Functional outcome of open acromioclavicular joint stabilization for instability following distal clavicle resection

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ABSTRACT

Background: Acromioclavicular joint instability following distal clavicle resection can result in considerable pain and dysfunction.

Method: We present a review of 13 patients who underwent ACJ stabilization following one or more distal clavicle resection procedures.

Results: The mean Quick DASH and CM scores were 26(0–57) and 73(46–100) respectively. All but one patient reported an improvement in the pain component of their CM score and in the work component of the Quick DASH score.

Discussion: Open ACJ stabilization to treat instability following distal clavicle resection resulted in improved functional scores, pain scores and facilitated return to work in most patients.

Level of evidence IV.

1. Introduction

Arthroscopic distal clavicle resection is a common procedure for the management of refractory pain arising from the acromioclavicular joint (ACJ) due to degenerative arthritis. Clinical results are good to excellent in over 85% of patients,¹ however a small subset of patients may experience persistent post-operative discomfort arising from the ACJ. The cause may be inadequate resection, incorrect pre-operative diagnosis, other co-existing shoulder pathology or over-resection leading to instability. Biomechanical studies have demonstrated that the ACJ capsular ligaments, in particular the superior and posterior components, are responsible for up to 50% of the restraint to anterior translation and 90% restraint to posterior translation of the distal clavicle.^{2,3} At higher loads, the conoid ligament contributes 60% resistance to superior translation with the trapezoid ligament providing the primary restraint to axial compression of the clavicle on the acromion. When performing distal clavicle resection, greater than 10mm excision may violate the superior ACJ capsular ligaments,⁴ that can lead to excessive AP motion of the distal clavicle and encroach on the trapezoid ligament.⁵ A significant increase in anterior, horizontal translation of the distal clavicle can be seen following a 10mm resection and is further exacerbated by sectioning the ACJ capsular ligaments, whereas posterior translation significantly increases following a 10mm resection only after sectioning of the ACJ ligaments.⁶

Gross instability from over aggressive distal clavicle resection may be diagnosed on physical and radiographic examination but more subtle instability in the presence of conservative resection margins is difficult to diagnose clinically. As such symptomatic ACJ instability following distal clavicle resection may be an underappreciated entity, which is reflected by the paucity of data regarding this condition.

The aim of this study was to describe the results of open ACJ stabilization in patients with symptomatic instability following distal clavicle resection, in order to highlight the existence of this uncommon condition and provide data on the clinical outcome following stabilization.

2. Materials and methods

Thirteen patients (8 male, 5 female) were prospectively followed up having undergone open ACJ stabilization for chronic pain and dysfunction following one or more (range one to three) prior distal clavicle resection procedures. Mean age was 41 years old (range 18–64). Mean follow-up was 28 months (12–62 months).

All patients had a preceding arthroscopic distal clavicle resection. Four patients had a second procedure (arthroscopic or open distal clavicle resection), and two of these patients had a third procedure, which was an open distal clavicle resection in both cases. Nine patients reported a history of a preceding traumatic shoulder injury prior to their

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initial presentation and before any surgery had been performed. Mean time to stabilization from the original procedure was 25 months (6–80 months). All patients underwent a period of non-operative management including analgesia and physiotherapy. Diagnostic local anesthetic injections were performed in all patients and one patient underwent a period of pain team management prior to operative intervention.

Diagnosis of ACJ instability was made on clinical examination and a combination of injections, radiographs, MRI and dynamic ultrasound scan (USS). Instability was defined as painful, clinically reproducible increased translation of the distal clavicle as compared to the opposite shoulder in horizontal and/or vertical directions clinically and on dynamic ultrasound scanning, where possible. Residual bony impingement was excluded with further imaging. Six of thirteen patients had pre-operative MRI scans available for review. One was reported as normal whilst five reported increased signal or edema in the lateral clavicle, acromion or acromioclavicular joint in general. Five patients underwent dynamic USS assessment in clinic by the senior author. Increased mobility of the distal clavicle was found relative to the contralateral side in four patients whilst in one case no difference was found.

2.1. Surgical technique

Surgery was performed in the beach chair position through a bra-strap incision. The delto-trapezial fascia was intact in all patients. This was opened longitudinally with a vertical extension in the line of the deltoid fibres towards the coracoid tip. The posterior superior capsular-ligamentous tissues were found to be either attenuated or absent in all patients. When present these were split and reefed around the reconstruction at the end of the procedure. The senior author prefers the use of a synthetic ligament as it avoids donor site morbidity and provides immediate stability over biologic grafts due to its relative stiffness and reduced likelihood of elongation. In 12 patients, reconstruction was performed using a polyethylene terephthalate synthetic ligament (Ligament Augmentation & Reconstruction System, LARS France), and were anatomic coracoclavicular ligament reconstructions, as per the manufacturer technique with a modification to improve anterior posterior stability of the ACJ.⁷

The LARS ligament graft was passed under the coracoid from medial to lateral. The lateral limb was passed through a 3.5mm drill hole through the clavicle from anterior-inferior to posterior-superior. The medial limb was passed through a 3.5 mm drill hole in the posterior-inferior to anterior-superior direction. The ligament is held with 4.7 mm interference screws in the tunnels. The senior author's modification was performed in 11 patients. This involved taking the medial

and lateral limb and passing one under the coracoid again then suturing it to the other in a figure-of-eight configuration, effectively doubling the repair and adding an anterior translation force to the construct. One patient had an additional drill hole made in the acromion to pass the graft across the ACJ. In one case a modified Weaver Dunn procedure was employed due to a 4 cm of distal clavicle defect. The coracoclavicular ligament (CAL) was released from the acromion with a sliver of bone, and whipstitched with a braided non-absorbable suture. Two drill holes were made in the superior clavicle, and the CAL was shuttled into the canal of the clavicle by passing the whipstitches through the drill holes. The sutures were then tied over the bone bridge. This was reinforced with two suture anchors in the clavicle and multiple non-absorbable sutures looped around the coracoid and tied to each other to provide early mechanical stability while the CAL graft incorporated.

2.2. Post-operative rehabilitation

During the first three weeks a shoulder immobilizer is worn with isometric rotator cuff exercises, passive external rotation as pain allows and flexion to 90° with the elbow supported. Closed chain exercises are performed below 90° of abduction and flexion. After three weeks the patient is weaned off the sling. Abnormal movement patterns are corrected, isometric cuff exercises are progressed to open chain active and resistance exercises. From week six dynamic exercises, active exercises through a full range of motion, cuff and deltoid strengthening and open chain exercises are progressed. Load bearing progresses as tolerated under therapist supervision.

2.3. Data analysis

Outcome data was collected prospectively using the disabilities of arm, shoulder and hand (Quick DASH) score and the Constant Murley (CM) score. All patients had post-operative outcome data collected. Eight patients had pre-operative outcome scores available for comparison. Categorical demographic data are presented using frequencies and percentages. Continuous variables are presented using means and standard deviations (SD). Comparison between groups was performed using the independent students t test for parametric and Mann Whitney U test for non-parametric data. Paired tests were used when appropriate. Paired tests performed for all tests were two-sided with the level of significance set at 0.01.

Table 1
Summary of results.

Age	Sex	Prior ops	F/U months	CM		Quick DASH		Quick DASH Pre-op			Quick DASH Post-op		
				Pre	Post	Pre	Post	Work	Sports	Pain	Work	Sports	Pain
27	M	1	13	52	89	24.2	2.3	Mod	U	Severe	N	N	None
50	M	2	12	18	77	38.6	27.3	Mod	U	Severe	Mild	Mod	Moderate
49	F	3	24	15	71	47.7	18.2	Mod	No sport	Moderate	Mild	Mild	Mild
59	M	1	53	24	82	34.1	0	No work	Mod	Moderate	No work	N	None
64	F	1	59	36	46	25.0	56.8	U	U	Extreme	S	S	Moderate
24	F	2	62	34	66	66.7	27.3	S	S	Severe	N	Mild	Moderate
38	M	2	12	46	58	38.6	45.5	Mild	Mild	Moderate	S	Mod	Severe
48	M	1	19	42	74	43.2	27.3	U	U	Moderate	Mild	Mod	Mild
49	M	1	12		69		47.7				U	U	Severe
39	F	1	16		60		31.8				Mild	Mild	Moderate
18	F	1	15		93		11.4				Mild	Mild	Mild
44	M	3	38		66		47.7				S	S	Severe
30	M	1	29		100		0				N	N	None

CM, Constant Murley score; DASH, disabilities of arm, shoulder and hand score; Work, Work module 'Did you have difficulty doing your work because of arm, shoulder or hand pain?'; Sport, Sport / performing arts module 'Did you have difficulty playing your instrument/sport because of pain?'; Function, use of arm for painless activities; U, unable; S, severe difficulty; Mod, moderate difficulty; Mild, mild difficulty; N, no difficulty.

3. Results

The overall mean Quick DASH score and the CM score were 26 (range 0–57, SD 19.36) and 73 (range 46–100, SD 15.07) respectively (Table 1). In the eight patients who had pre-operative outcome scores measured, there was a significant improvement in the mean CM score (33–70, $p = 0.001$). The mean Quick DASH score also improved but was not statistically significant (40 to 25, $p = 0.12$).

All but one patient reported an improvement in the pain component of their CM score (88%) and in the work component of the Quick DASH score. Strength improved in all patients with both pre and post-operative scores. Eight of thirteen patients achieved maximum strength on the CM score. The remaining five patients achieved 75% maximum strength. Three of the patients that did not regain full strength had developed a frozen shoulder requiring treatment. The other two patients were the oldest in the cohort at 59 and 64 years of age. None of the five patients who had more than one previous operation were pain free at an average 34 months follow-up. However having a higher number of previous procedures did not affect ROM adversely. There was no significant difference in the outcome between those with an injury and those without. There was no correlation between age and sex on the outcome of surgery.

Ten patients returned to sport with no, mild or moderate problems. One patient who returned to sport with mild symptoms was an olympic standard archer. Of the three patients who returned to sport with no problems, one was a keen golfer, one an amateur rugby player and the third a professional rugby player who continues to play in the English premiership three years after his procedure.

4. Complications and re-interventions

One patient who had undergone three previous operations developed a frozen shoulder that required treatment with an arthroscopic release following two unsuccessful hydrodilatation procedures. One patient who had received two previous operations developed a frozen shoulder that resolved by six months following the index procedure with physiotherapy alone. This patient had been treated for frozen shoulder following a prior procedure. The third case of frozen shoulder required hydrodilatation. One patient had continued chronic pain. Both of these patients had undergone one previous operation.

5. Discussion

Coracoclavicular ligament reconstruction as a means of ACJ stabilization to treat instability following distal clavicle resection resulted in improved functional scores, pain scores and facilitated return to work and sport in the majority of patients. The biomechanical theory behind CC ligament reconstruction for instability following lateral clavicle resection is based on the likelihood of these ligaments being abnormally stressed as a result of the normal stabilizers of the ACJ being rendered incompetent.

It has been demonstrated that the arthroscopic approach to acromioplasty and distal clavicle resection leads to disruption of the inferior ACJ capsular ligament.⁸ When acromioplasty is coupled with distal clavicle resection a 30% increase in posterior translation has been demonstrated. Subsequent anterior loading has been shown to increase forces measured in the CC ligaments indicating a change in the contribution of these ligaments to resist posterior translation. This increased posterior translation can result in higher pain scores.⁹ Previous biomechanical studies suggest that the clavicular insertion of the superior ligament can be completely removed with as little as 2.6 mm of distal clavicle resection in men and 2.3 mm in women.⁴ When a 5 mm distal clavicle resection is combined with either superior or inferior capsular ligament sectioning, a large increase in distal clavicle motion can result. This motion is a combination of AP, superoinferior translation and rotation.¹⁰ However further investigation suggests that with a

limited arthroscopic resection of 10mm in the presence of intact coracoclavicular ligaments and superior and posterior capsule, only anterior translation was increased. Posterior translation increased only with additional complete ACJ capsule resection.⁶

At a mean follow-up of 28 months all patients with pre-operative scores reported improved pain and strength on the CM score, however it is uncommon for patients to have full resolution of their symptoms. This is likely a sequelae of previous procedures and the chronicity of symptoms (mean 25 months). Although several surgical options have been described for symptomatic ACJ instability following distal clavicle resection, the literature reporting outcomes of such intervention *in vivo* is sparse.^{11–13}

Cadaveric biomechanical analysis demonstrated a 32% increase in posterior translation after ACJ capsular incision and distal clavicle resection was reduced to 13% increase in translation after surgical coracoclavicular ligament augmentation by stitching to the undersurface of the distal clavicle.¹⁴ Capsular repair alone was not effective at limiting posterior translation that was attributed to the likely complete disruption of the clavicular insertion of the superior ACJ capsular ligament. The authors suggest that the additional stabilizing effect of coracoclavicular ligament augmentation maybe of value in patients with previous ACJ separation or in those with chronic posterior instability following distal clavicle resection.

Strauss et al, describe the anatomic CC ligament reconstruction using allograft in the management of failed distal clavicle resection with instability. They describe the use of residual graft material passed laterally to reconstruct the acromioclavicular ligaments and joint capsule however do not report on functional outcome.¹² Nicholson has previously presented the results of ACJ stabilization using a modified Weaver Dunn technique in 19 patients following distal clavicle resection. Excellent results were seen in eight patients, good in ten and unsatisfactory in one patient at a mean follow-up of 2.3 years (range 1–4).¹⁵

The senior author's preferred approach is to perform a coracoclavicular ligament reconstruction using a LARS technique with a modification to reinforce the construct. This acts to pull the clavicle anteriorly as well as increasing the resistance to superior-inferior forces on the clavicle. In each case following this process an assessment was made of the stability in the AP plane. The ACJ capsule was not reconstructed as standard. This may well improve the AP stability of the construct however due to the time delay in operative intervention seen in most patients the tissue quality often precluded satisfactory repair. In several cases the amount of previous bone resection also negatively impacted on this technique.

The number of previous procedures may affect the outcome of this intervention. No patient having received more than one previous operation was pain free at an average 34 months follow-up. Three patients developed a frozen shoulder and one had ongoing pain. It remains unclear why patients would go on to develop a frozen shoulder following this extra articular procedure. Nine of 13 patients (69%) in our cohort had an injury preceding the first procedure. Debski et al, postulated that those patients with a history of trauma may be more susceptible to instability due to an existing partial incompetence of the stabilizing structures which will be exacerbated by distal clavicle resection.⁸ Subtle underlying instability as a result of previous trauma may leave this group of patients susceptible to developing ACJ arthritis. Subsequent distal clavicle resection to treat this may exacerbate instability resulting in post-operative discomfort. In our cohort there was no significant difference in the outcome following CC ligament reconstruction between those with a previous ACJ injury and those without.

Ten patients returned to sport with no, mild or moderate problems. This group included a keen golfer, an olympic standard archer, one amateur and one professional rugby player. This indicates that this technique can produce good results in higher functioning athletes including those involved in contact sports.

Several factors limit the validity of the present study. The variation in management prior to being seen in our service is not accounted for and may impact the outcome of the procedure. The limited number of patients and wide spectrum of functional demand will affect the external validity. Not all patients had pre-operative functional scoring for comparison. In conclusion ACJ stabilization to treat instability following distal clavicle resection resulted in improved functional scores, pain scores and facilitated return to work in most patients including high level athletes. However, it is uncommon for patients to have full resolution of their symptoms. This is likely a sequelae of previous procedures and the chronicity of symptoms.

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Conflict of interest

None.

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