

## Clinical results of coracoacromial ligament transfer in acromioclavicular dislocations: A review of published literature

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### ABSTRACT

Acromioclavicular joint dislocations are common injuries, which typically occur with trauma in young men. Treatment recommendations for these injuries are highly variable and controversial. There are greater than 100 surgical techniques described for operative treatment of this injury. One of the most widely recommended methods of surgical reconstruction for acromioclavicular joint dislocations is to utilize the coracoacromial ligament for stabilization of the distal clavicle. Several modifications of this procedure have been described which have involved adjunct coracoclavicular fixation or fixation across acromioclavicular joint. Although the literature is replete with descriptive papers, there is paucity of studies evaluating the surgical outcome of this procedure. We systematically reviewed the English language published literature in peer reviewed journals (Medline, EMBASE, SCOPUS) and assigned a level of evidence for available studies. We critically reviewed each paper for the flaws and biases and then evaluated the comparable clinical outcomes for various procedures and their modifications. The published literature consists entirely of case series (Level IV evidence) with variability in surgical technique and outcome measures. On review there is low level evidence to support the use of coracoacromial ligament for acromioclavicular dislocation but it has been associated with high rate of deformity recurrence. Adjunct fixation does not improve clinical results when compared to isolated coracoacromial ligament transfer. This is in part because of the high incidence of fixation related complications. Similar results are reported with coracoacromial ligament reconstruction for acute and chronic cases. The development of secondary acromioclavicular joint symptoms with distal clavicle retention is poorly reported with the incidence rate varying from 12% to 32%. Despite this, the retention or excision of distal clavicle did not affect overall clinical results except in the patients with pre existing acromioclavicular joint osteoarthritis who have inferior results with retention of distal end of clavicle. Further well designed clinical trials with validated outcome measures are required to fully evaluate the clinical results of this procedure.

**Key words:** Coracoacromial ligament, weaver-dunn reconstruction, acromioclavicular dislocation, modified weaver-dunn, acromioclavicular stabilization

### INTRODUCTION

Acromioclavicular joint (ACJ) injuries have been recognized since the time of Hippocrates and the treatment has ranged from skillful neglect to various forms of operative stabilization. Current treatment recommendations are based on the severity

of injury. Non operative treatment is advised for acute minor injuries,<sup>[1,2]</sup> whereas surgical stabilization is generally recommended for the more severe separations.<sup>[3]</sup> The treatment of intermediate separations or dislocations is controversial with available literature recommending non operative management in most cases.<sup>[2,4,5]</sup> Early surgical intervention for intermediate

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separations is a common recommendation in a select subgroup of patients (heavy manual laborers, overhead workers and elite sportsmen who require the ability to throw) for optimum outcome.<sup>[3,5-8]</sup> This is supported by the literature findings that approximately 17% to 28% of patients treated non operatively will have disability with pain, weakness, fatigue, impingement and ACJ instability.<sup>[3,6,9-14]</sup> There are however, no scientific papers which prove the superiority of acute intervention compared to delayed treatment in this subgroup.

The first recorded surgical procedure for an ACJ injury was reported by Cooper in 1861.<sup>[15]</sup> When Urist<sup>[16]</sup> published his review of the ACJ injuries in 1959 there were at least 30 different methods of surgical repair or stabilization. This has now expanded to more than 100 different fixation methods.<sup>[5]</sup> These various operative stabilizations have included trans-articular fixation across ACJ (pins, screws, tension band wiring, plates), coracoclavicular (CC) fixation with screws or slings, fascial weaves, dynamic muscle transfers and reconstruction using coracoacromial ligament (CAL) with or without distal clavicle excision.<sup>[5]</sup> The majority of the operations described are now of historical interest only and are not routinely used today. More recently, various authors have advocated utilizing a free tendon graft to anatomically reconstruct the native coracoclavicular ligament (CCL),<sup>[17-19]</sup> similar to the fascial weave originally described by Bunnell.<sup>[20]</sup> However, there are no clinical studies to support the clinical efficacy of such anatomical reconstructions especially in view of the potential for donor site morbidity. The CAL transfer (with or without adjunct fixation) is still commonly performed for both acute and chronic ACJ dislocations.<sup>[5]</sup>

The CAL can be removed from its coracoid attachment or its acromial attachment and utilized for stabilization of AC joint. Neviasser published the technique of removing CAL from its coracoid attachment to reconstruct superior acromioclavicular ligament.<sup>[21,22]</sup> This technique is not considered to be biomechanically sound as the reconstructed ligament runs perpendicular to the force vector. Despite the good results published by Neviasser<sup>[23]</sup> it has not been well accepted. There are very few published reports on this technique and it is not discussed further in this review.

The removal of CAL from its acromial end and subsequent transfer to distal clavicle for ACJ dislocation was first described by Cadenat<sup>[24]</sup> in 1917. He described anterior and posterior fascicles of the CA ligament, detached the posterior fascicle off acromium and sutured it to remnants of the conoid ligament and periosteum of posterior superior aspect of clavicle. Lateral end of clavicle was retained and no adjunct fixation was used. In 1972 Weaver and Dunn<sup>[25]</sup> were the first to publish a case series of 15 patients with CAL transfer for ACJ dislocation. Their described technique involves 1.5 to 2cm lateral clavicle resection, reduction of the dislocated clavicle and CAL transfer to the lateral clavicle, without additional fixation. Since then several studies have reported on the results of

different modifications of this procedure.<sup>[13,26-42]</sup> Clinical reports of Weaver Dunn procedure or its modifications are confusing and varied, leaving the surgeon with questions regarding the clinical efficacy of the variations in the technique. These variations include isolated CAL transfer versus different modifications of the original procedure, adjunct fixation across ACJ versus CC stabilization, clinical efficacy in acute versus chronic dislocations and with or without excision of distal end of clavicle. In addition, most reports are case series of patients treated with one form of stabilization and relatively short duration of follow-up (Level IV evidence). This makes it difficult to make any recommendations regarding clinical efficacy of CAL transfer in ACJ dislocation. The importance of a clear understanding of the role of this procedure is highlighted by the recent biomechanical evidence showing that a more anatomic reconstruction in which a tendon graft is woven between the coracoid, clavicle and ACJ (thus reconstructing the CC and AC ligaments) may be superior to CAL transfer.<sup>[18,19,43-45]</sup> At the same time, other authors have described arthroscopic techniques of CAL transfer for ACJ dislocation with potential advantages of minimal scarring, earlier rehabilitation and minimal iatrogenic disruption of the deltotrpezial fascia.<sup>[46,47]</sup> A systematic review of the medical literature was performed using the recently published guidelines.<sup>[48]</sup> The primary aim of this review was to evaluate the current clinical evidence for the CAL transfer for ACJ dislocation. Specifically, we attempted to answer the following questions: 1) Is the use of CAL transfer for ACJ dislocation supported by the current literature? 2) Does the CAL transfer with adjunct fixation yield better results when compared to isolated CAL transfer? 3) Does adjunct stabilization across ACJ have similar results as does CC fixation? 4) Is there any difference in clinical outcome when this procedure is used in acute dislocation versus in chronic dislocation with scarred and attenuated adjacent tissues?

## MATERIALS AND METHODS

We performed a systematic review of the English-language literature using the MEDLINE (1966 - June 2007), EMBASE (1980 - June 2007) and SCOPUS (1960 - June 2007) database. The search identified all articles published in the medical literature on "Acromioclavicular joint dislocation" or "Acromioclavicular dislocation." Other topics including "Acromioclavicular joint stabilization," "coracoacromial ligament" and "Weaver-Dunn" also were searched. After MEDLINE searches were completed, all abstracts were reviewed and individual articles on the surgical management of ACJ dislocation involving CAL were obtained. The inclusion criteria for scientific articles for systematic review allowed only clinical research studies published in peer-reviewed journals. Review articles, textbook chapters, poster presentations, meeting abstracts, case reports and biomechanical studies were gathered to augment overall knowledge and to identify research articles or data not obtained by the search engines; however, we excluded these sources in systematic review. The articles obtained were then critically reviewed by two reviewers (AS, NW), assigned a "level of

evidence,” and were organized and reported in our results. After review of the specific articles, any other references cited in the text of the article were obtained and reviewed.

Inclusion criteria used:

1. Clinical trials published in peer reviewed journals in English literature
2. Clear description of surgical technique involving CAL transfer
3. Results specifically described for surgery involving CAL transfer
4. Minimum of 10 patients in the study and minimum follow up of eighteen months
5. Level IV or higher evidence
6. Acute reconstruction defined as surgery within six weeks of injury
7. Tossy<sup>[49]</sup> and Allman<sup>[50]</sup> Grade III and Rockwood<sup>[51]</sup> Grade III - VI ACJ dislocations

## RESULTS

The Medline search for “Acromioclavicular joint dislocation” yielded 335 abstracts, of which we selected 44 papers for full text review. “Acromioclavicular dislocation” produced 367 abstracts which only included additional 32 papers. Of these seven papers were selected for thorough review. The search for “coracoacromial ligament”, “Weaver-Dunn” and “Acromioclavicular stabilization” yielded 159, 49 and 28 abstracts that were narrowed to additional 21 full text articles for thorough review. This was repeated using the EMBASE and SCOPUS search engines with 7 additional relevant references identified from the MEDLINE database search. These full text articles were obtained and systematically reviewed. Other articles not obtained by the Medline/EMBASE/SCOPUS search were obtained through cross-checking references through all of the articles.

Fifteen clinical trials met the inclusion criteria. The reasons for exclusions included review articles, tips and techniques descriptive papers, expert opinions, results not specifically mentioned for procedures involving CAL transfer, biomechanical papers and studies on unrelated topics (CAL anatomy etc.).

All of the fifteen studies were Level IV evidence. The follow-up ranged from 18 months to 72 months. When evaluating the success or failure of the procedure, the outcome measures utilized were variable with variable emphasis on pain, function, range of motion, cosmesis and fixation complications. Some articles utilized simple categories such as “good” or “satisfactory”

while others employed scoring systems (i.e, UCLA, Constant-Murley, Imatani scoring system etc). Some papers specifically mentioned clinical and radiological (including stress views) recurrence of deformity whilst others did not include it in results. Finally, residual pain at the ACJ in cases of retained distal end of clavicle was also inconsistently mentioned. All these variables made accurate comparisons impossible. In an effort to make objective comparisons between the studies, we compared the different reports with generalized terms such as “good/excellent” or “fair/poor.” In studies that utilized “satisfactory” as the highest level of success after treatment, we have included those results with the “good or excellent” results. It is a quite simplified method of evaluating the results of this procedure in view of the heterogeneity of the indications for surgery (Rockwood Grade III - VI), surgical technique and post operative outcome measures. These simplified groupings are a practical method of critically evaluating the literature as a whole and provide the surgeon with a guide of the published literature. However, it is important to appreciate that it is merely a guide and we should be careful not to make absolute comparison between the different studies and surgical techniques.

### Clinical evidence for isolated CAL transfer for ACJ dislocation

There are four published papers on CAL reconstruction of ACJ dislocation without adjunct fixation<sup>[25,36,37,39]</sup> [Table 1]. All have utilized this technique in acute and chronic dislocations but with slight variation to the original description by Weaver-Dunn.<sup>[25]</sup> Overall 66/73 (90%) patients were reported as having good to excellent results. Rauschnig<sup>[36]</sup> reports 100% satisfaction and excellent results despite 21% incidence of recurrence of deformity after reconstruction. Similarly Warren-Smith<sup>[39]</sup> reported 28/29 good to excellent results despite 4/29 patients complaining of residual deformity and poor cosmesis as well as 10/29 patients complaining of fatigue on heavy exertion. In his series, all the cases of recurrence occurred in reconstruction for chronic ACJ dislocation.

Overall there were 12/73 (17%) patients with recurrence of deformity. Efficacy of isolated CAL reconstruction in acute versus chronic dislocation is controversial. Warren-Smith<sup>[39]</sup> reported much higher rate of recurrence of deformity in chronic dislocations (4/20) when compared with acute dislocations (0/9). Weaver-Dunn<sup>[25]</sup> reported in their series of 12 acute and 3 chronic ACJ dislocations that this technique is equally effective in both situations without providing the data for acute or chronic cases separately. The other papers did not distinguish between results of acute or chronic cases.

**Table 1: Clinical evidence for isolated coracoacromial ligament transfer for acromioclavicular joint dislocation**

Author	Number	Follow up (Average)	Outcome measures	Results (G/E)	Recurrence of deformity
Weaver-Dunn <sup>[25]</sup>	15 (12A, 3C)	36 m	Clinical assessment	11	4
Rauschnig <sup>[36]</sup>	17 (12A, 5C)	36 m, 3 lost to f/u	Stress radiographs	14	3
Shoji <sup>[37]</sup>	15 (12A, 3C)	25 m	Stress radiographs	13	1
Warren-Smith <sup>[39]</sup>	29 (9A, 20C)	38 m	Imatani scale <sup>[71]</sup>	28	4

A - Acute, C - Chronic, G/E - Good to excellent

Distal end of clavicle was excised in all the series. No valid conclusions can be drawn in terms of the merit of retaining or excision of ACJ with isolated CAL transfer in acute or chronic setting.

**Clinical evidence for CAL transfer with trans-articular fixation across ACJ**

We identified six suitable published papers on CAL reconstruction of ACJ dislocation with adjunct stabilization across ACJ<sup>[26,27,29,38,41,42]</sup> [Table 2]. There was variation in surgical technique with four of the series utilized smooth K wires across the ACJ with tension band wiring<sup>[26]</sup> or without tension band wiring<sup>[27,29,41]</sup> Lupo<sup>[42]</sup> described a 2 bundle technique of CAL transfer and stabilization using either smooth K wires (7 patients) or threaded pin (9 patients). The paper by Tienen utilized 2mm braided absorbable PDS across ACJ in a figure of 8 configuration.<sup>[38]</sup> Reported good to excellent results ranged from 80%<sup>[27]</sup> to 100%.<sup>[41,42]</sup>

Cumulatively, 146/163 (90%) patients who underwent CAL reconstruction with trans-articular stabilization had good to excellent results. Adachi and Lupo reported 100% good to excellent results despite recurrence of deformity and fixation related complications.<sup>[41,42]</sup> Dumontier reported 26/32 (88%) good to excellent results in acute ACJ dislocations despite

6/32 (16%) patients having recurrence of deformity and 11/32 (34%) patients complaining of ACJ pain.<sup>[27]</sup> Similarly in chronic cases, 19/24 (79%) good to excellent results were reported despite 7/24 (29%) patients having recurrence of deformity and 7/24 (29%) patients complaining of persistent ACJ pain. Chronic ACJ dislocations had poorer outcome compared to acute cases in this series.<sup>[27]</sup> No other series directly compared results in acute ACJ dislocations to chronic dislocations but cumulatively 100/111 (90%) of the patients in acute reconstruction group had good to excellent results compared with 30/36 (85%) of chronic cases. The study by Lupo was excluded from this analysis as results were reported for the whole group without separating acute versus chronic patients<sup>[42]</sup> [Table 3].

Overall, 24/163 (15%) patients who underwent CAL reconstruction with trans-articular stabilization had recurrence of deformity [Table 4]. Tienen<sup>[38]</sup> used a PDS suture in a figure of 8 configuration across ACJ. In the other series, transfixing metalwork in all other cases was removed at 6-8 weeks eliminating duration of fixation as a contributing factor to final outcome. In all of the series, distal end of clavicle was preserved in both acute and chronic ACJ dislocations. It is not possible to make a comparison as whether to retain or excise the lateral end of clavicle based on the data available.

**Table 2: Coracoacromial ligament transfer with trans-articular acromioclavicular joint stabilisation**

Author	Number	Follow up (Av.)	Outcome measures	Results (G/E)	Recurrence of deformity	Fixation complications	ACJ symptoms
Karlsson <sup>[29]</sup>	47A	72 m	Stress radiographs self evaluation	44	3	7	2 (2)
Dumontier <sup>[27]</sup>	56 (32A, 24C)	48 m	Radiographic	Acute: 26, Chronic: 19	Acute: 6, Chronic: 7	3	Acute: 11 (1), Chronic: 7 (2)
Adachi <sup>[41]</sup>	11A	18 m	Kawabe score <sup>[41]</sup> Radiographic	11	2	1	0
Lupo <sup>[42]</sup>	16 (13A, 3C)	24 m	Taft score <sup>[72]</sup> Stress radiographs	16	2	2	2
Adam <sup>[26]</sup>	12C	20 m	UCLA ACJ ratings scale <sup>[28]</sup>	11	1	1	4
Tienen <sup>[38]</sup>	21A	36 m	Constant score <sup>[73]</sup> Radiographic	19	3	0	None

A - Acute, C - Chronic, G/E - Good to excellent, ACJ symptoms column represent patients with localized ACJ pain followed by number of patients with radiological osteoarthritis (OA) in brackets ( )

**Table 3: Overall outcome in acute versus chronic acromioclavicular joint dislocations**

Technique	Total number acute dislocations	Results (G/E)	Total number chronic dislocations	Results (G/E)
Isolated CAL transfer	N/A	N/A	N/A	N/A
CAL transfer with ACJ fixation	111	100 (90)	36	30 (83)
CAL transfer with CC screw	27	24 (89)	40	36 (90)
CAL transfer with CC loop	N/A	N/A	17	13 (76)

Figures in parentheses are in percentage, CAL - Coracoacromial ligament

**Table 4: Overall outcome according to the type of surgical technique employed**

Technique	Total number	Results (G/E)	Recurrence of deformity	Fixation related complications
Isolated CAL transfer	73	66 (90)	12 (17)	0
CAL transfer with ACJ fixation				
• K-Wire Fixation	142	127 (89)	21 (15)	14 (10)
• PDS suture <sup>[38]</sup>	21	19 (90)	3(14)	0
CAL transfer with CC screw	81	74 (91)	13 (16)	7 (9)
CAL transfer with CC loop	17	13 (76)	5 (29)	0

Figures in parentheses are in percentage, CAL - Coracoacromial ligament

After excluding the reports that did not categorically mention ACJ osteoarthritis (OA) or pain in their result section, there was increased incidence of ACJ symptoms in chronic dislocations when compared to acute cases [Table 5]. Overall incidence of ACJ sequelae (pain or radiological osteoarthritis) in reconstructed cases was 15/36 (42%) in chronic dislocations versus 13/111(12%) in acute dislocations with retained lateral end of clavicle. It is noteworthy that the patients who had PDS suture fixation of ACJ reported no pain or osteoarthritis even in the cases with recurrence of deformity.<sup>[38]</sup> Excluding these patients, the incidence of ACJ sequelae was 13/90 (14%) in acute dislocations.

Adam<sup>[26]</sup> in a series of 12 chronic cases with retention of lateral end of clavicle reported 11 satisfactory results despite four patients with ACJ pain on mild to moderate activity. They did not comment on incidence of radiological OA. The only case with "fair" result had surgery more than four months post initial injury whereas all good to excellent results were operated on with first four months of injury.<sup>[26]</sup> Karlsson<sup>[29]</sup> reported 2/47 patients with symptomatic ACJ OA at follow up but both these patients were older (46 y and 51 y) at time of surgery with pre existing ACJ arthritis. Authors recommended against retention of lateral end of clavicle if there is evidence of ACJ arthritis at the time of surgery. Dumontier<sup>[27]</sup> reported on radiographic changes of ACJ OA in 1/32 patients in acute group and 2/24 patients in chronic group. However, incidence of ACJ pain was higher at 34% in acute group and 29% in chronic group. Magnitude of pain was not quantified. Despite the high rate of ACJ pain, the overall good to excellent result was 88% for acute group and 79% for the chronic group. The current evidence suggests that patients with chronic dislocations and pre existing osteoarthritis have the highest incidence of ACJ sequelae. Incidence of ACJ pain is much higher than radiological evidence of osteoarthritis.

In this group fixation related complications ranged from 0%<sup>[38]</sup> to 15% (7/47).<sup>[29]</sup> When rigid fixation across ACJ was utilized for stabilization, there were 14/142 (10%) complications

(including 2 broken wires) contributing to recurrence of deformity [Table 4].

### Clinical evidence for CAL transfer with coracoclavicular screw stabilisation

There were four suitable published papers on CAL reconstruction of ACJ dislocation with adjunct fixation with CC screw<sup>[28,30,34,52]</sup> [Table 6]. There was significant variation in surgical technique with variables including retention<sup>[34,52]</sup> or sacrifice<sup>[28,30]</sup> of distal clavicle, type of screw (Bosworth,<sup>[34]</sup> AO<sup>[30,52]</sup> or Rockwood<sup>[28]</sup> screw) and whether CAL was harvested with<sup>[52]</sup> or without<sup>[28,30,34]</sup> bone block.

Cumulatively, 74/81 (91%) patients who underwent CAL reconstruction with CC screw stabilization had good to excellent results (range 83%<sup>[28]</sup> to 100%<sup>[30]</sup>). In two different papers, Kumar and Pavlik reported 100% good to excellent results despite having fixation complications, recurrence of deformity and residual ACJ pain [Table 6]. Guy utilized Modified UCLA Acromioclavicular ratings scale with "maintenance of reduction" being an outcome measure.

Overall 13/81 (16%) of patients who underwent CAL transfer with CC screw fixation were reported to have recurrence of deformity. This procedure had similar good to excellent results when performed for acute dislocation (24/27) compared with chronic dislocation (36/40) [Table 3]. Data from report by Kumar<sup>[30]</sup> included both acute and chronic dislocations without separately reporting results, thus this data is excluded from analysis.

Distal end of clavicle was retained in two series<sup>[34,52]</sup> and excised in two series.<sup>[28,30]</sup> Whilst none of the individual reports directly compared the two techniques, comparing across series, 33/37 (89%) patients had good to excellent results when lateral end of clavicle was excised compared to 41/44 (93%) patients with retained ACJ. There were a total of three patients with ACJ OA, two of these were symptomatic with pain. All of

**Table 5: Outcome in patients with retained distal end of clavicle in acute vs chronic acromioclavicular joint dislocations**

Technique	Total number acute dislocations	ACJ symptoms pain (OA)	Results (G/E)	Total number chronic dislocations	ACJ symptoms pain (OA)	Results (G/E)
Isolated CAL transfer	N/A	N/A	N/A	N/A	N/A	N/A
CAL transfer with ACJ fixation	111	13 (3 OA)	89 (89%)	36	15 (2 OA)	19 (79%)
CAL transfer with CC screw	27	3	24 (89%)	17	2 (3 OA)	17 (100%)
CAL transfer with CC loop	N/A	N/A	N/A	N/A	N/A	N/A

In ACJ symptoms column, number in brackets () represent patients with radiological OA

**Table 6: Clinical evidence for coracoacromial ligament transfer with CC screw fixation**

Author	Number	ACJ	Follow up (Av.)	Outcome measures	Results (G/E)	Recurrence of deformity	Fixation related complications	ACJ related symptoms
Guy <sup>[28]</sup>	23C	Excised	62 m	UCLA ACJ scale <sup>[28]</sup>	19	1	3	N/A
Pavlik <sup>[34]</sup>	17C	Retained	37 m	Constant score <sup>[73]</sup>	17	9	1	2 (3)
Kumar <sup>[30]</sup>	14 (11A, 3C)	Excised	33 m	Imatani score <sup>[71]</sup>	14	2	2	N/A
Lin <sup>[52]</sup>	27A	Retained	24 m	Stress radiographs Imatani score <sup>[71]</sup>	24	1	1	3

A - Acute, C - Chronic, G/E - Good to excellent, ACJ symptoms column represent patients with localized ACJ pain followed by number of patients with radiological OA in brackets ()

these patients had chronic dislocations and were noted to have arthritic changes pre operatively and/or intra operatively.<sup>[34]</sup> Thus, it was recommended to excise distal end of clavicle in such cases. Excluding pre existing arthritic changes at ACJ, retention of the lateral end of clavicle did not increase the risk of symptomatic problems at the ACJ.

Fixation related complications ranged from 6%<sup>[34]</sup> to 14% (2/14).<sup>[30]</sup> Cumulatively, there were 7/81 (9%) complications (including 2 broken screws).

**Clinical evidence for CAL transfer with coracoclavicular loop stabilisation**

There was only one suitable published paper on CAL reconstruction of ACJ dislocation with adjunct fixation with CC loop.<sup>[40]</sup> Weinstein<sup>[40]</sup> reported on 17 chronic dislocations which were treated with excision of lateral end of clavicle, CC loop of No 5 non absorbable suture and CAL transfer [Table 7]. There were 13 patients (76%) with good to excellent result. Of the four patients with poor results; two had complete re dislocations and two had persistent pain and weakness. There were five patients with recurrence of deformity (29%) despite the paper reporting no fixation related complications. The paper did not mention mode of failure in patients with complete or partial loss of reduction. This report suggests high failure rate when CC loop stabilization of CAL transfer is used for the treatment of chronic ACJ dislocation.

**Isolated CAL transfer versus CAL transfer with adjunct fixation**

The published reports for isolated CAL transfer for ACJ dislocation are largely supportive of the procedure, with 73% to 97% (average 90%) “good or excellent” results. The results for CAL transfer with adjunct fixation are also of similar evidence level with satisfactory results ranging from 89% (trans-articular fixation), 91% (CC screw) and 76% (CC loop). Similarly there is no improvement between rates of deformity recurrence between isolated CAL transfer and CAL transfer with adjunct fixation [Table 4]. In addition, metallic adjunct fixation was associated with high complication rate, which was similar with transfixing K wires (10%) and CC screw (9%). Whether recurrence of deformity equates to poorer clinical outcome is controversial and no valid conclusion from the current evidence can be drawn.

**Early versus late surgery**

Overall comparison of results of CAL transfers in acute versus chronic dislocation (inclusive of all techniques) revealed similar results [Table 3].

**Distal clavicle retention**

Overall incidence of pain (and radiological OA) in acute and chronic dislocations was 12% and 32% respectively. Incidence of ACJ pain was higher with trans-articular fixation especially in chronic reconstructions when compared to CC screw fixation [Table 5]. Higher rates of ACJ pain did not necessarily translate into poorer overall result, which may be a reflection of insensitivity of the outcome measure used. None of the papers revealed any superiority with retention of distal clavicle when compared to excision.

**DISCUSSION**

The CAL has long been used for the reconstruction of a dislocated ACJ. It lies adjacent to the disrupted CC ligament, is made up of the same material and part of the same anatomical layer. Replacing ligament by a ligament seems the most logical method of repair. However, there is conflicting clinical data regarding the utilization of CAL in ACJ dislocation. This review provides the reader with a summary of the current evidence in literature regarding clinical efficacy of CAL transfer and its various modifications, for ACJ dislocation.

**Isolated CAL transfer versus CAL transfer with adjunct fixation**

The original method of transfer of CAL without adjunct fixation has largely been abandoned because of biomechanical studies revealing insufficient mechanical strength<sup>[53,54]</sup> and clinical observations of inadequate maintenance of reduction.<sup>[25]</sup> However, the published reports for isolated CAL transfer for ACJ dislocation yielded similar results {overall outcome and deformity recurrence} to CAL transfer with different forms of adjunct fixation [Table 4].

There is a trend in literature of gradual move from isolated CAL transfer to CAL transfer with ACJ transfixation and more recently to CC stabilization. Correspondingly there may have been improvement in diagnosis and reporting of complications with greater emphasis of deformity. This creates a bias which could account for lack of any apparent improvement.

Complications of transfixation of the ACJ have included breakage and penetration of pin, which may migrate medially into chest, lung, spinal canal and abdominal visceral organs.<sup>[5,55,56]</sup> To avoid these potentially life-threatening complications, CC screw fixation as an adjunct fixation to CAL transfer gained popularity. Major advantage of screw fixation is the ability to maintain reduction in vertical and horizontal planes when compared to other fixation methods, such as, sutures, wire or tape. However CC rigid fixation restricts axial rotation

**Table 7: Clinical evidence for coracoclavicular ligament transfer with CC loop stabilisation**

Author	Number	Follow up (Av.)	Outcome measures	Results (G/E)	Recurrence of deformity	Fixation related complications
Weinstein <sup>[40]</sup>	17C	4 years	Radiographic	13	5	0

between clavicle and scapula resulting in high fixation related complications including screw pull out and breakage.<sup>[5,28]</sup> It may also necessitate additional surgery for removal of screw in some patients. In this review we found similar fixation related complication rate with transfixing K wires and CC screw. This high proportion of fixation related complications may contribute to lack of any improvement between rates of deformity recurrence between CAL transfer with or without adjunct fixation. Currently the favored adjunct fixation is CC loop with absorbable or non absorbable sutures.<sup>[40,57]</sup> Previously Dacron and Mersilene tape has been used as CC loop but abandoned because of problems with erosion through the distal clavicle, infection and sinus formations.<sup>[58]</sup> The only study which utilized CC loop adjunct fixation with non absorbable suture reported only 76% good to excellent clinical results.<sup>[40]</sup> Recent studies have recommended suture anchors as a potential form of adjunct fixation with CAL transfer but there are no clinical series to support its efficacy.<sup>[59,60]</sup> In view of high rate of deformity recurrence and fixation related complications, there is a need for a more suitable form of adjunct fixation.

### Early versus late surgery

There is little information in literature as to whether better functional results can be obtained with early rather than late operative repair.<sup>[1,39]</sup> The dividing line between acute and chronic injuries has been defined as two weeks,<sup>[61]</sup> three weeks<sup>[62]</sup> and four weeks.<sup>[63]</sup> In this review, surgical treatment within six weeks of sustaining the ACJ dislocation was considered acute treatment. Although the overall comparisons of results of CAL transfer in acute versus chronic dislocation (inclusive of all techniques) revealed similar results [Table 3], Warren-Smith<sup>[39]</sup> and Adam<sup>[26]</sup> reported higher rate of deformity recurrence and poorer outcome in chronic cases.

### Distal clavicle retention

Retention of the distal end of clavicle in reconstruction of ACJ dislocation is controversial with the risk of post traumatic osteoarthritis especially with trans-articular K wires.<sup>[64]</sup> Others have reported no increase in ACJ osteoarthritis with CC fixation which did not violate ACJ.<sup>[65,66]</sup> The proponents of retention of lateral clavicle site the biomechanical studies which have shown the importance of the AC ligaments and capsule to the stability of lateral end of clavicle during both small and large amounts of loading.<sup>[67-70]</sup> They argue that given the young age and sporting activity level of the typical patient with ACJ dislocation, retention of lateral end of clavicle can be potentially advantageous. In this review, overall the incidence of pain in acute and chronic dislocations was 12% and 32% respectively [Table 5]. In addition, there was a higher incidence of ACJ pain with trans-articular fixation especially in chronic reconstructions when compared to CC screw fixation. It suggests that trans-articular fixation causes insult to ACJ joint in addition to the damage caused by original injury and surgery. This finding is consistent with other reports in literature. None of the papers revealed any superiority with retention of distal

clavicle when compared to excision. Whilst the incidence of ACJ sequelae is high with retention of distal clavicle, there is no comparative data of incidence of ACJ pain with excision of distal clavicle. In view of these findings, it is difficult to argue for or against routine retention of distal clavicle. Current evidence recommends excision of distal clavicle in chronic cases, older patients and pre existing ACJ arthritis. Risk of ACJ sequelae is higher with trans-articular rigid fixation especially in chronic cases.

This review clearly illustrates that there is little in the literature in the way of good research to establish definitive guidelines regarding utilization of CAL transfer for ACJ dislocation. In addition, ideal method of adjunct fixation remains elusive. Whether CAL is a suitable alternative for reconstruction of damaged coracoclavicular ligaments from an anatomical and biomechanical properties point of view is beyond the scope of this article.

## CONCLUSION

The published literature supporting CAL transfer in patients with ACJ dislocation is very heterogeneous and constitutes of Level IV evidence. We are unable to make definitive conclusions regarding a specific procedure, without higher level of evidence to provide comparisons between control groups, randomized experimental designs and adequate statistical analysis minimizing bias and flaws. Each modification has its theoretical benefits and flaws but no "Gold Standard" has been established. The question of retention or excision of distal clavicle, especially in acute cases still needs to be answered in further studies. Caution should be used in retention of distal clavicle and trans-articular fixation in reconstruction of chronic ACJ dislocations. The current data suggests similar results with CAL transfer in acute and chronic cases.

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