Gracilis tendon autograft for acute coracoclavicular ligaments reconstruction

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ABSTRACT

Background:
The acromioclavicular (AC) joint injuries are more frequent among males and resemble about 3 – 12% of shoulder injuries. The orthopedic literature does not restrict strategies for a one operative procedure as the perfect rebuilding surgery for AC joint dislocation. Postoperative failure rates of AC joint reconstruction procedures can range from 20 to 30% or more. In recent years, stress has been on rebuilding procedures employing tendon grafts.
Patients and methods:
The current study was carried out on twenty patients with 20 acute AC joint dislocations operated within 3 weeks of injury, treated by the rebuilding of coracoclavicular ligaments using an autogenous gracilis tendon graft. The follow-up period was 24 months. The ages of patients ranged from 21-50 years with a mean age of 31.2 +/- 10.21. Nine cases (45%) were grade III, two cases (10%) were grade IV and nine cases (45%) were grade V. Constant and Murley shoulder score was employed for patient evaluation.
Results:
The final mean score was 90.7 +/- 8.62 ranging from 67 to 100 based on the Constant and Murley shoulder score. Fourteen patients (70%) obtained excellent results, five patients (25%) obtained good results, and one patient (5%) obtained unsatisfactory outcomes.
Conclusion:
Reconstruction of coracoclavicular ligaments using gracilis tendon autograft offers a better alternative for the management of acute disruption of AC joint.
Keywords:
Acromioclavicular articulation, Gracilis tendon graft, Coracoclavicular rebuilding.

Level of evidence: therapeutic level IV

INTRODUCTION:

The acromioclavicular (AC) articulation is one of the diarthrodial joints. It bridging from the acromial medial facet to the lateral clavicle end. It connects the shoulder girdle with the axial skeleton [(1)]. Maintaining stability the AC joint is acquired through action joint capsule and coracoclavicular (CC) ligaments [(2)].

The superior AC ligament is the most powerful, most firm ligament of the AC capsular complex. It supplies about 90 % of its capsuloligamentous toughness [(3)]. Besides the superior AC ligament, the lesser posterior AC ligament is thought to primarily limit posterior translocation while the inferior AC ligament primarily limits anterior movement [(4)].

The CC ligaments are devoted to the vertical stability of the AC articulation. It consisted of conoid and trapezoid ligaments bridging from the inferior surface of the lateral part of the clavicle to its coracoid process [(3, 5)].

AC articulation injuries are present in male players under the age of 30 years. It constitutes about 3 – 12% of the shoulder injuries [(6, 7)].

AC dislocations mostly result from a fall down on the adducted shoulder. Most orthopedist categorize AC disruption employing Rockwood system. It is based on the damage to the AC joint capsule and ligaments, in addition to coracoclavicular ligaments [(7)].

Type I and II injuries are most often managed conservatively. Type IV-VI disruption usually needs operative management, to eliminate deformity, pain, and weakness. The debate about the management of type III injuries is long-lasting [(7,8)]. Complete acromioclavicular dislocations (type III-VI) engaging rupture of both the AC and coracoclavicular ligaments one. Since the first mentioned surgery for AC joint restoration by Cooper in 1861, huge numbers of procedures were used to manage AC dislocation [(6)].

The orthopedic literature does not restrict strategies for a one operative procedure as the

perfect rebuilding surgery for AC joint dislocation. Postoperative failure rates of AC joint reconstruction procedures can range from 20 to 30% or more [8-13].

In the last years, the stress is towards rebuilding approaches utilizing tendon grafts[8]. As the need for implant removal is avoided and implant fracture, loosening, and migration are cleared, different tendon grafts, have been utilized [14, 15].

X-ray imaging of the AC joint includes a standard series of films (AP and axillary views) and zanca view. Shoulder axial view can detect anterior or posterior translocation of the clavicle. Weighted stress views may differentiate type II from type III. When AC disruption is present with normal coracoclavicular distance stryker notch view should be taken to exclude the fracture coracoid process [16,17].

Magnetic Resonance Imaging (MRI) may help to differentiate type II from type III injuries, which is not needed in all cases [18].

Wide field of view dynamic CT (4D CT) is an exact, quantitative and rapid process to diagnose and categorize AC joint injury. It gives dynamic data not available by other imaging methods [19].

Heers and Hedtmann 2005 reported that ultrasound of the AC joint in well-trained hands had 100% sensitivity for the diagnosis of deltoid muscle detachment and 80% sensitivity and 100% specificity for trapezius muscle injury [20].

Acromioclavicular (AC) disruption is a common type of shoulder injury. In spite the incidence of acromioclavicular dislocation is frequent, there are many opinions regarding the treatment. Many different surgeries have been proposed for treatment, but all these methods have been questioned from many views, and the gold standard treatment has not yet been determined [21].

Therefore, we decide to evaluate the used technique as a primary reconstruction of the CC ligaments using gracilis tendon autograft in acute traumatic acromioclavicular and secondary stabilization crossing the lateral clavicle end and the coracoid.

PATIENTS AND METHODS:

A prospective study was carried out on twenty patients during the period from June 2016 to February 2019. All patients approved written informed consent. The study was carried out after being approved by our institutional research board.

The study involved patients with acute traumatic AC joint disruption within 3 weeks of injury graded III to VI aged 20 to 50 years. Patients who refused surgery, were medically unfit for surgery, with non-functioning limb, AC joint arthritis, and/or with injury more than 3 weeks were excluded from the study. Because of the debate about the management of Type III, patients were instructed about the benefits and risks of both operative and conservative treatment but they chose surgical treatment.

Twenty patients with acute AC joint disruption were involved in the study; they were treated with reconstruction of CC ligaments using gracilis tendon autograft. The results were measured using the Constant and Murley shoulder score [22]. The score is containing four categories: pain (15 points), activities of daily living (20 points), strength (25 points), and range of motion: forward elevation, external rotation, abduction, and internal rotation of the shoulder (40 points). The higher the score, the better quality of the function [23].

The ages of patients ranged from 21-50 years with a mean age of 31.2 +/- 10.21. Fifteen patients (75%) of patients were manual hard workers or athletes, while five patients (25%) were lightworkers. All cases were males. Nine cases (45%) were grade III, two cases (10%) were grade IV and nine cases (45%) were grade V. Fifteen patients (75%) of patients had left AC joint disruption, while five patients (25%) had right AC joint disruption. All patients had right-side dominance.

The included patients were subjected to the following: history taking, Physical examination of skin condition, deformity, range of motion, Instability and neurovascular examination, pre and postoperative radiological evaluation including standard X-ray films (AP and axillary views).

Surgical technique:

The surgeries were done in a beach chair position. Radiolucent operating tables were used. Head and neck were tilted toward the opposite side while a small pillow was placed behind the ipsilateral scapula. Preparation and drape included the upper limb and the ipsilateral upper leg for tendon graft harvest, 1g Cefazolin was given at least half an hour before incision. Assessment of stability of the shoulder joint in both vertical and horizontal planes, and reducibility of the AC joint was always tested before skin incision. Gracilis tendon graft is harvested with a tendon stripper through a small vertical incision over the pes anserinus and whipstitched using No.1 Vicryl sutures (Fig.1A)

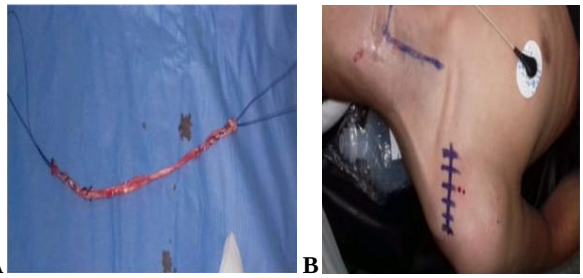

Fig.1: A. Gracilis tendon graft after preparation. **B.** Curvilinear incision used for exposure of AC joint.

A curvilinear incision 3.5 cm from the lateral clavicle end in the lines of Langer to the tip of the coracoid was made. Full-thickness flaps anteriorly and posteriorly around the clavicle (Fig.1B). A tunnel beneath the coracoid was created with a right-angle clamp to obtain easy graft passage. Two tunnels were done through the clavicle for passage of the graft. The first tunnel is drilled 45 mm from the distal clavicle using an appropriate drill bite. It was positioned posterior to rebuild the normal conoid lig. insertion site. The second tunnel was drilled 15-20 mm anterolateral to the first hole to rebuild the trapezoid lig. insertion site (Fig.2).

Fig.2: Clavicular tunnel

The graft is passed under the coracoid (Fig 3. A) and the lateral limb of the graft with suture was passed through the first (posterior) hole, crossing it posteriorly to make was a figure-of-eight. Then the medial limb of the graft was passed through the anterior hole then the suture ends were tied on top of the clavicle after reduction of the AC joint and holding the reducing by 1.6 mm Kirschner wire (Fig 3. B). The deltotrapezial fascia is closed well with Vicry l suture. The skin is closed with absorbable monofilament sutures.

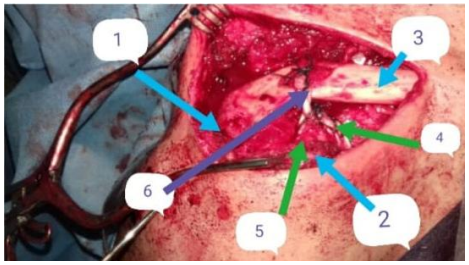

Fig 3: Final coracoclavicular reconstruction showing 1- reduced ac joint 2-coracoid 3-clavicle 4-the medial limb of the graft passed through the anterior clavicular hole 5- the lateral limb of the graft passed through the posterior clavicular hole 6- then the suture end tied after reduction of the AC joint

The patients were followed up for two years after surgery. The operated arm was immobilized in an arm sling for the first 4 weeks. Patients were informed not to raise the operated upper limb more than 70 degrees in all planes for the first month post-operative (active/passive range of motion).

Limit direct palpation and mobilization on incisions for one month, avoid raising any objects more than 5 pounds with the operated arm for one and half months postoperatively. Excessive reaching and external/internal rotation are restricted one and half months postoperatively and to maintain good upright shoulder girdle posture at all times and especially during sling use. Follow-up clinical and radiological assessment was followed weekly for 1st month and then monthly 6 months and after that every 3 months. Pre. and post-operative, and 2 years x rays are shown in Fig.4.

Fig.4: A: Pre, **B:** post-operative and **C:** 24 months post-operative x-ray showing the clavicular tunnels and AC joint fixation by K-wires.

RESULTS

The final mean score was 90.7 +/- 8.62 ranging from 67 to 100 based on the Constant and Murley shoulder score. Fourteen patients (70%) got excellent outcomes, five patients (25%) got a good outcome, and one patient (5%) got unsatisfactory outcomes, (table 1).

The final Constant score for pain was 12 +/- 2.99 ranging from 5 to 15. All patients started to resume their work after about 10 to 12 weeks. The mean final Constant score for the activity of daily living was 19 +/- 0.88 ranging from 16 to 20. The mean final Constant score for active forward flexion was 8.6 +/- 0.82 ranging from 8 to 10. The mean final Constant score for active abduction was 8.7 +/- 0.73 ranging from six to ten and for active external rotation was 8.2 +/- 1 ranging from 8 to 10. The mean final Constant score for active internal rotation was 8.3 +/- 1.19 ranging from 6 to 10 (table 2).

Table (1): Distribution of the patients regarding the result according to Constant and Murely Score

	Total satisfactory: 19 patients (95%)		Total unsatisfactory: one patient (5%)
	Excellent	Good	Adequate
Number	14	5	1
Percent	70%	25%	5%

The mean final Constant score for strength was 24 +/- 1.75 ranging from 15 to 25, eighteen patients regained normal strength of the affected shoulder, one patient showed good strength, and one-showed fair results.

There is no correlation between the age of patients and outcome with a P-value = 0.462 (table 3).

Table (2): Distribution of the patients, according to Constant and Murely Score (active movement)

Active movement	Degrees	No. of patients	Percent
Forward flexion	0-120	0	0%
	121-150	4	20%
	151-180	16	80%
Abduction	0-90	0	0%
	91-120	0	0%
	121-150	3	15%
	151-180	17	85%
External rotation	Hand above head with elbow forward	0	0%
	Hand above head with elbow back	8	40%
	Full elevation	12	60%
Internal rotation	Waist	1	5%
	T12 vertebra	6	30%
	Interscapular T7	13	65%

Table (3): Relation between final outcome and age and time lapse before surgery

	Net result			Total	P value
		Satisfactory	unsatisfactory		
		No. (%)	No. (%)		
Age group	**20- >30**	9 (100)	0(0)	9	
	30->40	7 (100)	0 (0)	7	
	40->50	3(75)	1(25)	4	
	Total	19 (95)	1(5)	20	0.462
time lapse before surgery	**< days**	10 (100)	0 (0)	10	
	3-7	6 (100)	0 (0)	6	
	8-21	3 (75)	1(25)	4	
	Total	19	1	20	0.0001

There was no statistically significant relationship between right (dominant) and left (non-dominant) sides regarding the final score. The mean final score for the dominant side was 92.56 +/- 6.98 ranging from 84 to 100 and for the non-dominant site was 97.06 +/-.2.98 P-value = 0.307

There was a significant correlation between final results and the time between trauma and time of surgery with a P-value = 0.0001 (table 3).

Patients with grade III and IV injuries had no other associated injuries while patients with grade V had associated injuries as fractured ribs, scapula, lung contusions, and head injuries. There was a significant relationship between associated injuries and final score with a P-value = 0.0001 as the mean final score for patients without associated injuries was 97.1 whereas the mean final score for those with associated injuries was 84.

There was no statistically significant difference between type III and the other included types regarding the final score. The mean final score for type III was 96.64 +/- 5.86 and for types was 94.03 +/-.2.65. P-value = 0.316

Complications: There were three patients (15%) with the superficial infection that were improved after treatment with antibiotics. Only one case (5%) aged 36 years old had moderate AC joint pain, which was improved after steroid injection twice, and 6 (30%) cases with mild pain that was also improved after steroid injection once. About 4 cases (20%) showed radiological subluxation of

AC joint but clinically there was no pain, instability, or affected range of motion.

DISCUSSION:

AC joint dislocation surgeries have been performed since 1861[6]. Trials of AC joint fixation with pins, CC fixation with screw [24], hook plate [25], did not produce good results due to implant failure and dissatisfaction with results [9-13].

Soft tissue operations whose purpose was directed to rebuild the function of the injured CC and/or AC ligaments were also mentioned. An example is the modified Weaver-Dunn procedures that had a high redislocation rate because the transferred ligaments are not as powerful as the nature CC ligaments [26-28].

As a result, CC ligament rebuilding, which aims to rebuild the CC ligaments using a more powerful graft substance, is created to decrease complication rates and improve stability, and functional results.

Anatomical CC ligament rebuilding using autologous semitendinosus tendon was proved to be biomechanically [29-31] and clinically [32] better than Weaver-Dunn surgery and has more resemblance to the function of the nature CC ligaments.

Saccomanno et al mentioned in their research that anatomical rebuilding of CC and AC ligaments with an autologous semitendinosus tendon graft for the management dislocation of AC articulation provided better and reliable clinical and radiological results with a less failure rate at short-term follow-up. [33]

Recently, procedures using different stabilizing systems, as biotenodesis screws [34] or buttons [35,36] are being used with better clinical results, however, complications of clavicle fractures and hardware failure have been also mentioned [37-39].

Our used technique is a primary reconstruction of the CC joint with autogenous gracilis graft and secondary, temporary stabilization of the distal clavicle to the coracoid using K. wire.

Gracilis tendon harvesting may result in a weakness of knee flexors but does not impair subjective knee function. It is the approach that could be recommended if an autogenous tendon graft is needed. [40]

In our study 14 patients (70%) obtained excellent outcomes, 5 patients (25%) obtained good outcomes, and one patient (5%) obtained unsatisfactory outcomes. There were no cases with failure of reduction, no deep infection, no osteoarthritis of AC joint, no calcification, no clavicle or coracoid fractures, no k-wire migration, and no osteolysis of the distal clavicle.

Mori et.al conducted a similar study using an artificial ligament and they concluded that anatomical CC ligament rebuilding for the management of acute AC joint dislocation resulted in successful long-term clinical and radiological outcomes [41].

Although many studies gave satisfying results with conservative management, many studies have noted poor results in over 40% of cases. Most of them have subsequent operative treatment for pain and weakness. Long-term follow-up has shown residual symptoms in most patients with non-surgical treatment. This leads to a preference for surgical treatment for athletes, manual workers, and young age patients [16,18].

While reconstruction with synthetic grafts has the advantage of eliminating both the donor-site morbidity and disease transmission with fast rehabilitation, high graft failures, no so-called ligamentization, and severe synovitis have been reported as major disadvantages of synthetic grafts in other tendon reconstruction procedures[42].

Carofino and Mazzocca[34] described their technique for anatomical CC coracoclavicular ligament rebuilding by harvesting a semitendinosus allograft passed under the coracoid and through holes in the clavicle. The graft is fixed with an interference screw. Patients have significant improvement in pain levels and function. The mean ASES score increased from 52 preoperatively to 92. The Constant Murley rose from 66.6 to 94.7. There were three failures in their series, and two required revision surgery.

CONCLUSION:

Reconstruction of coracoclavicular ligaments using gracilis tendon autograft offers a good option for the treatment of acute disruption of the AC joint.

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