



Sternoclavicular joint reconstruction for traumatic acute and chronic anterior and posterior instability: Patient-reported outcomes at a minimum of 2 years

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Abstract

Background: Instability of the sternoclavicular joint (SCJ) is a rare problem that is often treated closed, with few published outcomes of surgical treatment with tendon graft reconstruction.

Methods: We reviewed a consecutive series of patients who underwent tendon graft reconstruction for SCJ instability over a 7-year period. Cases with acute fractures or fewer than 2 years of follow-up were excluded. Pre- and post-operative function and pain were assessed using Single assessment numeric evaluation (SANE), simple shoulder test (SST), and visual analog scale (VAS) outcome measures.

Results: Thirty cases were included, with 27 (90%) available for follow-up at a minimum of 2 years postoperatively. SANE scores improved from a median of 40 to 90. SST scores improved from a median of 3 positive responses to a median of 12 on a 12-point scale. VAS scores decreased from a median of 7 to 0 points. One patient underwent reoperation for recurrent instability and wound dehiscence. Three (11%) patients did not achieve a minimum 30% of maximum possible improvement in SST scores.

Conclusions: Tendon graft reconstruction for SCJ instability is a safe procedure with a low complication rate and statistically and clinically significant improvements in patient-reported outcome measures at 2-year minimum follow-up.

Level of evidence: Level IV: Therapeutic.

Keywords

clavicle, joint instability, figure-of-eight, sternoclavicular joint, tendon graft

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Introduction

Dislocations of the sternoclavicular joint (SCJ) are a rare injury, often associated with high-energy direct trauma to the chest.¹ The majority of these injuries can be treated with closed reduction in the operating room.² A small minority of injuries remain chronically unstable, resulting in limitations of functional activities. Due to the proximity of the SCJ to mediastinal structures, posterior instability of the SCJ can also result in difficulty with swallowing and breathing and can cause vascular compromise.¹

Surgical treatment has been recommended in cases where closed reduction does not result in satisfactory stability of the SCJ, but there have been few published data regarding clinical outcomes after reconstruction of the unstable SCJ in skeletally mature patients.³ Historical techniques for reconstructing the SCJ have included local soft-tissue repair, reconstruction with synthetic material, open reduction and internal fixation with screws and/or plates,

medial clavicular resection with or without ligament repair, and tendon transfers.⁴ Tendon graft reconstruction of the unstable SCJ has gained popularity in recent years as a result of the biomechanical stability provided by a figure-of-eight configuration.⁵ Several case series from the past decade have shown good clinical outcomes with a low complication rate.^{4–13} The purpose of this study was to review a consecutive series of tendon graft

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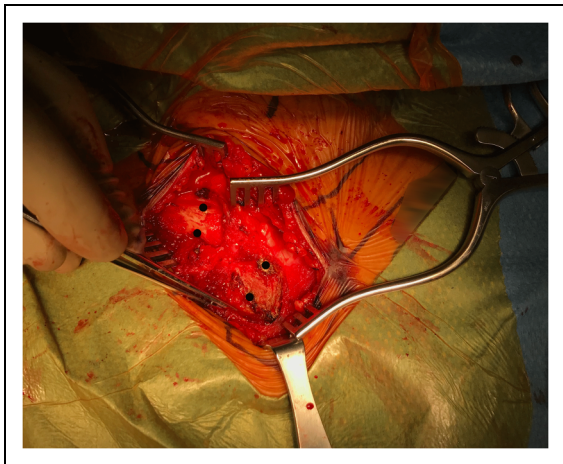


Figure 3. Tunnel sites for sternoclavicular joint reconstruction at the clavicle and sternum.



Figure 4. Unicortical tunnels are created for cases of anterior sternoclavicular instability.

bandage strip can be wrapped around the drill to mark the desired tunnel depth (Figure 5). The tunnels are connected with right-angle clamps, and the graft (semitendinosus allograft, prepared prior to SCJ incision and prepared with 2 size 0 looped nonabsorbable sutures) is shuttled through the tunnels with a Hewson suture passer, placing 2 parallel arms anteriorly (Figure 6). With the graft in the tunnels, it is demonstrated that the appropriate amount of tension and stability can be returned to the joint when tightened



Figure 5. Drill depth can be marked with an adhesive tape.

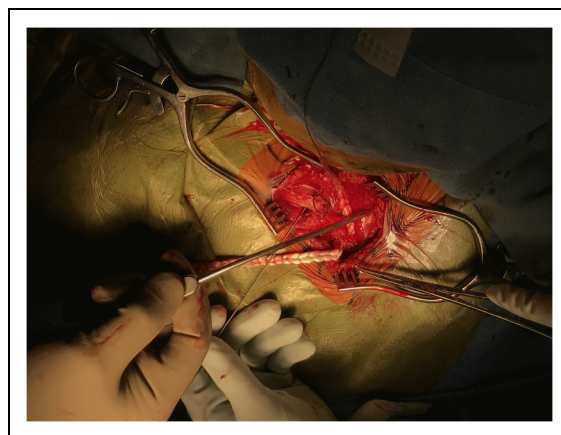


Figure 6. The tendon graft is passed through the unicortical tunnels.

(Figure 7). The graft is loosened to allow for a capsulorrhaphy to be performed with 2-0 nonabsorbable sutures in a figure-of-eight fashion, which greatly stabilizes the joint on its own. The graft is then secured as previously mentioned and oversewn with 2-0 nonabsorbable sutures until it is robustly fixed (Figure 8). Once the graft is snug, the joint is examined once again for clavicular stability.

For posterior instability, special equipment includes a posterior cruciate ligament (PCL) tunnel-aiming system to ensure added safety for tunnel placement, an 18-gauge

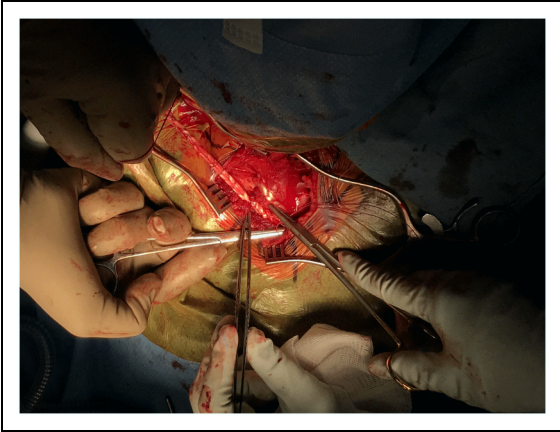


Figure 7. Graft configuration for anterior sternoclavicular instability.

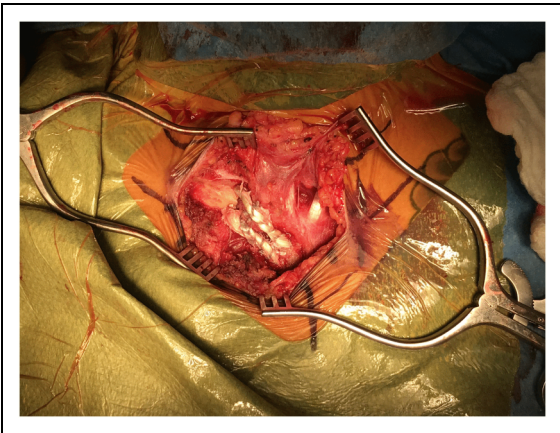


Figure 8. Final graft position after suture fixation.

wire to create smooth passing loops, and a 2-0 nonabsorbable suture for capsular repair.⁷ An allograft semitendinosus tendon is used in most cases, unless the patient has a preference for autologous tissue. After exposing the SCJ, a vertical incision is then made at the sternal notch between the sternothyroid muscles similar to the starting incision made for mediastinoscopy. Blunt-finger dissection is performed posterior to the sternum and clavicle. It is important that the posterior aspects of the SCJ and medial clavicle are free of soft-tissue attachments. Two bicortical tunnels are then placed through the medial clavicle and sternum for graft passage. Care should be taken to ensure an adequate bone bridge of at least 1 cm between the tunnels to prevent fracture. A PCL tibial-aiming guide is carefully placed behind the medial clavicle. A safety stop is attached to the drill guide at the measured length, and a guide wire is drilled just through the posterior cortex of the clavicle. The PCL-aiming guide and guide wire are removed. The blunt end of the guide wire is then inserted through the drilled

hole and captured in a blunt-tipped elevator. A tunnel can then be reamed over the guide wire to the desired diameter; this is based on the measured graft width and is typically 4 mm. Power reaming is used until the posterior cortex is reached. After the cortex is reached, the tunnel can be completed by hand reaming. A finger can be placed directly onto the posterior cortex of the clavicle during this step for added safety. This process is repeated at the clavicle and at the sternum twice, resulting in 4 parallel tunnels. Smooth, curved loops for suture passage are created using doubled segments of 18-gauge wire. The curve of the wire loops is fashioned so that the loop can safely pass through the tunnels out the sternal notch incision. The field is irrigated to allow for easier graft passage, and the graft is pulled through the tunnels in a figure-of-eight configuration. The parallel limbs of the figure-of-eight graft are positioned at the posterior aspect of the SCJ, and the limbs are crossed at the anterior aspect of the joint.

After graft passage, the SCJ capsulotomy is repaired using 2-0 nonabsorbable suture, with the joint held in a reduced position by medial pressure on the ipsilateral shoulder. The graft is then held taut, and the crossing ends of the graft are sutured to one another anteriorly with horizontal mattress 2-0 nonabsorbable sutures. The sutures should be aligned obliquely to the graft's line of pull to ensure that there is no loss of tension once the shoulder is no longer supported. If the sternal head of the SCM was detached, it should be repaired anatomically to ensure that there is no alteration of cosmesis or neck discomfort.

Postoperative course

A shoulder immobilizer is placed at the conclusion of surgery. The patient should perform only hand, wrist, and elbow active range of motion (AROM) for the first 2 weeks. From 2 to 6 weeks, supine active-assisted range of motion is initiated with a limit of 90 degrees forward elevation. The sling is discontinued at 6 weeks, but horizontal abduction past neutral is still restricted. From 6 to 9 weeks, AROM is advanced to a goal of 120 degrees of forward elevation and 90 degrees of abduction. Full AROM is targeted for 12 weeks. Light resistance weight training may be initiated at 3 to 4 months postoperatively, and gradual resumption of prior activities is expected from 4 to 6 months after surgery.

Data collection

The following patient-reported outcome scores were collected preoperatively and at latest follow-up: single assessment numeric evaluation (SANE), simple shoulder Test (SST), and visual analog scale (VAS) for pain. The Rockwood SCJ score¹⁵ was calculated on the basis of reported limitations in strength, range of motion and work, VAS pain score, and SANE subjective outcome score. Patients were also asked about any complications

or reoperations they had experienced, whether they had any residual limitations with regard to activities of daily living or sports, and whether they would recommend the procedure to others.

Statistical analysis

Statistical analyses were performed using JMP version 9 (SAS Institute, Cary, NC). Paired *t* tests were used for comparison from preoperative to postoperative matched pairs. A *P* value of <.05 was defined as statistically significant.

Results

During the retrospective study period, the senior author performed 30 cases of primary SCJ reconstruction using a tendon graft. Of these, 21 procedures were for anterior instability and 9 were for posterior instability. At a minimum of 2 years after surgery, 27 of the 30 cases (90%) were available for follow-up with patient-reported outcomes (median follow-up, 3 years; range, 2–7 years). Patient demographics are reported in Table 1.

Minimum 2-year outcomes for tendon graft reconstructions for SCJ instability: Clinical outcome measures are shown in Table 2

SANE scores improved from a median of 40 to 90 at latest follow-up (*P* < .0001). SST scores improved from a median of 3 positive responses at baseline to a median of 12 on a 12-point scale (*P* < .0001). VAS scores for pain decreased from a median of 7 to 0 points (*P* < .0001). One patient with an initial diagnosis of anterior instability underwent reoperation for recurrent instability; there were no additional reoperations related to the SCJ reconstruction. Three patients did not achieve a minimum 30% of

maximum possible improvement (MPI) in SST scores (11%); of these, 1 was the aforementioned patient who underwent reoperation, and 2 patients were in the posterior instability group.

One patient underwent reoperation for instability after a motor vehicle accident. A total of 3 patients had persistent symptoms and did not achieve a minimum 30% MPI in SST scores. One patient, a farmer with an active worker's compensation claim, had continued difficulty with overhead activity at latest follow-up. He reported that he would, however, recommend the surgery to a friend or family member. Another patient had previously undergone a 5-cm medial clavicle resection at an outside institution with subsequent difficulty with dysphonia, stridor, and neck pain. Following a technically successful reconstruction procedure, pain and functional limitations unfortunately persisted.

Clinical improvement and stability at a minimum of 2 years after surgery

In this series, patients who underwent tendon graft reconstruction for SCJ instability had significant clinical

Table 1. Patient demographics.

	Anterior instability	Posterior instability	All
N (%)	19 (70%)	8 (30%)	27
Gender			
Male (%)	10 (53%)	4 (50%)	14
Female (%)	9 (47%)	4 (50%)	13
Age, median (IQR)	30 (17–50)	51 (43–61)	43 (19–55)
Time from injury to surgery, months, median (IQR)	17 (12–27)	24 (6–63)	22 (12–36)

Table 2. Outcomes.

	Anterior instability (n = 18)	Posterior instability (n = 9)	All patients (n = 27)
SANE			
Preoperative, median (IQR)	40 (25–60)	40 (30–69)	40 (29–60)
Latest follow-up, median (IQR)	95 (80–100)	85 (50–100)	90 (79–100)
Simple shoulder test (SST)			
Preoperative, median (IQR)	5 (2–8)	1 (1–3)	3 (1–7)
Latest follow-up, median (IQR)	12 (9–12)	12 (5–12)	12 (9–12)
Visual analog scale, Pain			
Preoperative, median (IQR)	7 (5–9)	8 (6–9)	7 (5–9)
Latest follow-up, median (IQR)	1 (0–1)	0 (0–5)	0 (0–1)
Rockwood SCJ score			
Latest follow-up, median (IQR)	14 (12–15)	14 (9–15)	14 (12–15)

Table 3. Selected published outcomes, open treatment of sternoclavicular instability with tendon reconstruction.

Author(s)	Year	N (shoulders)	Loss to follow-up	Minimum follow-up	Technique	Outcomes	Reoperations
Guan and Wolf	2013	6	33%	≥2 years	Autograft hamstring; unicortical	↑DASH	1 of 6 (17%)
Singer et al.	2013	6	None	≥14 months	Autograft hamstring	↑DASH	None
Bak and Fogh	2014	27	16%	≥2 years	Autograft with suture anchor	↑WOSI	2 of 27 (7%)
Sabatini et al.	2015	10	9%	≥1 year	4.5 mm semitendinosus allograft	↑ASES and VAS	1 of 10 (10%)
Kusnezov et al.	2016	12	None	≥1.3 years	Various	↑VAS, 71% return to full duty	1 of 12 (8%)
Petri et al.	2016	18	14%	≥1 year	Autograft hamstring	↑ASES, QuickDASH, SANE and pain scores	1 of 18 (6%)
Sanchez-Sotelo et al.	2018	19	None	≥1 year	Allograft semitendinosus	↑VAS	2 of 19 (11%)
Gowd et al.	2019	12	29%	≥2 years	Allograft hamstring	↑ASES and VAS	None
Lacheta et al.	2020	18	18%	≥5 years	Autograft hamstring	↑ASES, SANE, QuickDASH and SF-12	3 of 18 (17%)
Present study		27	10%	≥2 years	Allograft hamstring	↑SANE, SST and VAS	1 of 27 (4%)

DASH: Disability of the arm, shoulder and hand score; WOSI: Western Ontario shoulder instability score; OSIS: Oxford shoulder instability score; ASES: American Shoulder and Elbow Surgeons score; SANE: single assessment numeric evaluation; SF-12: 12-item short form quality of life survey; VAS: visual analog score; SST: simple shoulder test.

improvement with regard to patient-reported pain and functional outcome measures. There was 1 reoperation for recurrent instability. Most patients (89%) achieved a minimum 30% MPI in patient-reported outcomes.

Discussion

Over the last decade, there has been renewed interest in reconstructive techniques for the patient with severe symptoms and chronic SCJ instability. In 2014, Uri et al.⁸ reported a case series of 32 reconstructions using a SCM transfer technique, in which a segment of the proximal SCM was detached, looped around the clavicle, and secured to the sternum with nonabsorbable suture. Notably, these authors preserved the medial clavicle if no evidence of arthritis was noted. Postoperative instability was observed in only 2 patients, with otherwise excellent improvement in patient-reported outcomes. Bak and Fogh⁷ reported 27 reconstructions using autograft tendon secured with a suture anchor, also with improvements in patient-reported outcomes and with 2 complications requiring reoperation.

In 1938, Bankart¹⁶ described a technique for reconstruction of the unstable SCJ using fascia lata autograft passed through bone tunnels in the clavicle and manubrium. Most recent clinical series have used a variation of this technique using autograft or allograft tendon passed through bone tunnels. As shown in Table 3, these series demonstrate significant improvements in patient-reported outcomes at follow-up periods ranging from 1 to 5 years and reoperation rates ranging from 0% to 17%. The present study demonstrates similar findings in one of the largest case series to date, with statistically significant improvements in patient-reported outcomes and pain in addition to a low reoperation rate.

In this series, resection of the medial clavicle was kept to a minimum, generally less than 5 mm. This is in contrast to prior authors, who often recommended substantial resection of the medial clavicle.¹⁷ Biomechanical testing by Katthagen et al.¹⁸ has supported a “minimalist” approach to resection, with a 5-mm resection parallel to the joint line providing adequate joint decompression. A clinical outcome study by the same research group confirmed a low rate of post-traumatic or post-reconstruction arthritis

at minimum 5-year follow-up.⁵ This mirrors the experience of the senior author, who has not observed long-term sequelae of inadequate resection. Conversely, the sequelae of excessive resection can be challenging to manage.¹⁹

Clinical reports to date regarding tendon graft reconstruction for posterior instability have been limited to very small case series. A recent systematic review⁴ identified only 11 previously published cases of tendon graft reconstruction for chronic posterior SCJ instability, with the largest series²⁰ reporting outcomes of 4 cases. All 4 of these patients returned to military duty with improvements in pain and range of motion; however, patient-reported outcome measures were not included in this study. This makes it difficult to counsel patients regarding the expected outcomes after this procedure. In our series, there were no reoperations or major complications among 9 patients with reconstruction performed for posterior instability. However, 2 of these 9 patients did not reach 30% MPI in their SST score at latest follow-up. The reasons for this disparity in outcomes are not clear and require further study.

Limitations

Limitations of this study include: (a) the lack of long-term clinical and radiographic follow-up to ascertain whether the minimalist resection strategy in chronic instability cases with concomitant SCJ arthritis results in symptomatic arthritis, (b) the lack of additional patient-reported outcome measures, such as the American Shoulder and Elbow Surgeons score or quality of life measures, and (c) the fact that all surgeries were performed in a quaternary referral practice that may not be generalizable to other practice settings.

In conclusion, patients who underwent tendon graft reconstruction for SCJ instability had good functional outcomes and a high level of return to work and sport. The presented techniques for reconstruction of anterior and posterior instability allow for safe tunnel placement with durable 2-year outcomes.

Contributorship

JSS did conceptualization, methodology, project administration, supervision, writing the original draft, reviewing and editing. KMP did conceptualization, formal analysis, investigation, methodology, project administration, writing the original draft, reviewing and editing. WJW did formal analysis, investigation, methodology, writing the original draft, reviewing and editing. All authors approved the final version.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Institutional Review Board approval (IRB# STUDY00008239) was granted by the University of Washington Human Subjects Division for a retrospective review of a longitudinal, prospectively compiled outcomes database.

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Informed consent

Informed consent was waived by the University of Washington Institutional Review Board (IRB#STUDY00008239).

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References

- Groh GI, Wirth MA and Rockwood CA Jr. Treatment of traumatic posterior sternoclavicular dislocations. *J Shoulder Elbow Surg* 2011; 20: 107–113.
- Spencer EE Jr and Kuhn JE. Biomechanical analysis of reconstructions for sternoclavicular joint instability. *J Bone Joint Surg Am* 2004; 86: 98–105.
- Provencher MT, Bernholt DL, Peebles LA, et al. Sternoclavicular joint instability and reconstruction. *J Am Acad Orthop Surg* 2022; 30: e1076–e1083.
- Kusnezov N, Dunn JC, DeLong JM, et al. Sternoclavicular reconstruction in the young active patient: risk factor analysis and clinical outcomes at short-term follow-up. *J Orthop Trauma* 2016; 30: e111–e117.
- Lacheta L, Dekker TJ, Goldenberg BT, et al. Minimum 5-year clinical outcomes, survivorship, and return to sports after hamstring tendon autograft reconstruction for sternoclavicular joint instability. *Am J Sports Med* 2020; 48: 939–946.
- Petri M, Greenspoon JA, Horan MP, et al. Clinical outcomes after autograft reconstruction for sternoclavicular joint instability. *J Shoulder Elbow Surg* 2016; 25: 435–441.
- Bak K and Fogh K. Reconstruction of the chronic anterior unstable sternoclavicular joint using a tendon autograft: medium-term to long-term follow-up results. *J Shoulder Elbow Surg* 2014; 23: 245–250.
- Uri O, Barmpagiannis K, Higgs D, et al. Clinical outcome after reconstruction for sternoclavicular joint instability using a sternocleidomastoid tendon graft. *J Bone Joint Surg Am* 2014; 96: 417–422. doi:10.2106/JBJS.M.00681
- Guan JJ and Wolf BR. Reconstruction for anterior sternoclavicular joint dislocation and instability. *J Shoulder Elbow Surg* 2013; 22: 775–781.
- Singer G, Ferlic P, Kraus T, et al. Reconstruction of the sternoclavicular joint in active patients with the figure-of-eight technique using hamstrings. *J Shoulder Elbow Surg* 2013; 22: 64–69.

11. Sabatini JB, Shung JR, Clay TB, et al. Outcomes of augmented allograft figure-of-eight sternoclavicular joint reconstruction. *J Shoulder Elbow Surg* 2015; 24: 902–907.
12. Sanchez-Sotelo J, Baghdadi Y and Nguyen NTV. Sternoclavicular joint allograft reconstruction using the sternal docking technique. *JSES Open Access* 2018; 2: 190–193.
13. Gowd AK, Liu JN, Garcia GH, et al. Figure-of-eight reconstruction of the sternoclavicular joint: outcomes of sport and work. *Orthopedics* 2019; 42: 205–210.
14. von Elm E, Altman DG, Egger M, et al. The strengthening of reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008; 61: 344–349.
15. Rockwood CA Jr, Groh GI, Wirth MA, et al. Resection arthroplasty of the sternoclavicular joint. *J Bone Joint Surg Am* 1997; 79: 387–393.
16. Bankart ASB. An operation for recurrent dislocation (subluxation) of the sternoclavicular joint. *Br J Surg* 2005; 26: 320–323.
17. Groh GI and Wirth MA. Management of traumatic sternoclavicular joint injuries. *J Am Acad Orthop Surg* 2011; 19: –7.
18. Katthagen JC, Marchetti DC, Dahl KD, et al. Biomechanical comparison of surgical techniques for resection arthroplasty of the sternoclavicular joint. *Am J Sports Med* 2016; 44: 1832–1836.
19. Kendal JK, Thomas K, Lo IKY, et al. Clinical outcomes and complications following surgical management of traumatic posterior sternoclavicular joint dislocations: a systematic review. *JBJS Rev* 2018; 6: e2.
20. Warne W and Papadonikolakis A. The use of a PCL drill guide to increase safety in the reconstruction of unstable sternoclavicular joints. *Tech Shoulder Elbow Surg* 2012; 13: 142–144.