and the two Kirschner wires were drilled across the spine of the scapula.

After cannulated 2.7-mm drilling and tapping over the Kirschner wires, two 40- to 50-mm long screws with long threads were used to fix the graft in place. Number 2 Ethibond® sutures (Ethicon, Inc, Somerville, NJ) were placed around the neck of each screw before final advancement. Eighteen-gauge wires then were placed through the screws and tightened securely over the top of the acromion in a figure-of-eight fashion (Fig. 5).

The arm then was flexed to 90° to release tension from the deltoid, and the deltoid was repaired with the anchored Number 2 Ethibond® sutures and Number 5 FiberWire® (Arthrex, Naples, FL) placed through the posterior, lateral, and anterior graft drill holes. Horizontal mattress and Mason-Allen stitch configurations were used (Figs. 6–8).

Postoperatively, patients wore a brace at 40° abduction for 6 weeks. No adduction motion was permitted. Gentle active and passive ROM exercises began at 6 weeks under careful supervision.

Minimum followup was 41 months (mean, 50 months; range, 41–66 months). Outcomes evaluated were ASES scores, pain relief (visual analog scale), ROM, cosmesis, complications, and query regarding whether patients would undergo the procedure again if given the choice. The final ROMs, pain scores, and ASES scores represent values obtained at the most recent followup, after additional surgeries were performed.

Table 1. Patient demographics

Patient	Gender	Age (years)	Followup (months)	Anesthesia	Previous procedure
1	Male	62	41	Regional + general	Open RCR, acromioplasty
2	Male	36	66	Regional + general	Open RCR, acromioplasty, SLAP repair
3	Male	24	47	General only	Bankart repair, failed acromion ORIF
4	Female	41	44	Regional + general	Open RCR x3, acromioplasty
Mean		41	50		

RCR = rotator cuff repair; SLAP = superior glenoid labrum lesion; ORIF = open reduction and internal fixation.

Table 2. Preoperative and postoperative pain scores, ASES scores, and ROM

Patient	Pain (VAS)		ASES score		Active elevation (°)		Active abduction (°)		Active ER (°)		Active IR		Abduction strength*		ER strength*		IR strength*	
	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative
1	9	0	32	73	20	45	20	120	20	5	L5	S2	4	4	4	4	4	4
2	10	3	15	45	90	150	80	90	20	40	T10	T12	4	4	5	5	5	5
3	3	0	53	75	120	170	90	110	10	60	T10	T8	5	5	5	5	5	5
4	8	1	22	77	15	160	90	95	50	60	L3	T10	4	5	4	5	4	5
Mean	8	1	31	68	61	131	70	104	25	41			4	4.5	4.5	4.75	4.5	4.75

ASES = American Shoulder and Elbow Surgeons; ROM = range of motion; VAS = visual analog scale; ER = external rotation, IR = internal rotation.

* Muscle strength determined using Oxford Muscle Strength Grading Scale (Grade 0 = no movement, Grade 3 = completely moves body part against gravity, Grade 5 = normal).

Fig. 5 Eighteen-gauge wires are placed through the cannulated screws, which then are tightened securely over the tricortical graft in a figure-of-eight fashion.

Fig. 6 The final construct of acromion reconstruction and deltoid repair in the TID procedure is shown.

Results

Of the four patients who underwent the TID procedure, all had pain relief and improvement of motion (Table 2). The one patient with minimal improvement of function also had a latissimus transfer. All four patients had radiographic documentation of healing by CT scan with three-dimensional reconstruction (Figs. 9, 10). Two patients had persistent cosmetic defects, whereas two had marked improvement in cosmesis. All four patients stated they would elect to undergo the procedure again if given the choice.

The mean followup ASES score was 68 (range, 45–77), improving from 31 preoperatively. The mean followup

Fig. 7 This intraoperative photograph of the TID procedure shows the tension band construct and placement of sutures through drill holes for deltoidplasty.

Fig. 8 This radiograph of the patient in Figure 1 shows acromion reconstruction and deltoid repair with the TID procedure.

Fig. 9 Placement of two cannulated screws to achieve bony union of the tricortical iliac crest graft is seen in this CT scan.

Fig. 10 This three-dimensional CT scan of the patient in Figure 1 with acromion reconstruction and deltoid repair shows healing of the tricortical bone graft.

pain score was 1 (range, 0–3), improving from 8 preoperatively. The mean postoperative forward elevation, abduction, and external rotation were 131°, 104°, and 41°, respectively, versus 61°, 70°, and 25° preoperatively (Table 2).

There were no infections or wound complications postoperatively. Blood loss during surgery was reported as minimal for all patients. Operative time ranged from 2 to 4 hours, with the longest time corresponding to the patient who underwent the latissimus dorsi transfer concomitantly.

Two of four patients did not return to work postoperatively, a 62-year-old lobsterman (who underwent concomitant latissimus transfer) and a 36-year-old grocery store employee. The latter had diminished, albeit improved, deltoid function postoperatively. Revision deltoid repair was performed 10 months after the index procedure for partial lateral detachment. The patient also reported hardware prominence and had difficulty with overhead activity with a positive Hawkins impingement sign on physical examination. Thus, concurrent removal of hardware and arthroscopic subacromial decompression were performed at the time of revision deltoid repair. Symptoms of hardware prominence and shoulder impingement subsequently resolved.

The remaining two patients ultimately returned to work. The 41-year-old patient may have had impingement develop postoperatively secondary to acromial overgrowth; the patient had difficulty with overhead activity and had a positive Hawkins impingement sign on physical examination. The patient also reported hardware prominence. Her previous operations included an arthroscopic superior glenoid labrum lesion repair, a revision open rotator cuff repair, and an acromionectomy. Nine months after TID reconstruction, the patient underwent concurrent removal of hardware and arthroscopic subacromial decompression. Symptoms of hardware prominence and shoulder impingement subsequently resolved. She returned to work

as an assistant manager at a rental car agency on light duty. Finally, the 24-year-old patient reported hardware prominence and had it removed 18 months postoperatively; his body habitus was markedly ectomorphic. He returned to his profession in architecture design on a full-time basis.

Discussion

Deltoid insufficiency after iatrogenic or traumatic acromionectomy results from separation of the deltoid from its origin and mechanical fulcrum. Subsequent retraction of the tendon and formation of subdeltoid adhesions to the cuff and humerus result in stiffness and pain. We evaluated the clinical outcomes (pain relief, ROM, cosmesis, and complications) of four patients treated with the TID procedure for deltoid insufficiency after acromionectomy.

Limitations of this study include its retrospective design, small sample size, and its relatively short duration of followup. The fact that all TID procedures were performed by the principal investigator of this study within 2 years is important in light of the rarity of its clinical indication.

The practice of radical acromionectomy for impingement syndrome has been abandoned given its deleterious effect on the deltoid [9, 12]. Poor function associated with deltoid disruption after shoulder surgery generally is accepted [12]. In a study in which 24 patients underwent direct repair or rotational deltoidplasty reconstruction of a detached muscle origin, poor outcomes were associated with a prior lateral acromionectomy, involvement of the middle deltoid, a massive rotator cuff tear, and a residual postoperative defect larger than 2 cm. In select cases, repair or deltoidplasty improved function and pain [12].

In our study, all four patients had severe pain and major functional deficit. In addition to acromionectomy and deltoid insufficiency, one patient had a chronic massive rotator cuff tear requiring a latissimus dorsi-deltoid reconstruction, and another had symptoms of residual impingement before surgery. These patients compare well with others studied after deltoid disruption [3, 8, 9, 12]. Two of four patients included in this study are permanently disabled as a result of their shoulder impairment. Notably, these were workers compensation-related injuries.

The mean ASES score and pain score improved after the TID procedure, and there was a trend for improved ROM. These results compare favorably with results from similar studies [1, 8]. In one study, 10 patients were treated with autogenous tricortical iliac graft and deltoid reconstruction. The University of California-Los Angeles shoulder scores improved from a mean of 6.6 preoperatively to 26.3 postoperatively [8]. However, patients in this study were followed by plain radiographs, as CT scans and MRIs were not readily available [8]. An advantage of our study is that

patients underwent CT scans preoperatively and postoperatively. All four patients in our study had documented evidence of tricortical bone graft union by CT scan (versus radiographs).

The 41-year-old patient in our study may have had impingement develop postoperatively secondary to acromial overgrowth, highlighting the exuberant healing potential of autogenous tricortical iliac crest bone graft. During the first several months after surgery, the patient reported progressive symptoms of impingement and difficulty with overhead activity. On arthroscopic examination, acromial overgrowth was observed and subsequent arthroscopic decompression led to relief of her symptoms. Clinical awareness of this phenomenon should be heightened postoperatively. The use of CT scans to evaluate postoperative healing and graft incorporation also might facilitate identification of this potential complication.

Notably, three of four patients had their hardware removed postoperatively. The tension band technique is well described for treatment of symptomatic os acromiale [7] and its application to the TID procedure seems justified given that all patients in this study achieved union. However, patients should be warned of the likelihood of having their hardware removed. All associated symptoms resolved in patients who had hardware removal.

Deltoid insufficiency after acromionectomy is a difficult clinical problem with historically poor outcomes after surgical reconstruction. Although the clinical outcomes in this series of patients treated with the TID procedure will need to be validated with a larger series of patients, the early results for this procedure indicate it may hold promise for improving shoulder function in this patient population.

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