

# Functional Results following Acromioclavicular Joint Reconstruction Using Gracilis Tendon Augmented with Fibertape: A Prospective Study

C. Yashavanth Kumar, Srinivas B. S. Kambhampati<sup>1</sup>, P. Rahul, N. R. Chirag

Department of Orthopaedics, Ramaiah Medical College, Bengaluru, Karnataka, <sup>1</sup>SKDGOC, Vijayawada, Andhra Pradesh, India

ORCID:

C. Yashavanth Kumar: <https://orcid.org/0000-0003-0662-8272>

P. Rahul: <https://orcid.org/0000-0003-4057-2196>

N. R. Chirag: <https://orcid.org/0000-0002-4449-479X>

Srinivas B. S. Kambhampati: <https://orcid.org/0000-0002-4978-3590>

## Abstract

**Background and Objectives:** Acromioclavicular joint (ACJ) injuries are one of the common shoulder problems. Various autografts are being used in the reconstruction of higher grades of ACJ disruptions. The present study evaluates functional and radiological results of acute ACJ disruptions treated using gracilis tendon autograft and FiberTape. **Materials and Methods:** Our study included 16 cases of acute ACJ disruptions. After a thorough clinicoradiological evaluation, the patient received ACJ reconstruction using a gracilis autograft and FiberTape by mini-open technique. The patient was followed up postoperatively at 3 weeks, 6 weeks, 3, and 6 months. At each follow-up, functional results were studied using Disability of the Arm, Shoulder, and Hand (DASH) scores. **Results:** The mean (standard deviation) preoperative coracoclavicular distance (CCD) was 18.32 (1.84) and postoperative CCD was 10.41 (2.74) mm. Mean DASH scores during follow-up were 71, 59, 31, and 1 at 3 weeks, 6 weeks, 3 months, and 6 months, respectively. A significant difference was found in the pre- and postoperative CCD and DASH t scores ( $P < 0.001$ ). **Conclusion:** The present study shows good functional and radiological results following mini-open ACJ reconstruction using gracilis autograft and FibreTape without postoperative complications and donor site morbidity.

**Keywords:** Acromioclavicular joint, FiberTape, gracilis tendon

## INTRODUCTION

Acromioclavicular dislocations are seen in young and active individuals, often involving sports persons, and hence, achieving good functional outcomes is important.<sup>[1,2]</sup> These account for 9% of all shoulder injuries.<sup>[1-3]</sup> Milder-grade injuries are managed conservatively.<sup>[3-6]</sup> The strategies for the treatment of higher-grade injuries evolved from nonanatomical techniques to more anatomical ones. The current approach to management favors anatomical reconstruction, and the techniques to reconstruct are also evolving. The main contenders to achieve a stable reduction of the joint have been implantable synthetic devices and biological grafts, primarily, autografts. Among the autografts, semitendinosus (ST), gracilis, peroneus brevis, and toe extensors have been used.

None of these grafts have been reported to be superior to the other, but these have been proven to be biomechanically, clinically, and radiologically superior to conventional nonanatomical techniques.<sup>[3,4,7,8]</sup> Autograft reconstruction has been preferred among the many techniques.<sup>[8-10]</sup>

ST graft has been reported to achieve good results. However, the use of ST graft resulted in significant donor site morbidity

**Address for correspondence:** Dr. C. Yashavanth Kumar, Ramaiah Medical College, Bengaluru - 560 054, Karnataka, India. E-mail: [kumyashwanth@gmail.com](mailto:kumyashwanth@gmail.com)

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** [WKHLRPMedknow\\_reprints@wolterskluwer.com](mailto:WKHLRPMedknow_reprints@wolterskluwer.com)

**How to cite this article:** Kumar CY, S. Kambhampati SB, Rahul P, Chirag NR. Functional results following acromioclavicular joint reconstruction using gracilis tendon augmented with fibertape: a prospective study. Arch Trauma Res 2022;11:123-8.

**Received:** 11-04-2022,

**Revised:** 19-09-2022,

**Accepted:** 01-10-2022,

**Published:** 20-12-2022.

### Access this article online

Quick Response Code:



Website:  
[www.archtrauma.com](http://www.archtrauma.com)

DOI:  
10.4103/atr.atr\_24\_22

and weakness of knee flexion in sports persons. This can be an issue since acromioclavicular joint (ACJ) injuries too are commonly seen in sports persons.

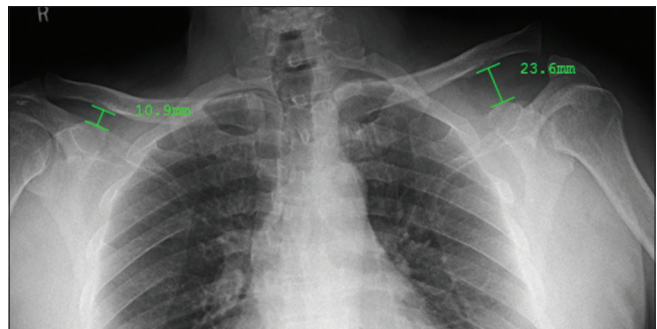
We hypothesized that gracilis tendon augmented with FiberTape would achieve similar results to ST autograft, and since it is a smaller tendon than ST, it would not result in donor site morbidity or weakness experienced following ST tendon used. Next, we evaluated the functional and radiological outcomes of reconstructions of ACJ type III and V injuries with this technique. No previous studies were found reporting on the reconstruction of the ACJ using gracilis tendon augmented with a FiberTape.

## MATERIALS AND METHODS

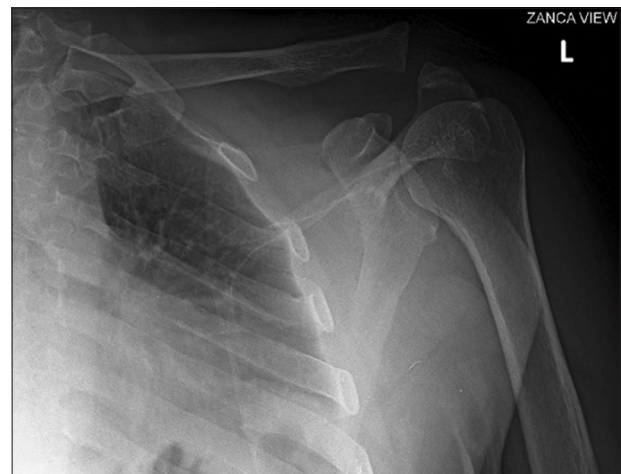
This prospective study was conducted at the tertiary care hospital for a period of 3 years from 2015 to 2018, comprising 16 patients with acute ACJ disruptions of grade III and V. Patients with acute ACJ disruption grade IV and VI, ipsilateral fractures, and those who underwent ipsilateral shoulder surgeries were excluded from the study. Informed consent was taken from all the patients included in the study. Institutional ethics committee approval was taken before the initiation of the study. The study was conducted in accordance with the principles laid down by the Declaration of Helsinki.

A thorough clinic radiological evaluation was done preoperatively including bilateral Zanca views for all cases [Figures 1 and 2]. The patient was operated in a supine position under general anesthesia. In the first step, the gracilis tendon was harvested from the ipsilateral knee with an oblique incision using a standard technique. Next, a whipstitch was applied on either end, and pretensioning of the graft was performed [Figure 3]. In the second step, a curvilinear incision was made over the ACJ to release the coracoid. To expose the base of the coracoid, the anterior deltoid was released from the clavicle. Then, two 4-mm tunnels were made on the lateral end of the clavicle 15 mm apart for the conoid tunnel and the trapezoid tunnel, 45 mm and 30 mm from the lateral end of the clavicle, respectively [Figure 4]. The harvested gracilis graft, together with a FiberTape (Arthrex, Inc., Naples, Florida), was looped under the coracoid and retrieved through both tunnels in the clavicle [Figure 5]. Then, the ACJ was reduced, and the FiberTape and gracilis graft were tightened, respectively. To prevent loosening, cross-fixation of the graft knot was done with nonabsorbable sutures (Ethicon 2-0). Finally, the wound was closed in layers, and the arm was immobilized in an arm pouch for 2 weeks.

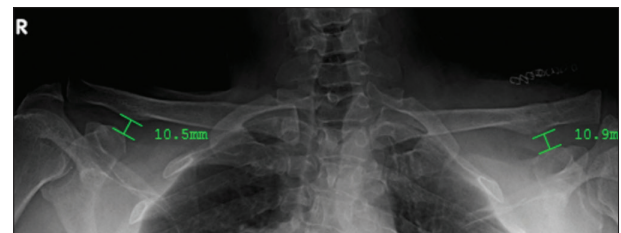
Clinical outcomes were assessed using the Disability of the Arm, Shoulder, and Hand outcome measure (DASH) score. All the patients were followed at four different time points, i.e., 3 weeks, 6 weeks, 3 months, and 6 months postoperatively. Radiological assessment was done with a Zanca view, and the coracoclavicular distance (CCD) of the operated side was compared with the normal side immediately postoperatively and



**Figure 1:** Bilateral Zanca view shoulder right side showing left ACJ disruption. ACJ: Acromioclavicular joint



**Figure 2:** Left shoulder Zanca View showing ACJ disruption. ACJ: Acromioclavicular joint



**Figure 3:** Gracilis graft used for reconstruction

at the final follow-up at 6 months [Figures 6 and 7]. The CCD of 25%–50% greater than that of the normal side indicates complete CC ligament disruption.

## Statistical analysis

The sample size was calculated by using G\*Power software. Assuming a small effect size (0.25) within the time point for the DASH score, at a 5% level of significance and 80% power, the sample size was 16 subjects. Here, 16 subjects were considered in the study.

Rv. 3.6.3 was used to analyze the data. The categorical variables were expressed as percentages, whereas continuous variables were expressed as mean  $\pm$  standard deviation (SD). Independent samples *t*-test was done for continuous variables.

A Chi-square test was done for categorical variables. Pearson correlation was done to determine the correlation between CCD and DASH scores. To compare the DASH score and CCD with a duration from injury to surgery, two-way repeated measures of ANOVA were used. Paired *t*-test with Bonferroni adjustment was used as *post hoc*.  $P < 0.05$  was taken as statistical significance.

## RESULTS

The demographic data of the study population are given in Table 1. The mean age of the patients was 34.44 (11.83) years with most between 20 and 40 years. A male predominance (81.3%) was noted. The injury was on the right side in most patients (56%) and predominately occurred in a traffic accident (81%). Most injuries were AC dislocation grade III (87.5%). The average time from injury to surgery was 9.18 (6.42) days; however, nearly half of the cases were operated upon within 7 days of injury (43.75%) [Table 1].

CCD was reduced from an average of 18.13 mm preoperatively to 10.41 mm on a postoperative day 1 and 10.34 mm after 6 months. Mean DASH scores during follow-up were  $70.68 \pm 5.57$ ,  $58.68 \pm 4.09$ ,  $31.06 \pm 3.06$ , and  $1.43 \pm 2.15$  at 3, weeks, 6 weeks, 3 months, and 6 months, respectively. Preoperative DASH scores were 0 in all cases. No evidence

of tunnel widening was found in any of our cases during follow-up.

Time taken from injury to surgery showed no interaction with DASH scores and CCD. However, DASH scores and CCD scores significantly differed between each time point ( $P < 0.001$ ) [Table 2].

Preoperative CCD exhibited a weak positive correlation with age and a weak negative correlation with the duration to surgery from injury. Postoperative CCD and CCD at 6 months were weakly negatively correlated with age and duration to surgery from injury ( $P > 0.05$ ) [Table 3].

Pre- and post-operative CCD scores have not correlated with DASH scores during the follow-up. Postoperative CCD showed a weak negative correlation with the DASH score at 3 and 6 weeks and at 3 months. Next, pre- and post-operative CCD at 6 months showed a weak positive correlation with the DASH score at 6 months [Table 4].

## DISCUSSION

The surgical approaches for ACJ dislocation have been classified in the past into five main types: (1) fixation using

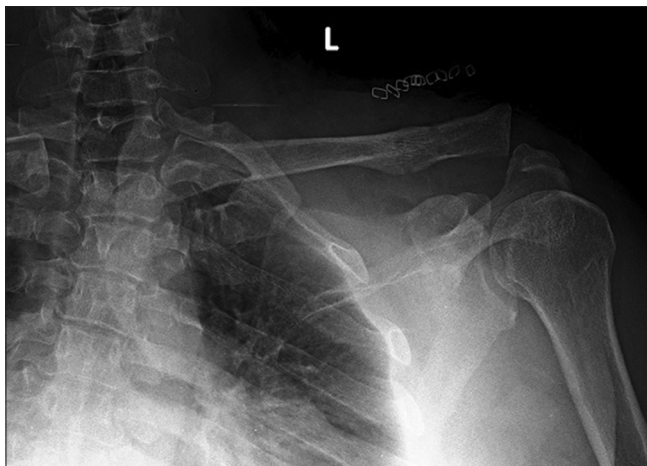


Figure 4: Intraoperative picture showing clavicle tunnels

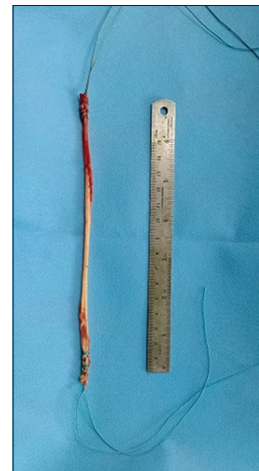


Figure 5: Intraoperative picture showing tunnels and graft

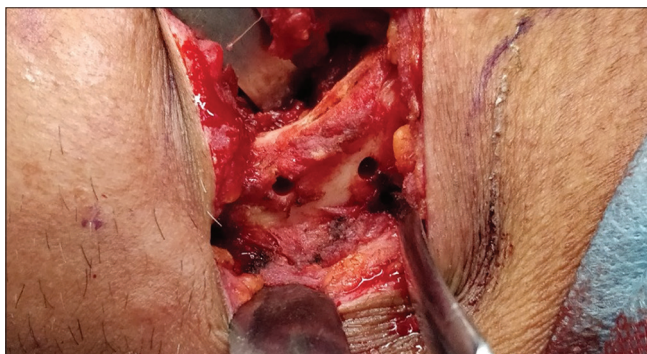


Figure 6: Postoperative left shoulder Zanca view



Figure 7: Postoperative bilateral Zanca view



pins, wires, or plates; (2) fixation of the coracoid to the clavicle using screws, synthetic slings, or tapes; (3) ligament substitution with the coracoacromial ligament; (4) dynamic muscle-tendon transfers; and (5) excision of the lateral end of the clavicle.<sup>[11]</sup> Anatomical reconstruction techniques may be added to this list. There are different approaches described to reconstruct ACJ anatomically – open, mini-open, or arthroscopic.<sup>[12-14]</sup>

Although augmentation of reconstruction has been described for Weaver–Dunn procedure, no augmentation with fiber wire of anatomical reconstruction procedures using gracilis autograft has been described in the literature.<sup>[15]</sup>

Biomechanical studies found the load-to-failure values (mean ± 3SD) for the intact CC, isolated conoid, and

isolated trapezoid ligaments to be 500 (6134) N, 394 (6170) N, and 440 (6118) N, respectively.<sup>[11]</sup>

The stiffness of FiberTape has been shown to be 23.9 N/mm and was the material with the greatest stiffness among the suture materials tested in a study for shoulder surgery.<sup>[16]</sup> Although it was shown that ACJ reconstruction with tendinous grafts exhibits greater mechanical resistance, the combined strength of FiberTape and gracilis has not been tested. In the knee joint, FiberTape has been used as an internal brace in reconstructions of partial or complete Anterior Cruciate Ligament (ACL) injuries.<sup>[17]</sup>

ACJ reconstruction using tendon grafts is not a novel technique.<sup>[17,18]</sup> Disadvantages of this technique are donor site morbidity, technicality, the incidence of tunnel widening, and the risk of fractures related to the tunnels. However, avoiding the need for implant removal, hardware migration, infection, and foreign body reaction made ACJ reconstructions using hamstring graft tendons more popular than other techniques.<sup>[19]</sup> These reconstructions, usually supplemented with cerclage fixation using synthetic ligament substitutes such as Dacron, Mersilene tape, and polydioxanone, provide initial stability till the autografts heal and take over biological stability.<sup>[20,21]</sup> Good-to-excellent results were reported even for revision surgery of ACJ using autografts.<sup>[22]</sup>

In our study, patients submitted to mini-open ACJ reconstruction using gracilis autograft and FiberTape resulted in excellent functional and radiological outcomes without postoperative complications, donor site morbidities, and revision procedures at the final follow-up of 6 months. This finding suggests that the technique potentially can result in satisfactory AC stabilization with complete soft-tissue healing. Similarly, a case report where the CC ligament was reconstructed using a gracilis tendon graft also showed improved functional outcomes according to constant scores during the follow-up.<sup>[23,24]</sup>

Harvesting both ST and gracilis for ACJ repair resulted in persistent atrophy and frequent retraction of ST muscle on the operated side.<sup>[25]</sup> One prospective study that harvested gracilis tendons showed weakness in knee flexion but did

**Table 1: Patient characteristics**

Variables	n=16, n (%)
Age group (years)	
<20	1 (6.25)
21-30	6 (37.5)
31-40	5 (31.25)
>40	4 (25)
Sex	
Female	3 (18.75)
Male	13 (81.25)
Injury side	
Left	7 (43.75)
Right	9 (56.25)
Injury mechanism	
Fall from height	1 (6.25)
Road traffic accident	13 (81.25)
Sports	2 (12.5)
Dislocation grade	
III	14 (87.5)
V	2 (12.5)
Duration from injury to surgery (days)	
<7	7 (43.75)
7-14	6 (37.5)
>14	3 (18.75)

**Table 2: Comparison of disability of the arm, shoulder, and hand score and coracoclavicular distance with duration from injury to surgery**

	Duration from injury to surgery (days)			P
	<7 days (n=7)	7-14 days (n=6)	>14 days (n=3)	
DASH score				
3 weeks	69±4.62	72.17±6.21	71.67±7.37	<0.001 <sup>T*</sup>
6 weeks	57.29±4.35	60.17±4.67	59±1	0.4414 <sup>D</sup>
3 months	31.14±2.61	29.83±2.23	33.33±5.03	0.5810 <sup>T:D</sup>
6 months	0.71±1.89	2.17±2.23	1.67±2.89	
Coracoclavicular distance				
Preoperative	19±1.41	17.33±1.51	17.67±0.58	<0.001 <sup>T*</sup>
Postoperative	10.57±0.93	10.33±0.52	10.17±0.29	0.2311 <sup>D</sup>
6 months	10.43±0.79	10.33±0.52	10.17±0.29	0.4993 <sup>T:D</sup>

T: Time, D: Duration from injury to surgery, T: D: Interaction, DASH: Disability of the arm, shoulder and hand

**Table 3: Correlation of coracoclavicular distance with age and duration from injury to surgery**

Coracoclavicular distance	Age	Duration from injury to surgery (days)
Preoperative coracoclavicular distance		
R	0.02676	-0.3764
P	0.9216	0.1508
Postoperative coracoclavicular distance		
R	-0.1379	-0.2371
P	0.6107	0.3767
Coracoclavicular distance at 6 months		
R	-0.01326	-0.2350
P	0.9611	0.3809

**Table 4: Correlation between pre- and postoperative coracoclavicular distance with Disability of the Arm, Shoulder, and Hand scores**

Coracoclavicular distance	DASH score			
	At 3 weeks	At 6 weeks	At 3 months	At 6 months
Preoperative	-0.34	-0.46	-0.11	0.02
	0.201	0.073	0.703	0.932
Postoperative	0.01	-0.43	-0.06	-0.02
	0.972	0.101	0.824	0.954
At 6 months	0.22	-0.05	-0.06	0.23
	0.402	0.858	0.805	0.376

DASH: Disability of the Arm, Shoulder, and Hand

not affect subjective knee function.<sup>[23]</sup> The gracilis tendon autograft has been reported for the reconstruction of the ACJ in the past. Some techniques, reported as single cases included using GraftMax and No 5 Hi-Fi Suture (Conmed), double fixation system, gracilis weave using tunnels in distal clavicle, and acromion or a transclavicular loop technique along with tightrope straddled by the gracilis tendon on either side.<sup>[26-29]</sup> FiberTape has also been used, but with ST tendon for reconstructing ACJ.<sup>[14]</sup> When both tendons (ST and G) were used to reconstruct ACJ with a mean follow-up of 4.5 years, Virtanen *et al.* found that almost half of their cases failed and common complications included lateral clavicle osteolysis, fractures of coracoid and clavicle, and tunnel widening.<sup>[12]</sup> This could be because of the bigger tunnel diameter required for both tendons. A prospective study that compared the two graft techniques (ST and gracilis) reported no significant difference in terms of power and joint stability and postoperative outcome after ACL reconstruction in the knee.<sup>[25,30]</sup>

While some studies reported that longer time from injury to surgery adversely affected the CC ratio, in this study, we found no significant correlation of duration from injury to surgery with either DASH score or CCD.<sup>[19,21]</sup> Lädermann *et al.* found

results similar to ours.<sup>[31]</sup> They did not find any difference in outcomes between the early or delayed reconstruction of ACJ, with the delayed group reconstructed using the gracilis tendon allograft. No significant difference in ACJI scores, Taft scores, VAS, SSV, or overall satisfaction was found at an average follow-up of 3.4 years (1–7.1 years).

Furthermore, we found that pre- and postoperative CCDs were not correlated with patient age or time of surgery from injury. In contrast, one previous study found that CCDs ( $r = 0.678$ ,  $P = 0.010$ ) and its differences ( $r = -0.763$ ,  $P = 0.004$ ) were correlated well with time elapsing between the injury and the surgery but not correlated with the patient's age.<sup>[23]</sup>

In our study, the follow-up time chosen was only 6 months as it is sufficient to show improvement after surgery in most musculoskeletal conditions. The present study indeed showed effective clinical and radiographic outcomes within 6 months after the surgical treatment of ACJ dislocation. CCD that measures the integrity of the ligament reconstruction reduced within the range 11–13 mm postoperatively after ACJ repair, demonstrating good radiological outcome. Next, DASH scores that detect the degree of disability and differentiate the changes in disability in patients with upper extremity disorders indicated excellent clinical outcomes after ACJ reconstruction.<sup>[24]</sup> Correlation analysis showed, although insignificant, CCD positively correlated with the DASH score. This indicates that radiological results correlate with the clinical outcome.

The current treatment option needs to be compared, preferably in a randomized controlled trial, against other conventional and standard techniques with a longer follow-up, to establish the role of this technique in the treatment algorithm of this condition.

Limitations of our study include a relatively short period of follow-up compared to previous studies and the presence of grade III ACJ disruptions. Future studies, preferably randomized controlled trials comparing standard techniques with this technique using general health scores such as SF12 and pain score may be included. The use of this technique for established ACJ disruptions requiring surgery would confirm the place of this technique in the treatment algorithm of ACJ disruptions.

### Article focus

- Gracilis as donor graft for acute acromioclavicular joint reconstruction without any donor site morbidity
- To study the study the functional and radiological results of gracilis in reconstruction acromioclavicular joint disruptions
- Comparing various graft options and their limitations.

### Strengths and limitations

- No similar studies using gracilis tendon have been reported in literature.
- Functional and radiological results are assessed following reconstruction.

- Low sample size and nonrandomization are limitations.

#### Level of Evidence: IV.

### CONCLUSION

ACJ repair with an autogenous gracilis tendon graft and FiberTape appears to be favorable in patients with acute type III and V ACJ dislocation with minimal morbidity to the donor site.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### REFERENCES

- Fraser-Moodie JA, Shortt NL, Robinson CM. Injuries to the acromioclavicular joint. *J Bone Joint Surg Br* 2008;90:697-707.
- Rockwood CA, Williams GR, Young CD. Injuries to the Acromioclavicular Joint. In: Rockwood CA, Bucholz RW, Court-Brown CM, Heckman JD, Tornetta P, editors. *Fract Adults*. Philadelphia, PA: Lippincott Williams & Wilkins; 2010.
- Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. *Am J Sports Med* 2007;35:316-29.
- Beitzel K, Cote MP, Apostolakis J, Solovyova O, Judson CH, Ziegler CG, *et al.* Current concepts in the treatment of acromioclavicular joint dislocations. *Arthroscopy* 2013;29:387-97.
- Ejam S, Lind T, Falkenberg B. Surgical treatment of acute and chronic acromioclavicular dislocation Tossy type III and V using the Hook plate. *Acta Orthop Belg* 2008;74:441-5.
- Spencer EE Jr. Treatment of grade III acromioclavicular joint injuries: A systematic review. *Clin Orthop Relat Res* 2007;455:38-44.
- Frank RM, Cotter EJ, Leroux TS, Romeo AA. Acromioclavicular joint injuries: Evidence-based treatment. *J Am Acad Orthop Surg* 2019;27:e775-88.
- Lee SJ, Nicholas SJ, Akizuki KH, McHugh MP, Kremenic IJ, Ben-Avi S. Reconstruction of the coracoclavicular ligaments with tendon grafts: A comparative biomechanical study. *Am J Sports Med* 2003;31:648-55.
- Gonzalez R, Damacén H, Nyland J, Caborn D. Acromioclavicular joint reconstruction using peroneus brevis tendon allograft. *Arthroscopy* 2007;23:4.e1-4.
- Nordin JS, Olsson O, Lunsjö K. The gracilis tendon autograft is a safe choice for orthopedic reconstructive procedures: A consecutive case series studying the effects of tendon harvesting. *BMC Musculoskelet Disord* 2019;20:138.
- Harris RI, Wallace AL, Harper GD, Goldberg JA, Sonnabend DH, Walsh WR. Structural properties of the intact and the reconstructed coracoclavicular ligament complex. *Am J Sports Med* 2000;28:103-8.
- Virtanen KJ, Savolainen V, Tulikoura I, Remes V, Haapamäki V, Pajarinen J, *et al.* Surgical treatment of chronic acromioclavicular joint dislocation with autogenous tendon grafts. *Springerplus* 2014;3:420.
- Selim NM. Minimally invasive approach for stabilization of type III acute acromioclavicular dislocation by using suture anchors. *Egypt Orthop J* 2017;52:1-5.
- Tauber M, Valler D, Lichtenberg S, Magosch P, Moroder P, Habermeyer P. Arthroscopic stabilization of chronic acromioclavicular joint dislocations: Triple- versus single-bundle reconstruction. *Am J Sports Med* 2016;44:482-9.
- Zooker CC, Parks BG, White KL, Hinton RY. TightRope versus fiber mesh tape augmentation of acromioclavicular joint reconstruction: A biomechanical study. *Am J Sports Med* 2010;38:1204-8.
- Taha ME, Schneider K, Clarke EC, O'Briain DE, Smith MM, Cunningham G, *et al.* A biomechanical comparison of different suture materials used for arthroscopic shoulder procedures. *Arthroscopy* 2020;36:708-13.
- Assuncao JH, Ferreira Neto AA, Benegas E, Malavolta EA, Gracitelli ME, Silva FB. Coracoclavicular reconstruction using tendinous graft for chronic acromioclavicular joint dislocation. *Acta Orthop Bras* 2011;19:299-304.
- Ho JP, Ahmad Faizal A, Sivapathasundaram N. Acromioclavicular reconstruction using autogenous semitendinosus tendon graft and the importance of postoperative rehabilitation: A case report. *Malays Orthop J* 2013;7:30-2.
- Frank RM, Bernardoni ED, Cotter EJ, Verma NN. Anatomic acromioclavicular joint reconstruction with semitendinosus allograft: Surgical technique. *Arthrosc Tech* 2017;6:e1721-6.
- Morrison DS, Lemos MJ. Acromioclavicular separation. Reconstruction using synthetic loop augmentation. *Am J Sports Med* 1995;23:105-10.
- Stam L, Dawson I. Complete acromioclavicular dislocations: Treatment with a dacron ligament. *Injury* 1991;22:173-6.
- Tauber M, Eppel M, Resch H. Acromioclavicular reconstruction using autogenous semitendinosus tendon graft: Results of revision surgery in chronic cases. *J Shoulder Elbow Surg* 2007;16:429-33.
- Law KY, Yung SH, Ho PY, Chang HT, Chan KM. Coracoclavicular ligament reconstruction using a gracilis tendon graft for acute type-III acromioclavicular dislocation. *J Orthop Surg (Hong Kong)* 2007;15:315-8.
- Sidharta MT, Wien Aryana IG, Arimbawa IB. Functional outcome following coracoclavicular ligament reconstruction using a gracilis tendon graft for acute type III acromioclavicular dislocation: A case report. *Int J Res Med Sci* 2018;6:2836-40.
- Burks RT, Crim J, Fink BP, Boylan DN, Greis PE. The effects of semitendinosus and gracilis harvest in anterior cruciate ligament reconstruction. *Arthroscopy* 2005;21:1177-85.
- Leong YC, Muhammad-Suhairi J. Graft and button modification of technique of coracoclavicular joint reconstruction in treatment of chronic type V acromioclavicular joint dislocation: A case report. *Malays Orthop J* 2019;13:45-8.
- Aramberri-Gutiérrez M, Ferrando A, Tiso D'Orazio G, Sines Castro F, Mediavilla I. A modified arthroscopic technique of gracilis tendon graft with double fixation system for treatment of type V acromioclavicular injuries: A case report. *JBS Case Connect* 2019;9:e0234.
- Lewicky YM, Robertson CM, Foran JR. Anatomic coracoclavicular and acromioclavicular ligament reconstruction for high-grade acromioclavicular separations: The gracilis weave. *Orthopedics* 2010;33:166-71.
- Scheibel M, Ifesanya A, Pauly S, Haas NP. Arthroscopically assisted coracoclavicular ligament reconstruction for chronic acromioclavicular joint instability. *Arch Orthop Trauma Surg* 2008;128:1327-33.
- Vairo GL. Knee flexor strength and endurance profiles after ipsilateral hamstring tendons anterior cruciate ligament reconstruction. *Arch Phys Med Rehabil* 2014;95:552-61.
- Lädemann A, Denard PJ, Collin P, Cau JB, Van Rooij F, Piotton S. Early and delayed acromioclavicular joint reconstruction provide equivalent outcomes. *J Shoulder Elbow Surg* 2021;30:635-40.