

Loop SC Joint Reconstruction

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Single Loop Allograft Reconstruction for Sternoclavicular Joint Instability

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Running Title: Loop SC Joint Reconstruction

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11 **Abstract**

12 **Background**

13 Various surgical strategies have been utilized for the treatment of sternoclavicular joint
14 instability with variable results. The purpose of this study was to report the clinical results of
15 patients undergoing single loop allograft reconstruction for sternoclavicular joint instability.

16

17 **Methods**

18 10 patients underwent single loop allograft reconstruction for sternoclavicular joint instability
19 from 6/2012 to 8/2014 by a single surgeon. All patients had a history of instability of the
20 sternoclavicular joint with persistent chronic subluxation of the joint, MRI disruption of the
21 sternoclavicular ligaments and persistent symptoms of pain and instability. Regarding the
22 surgical technique, a single 5.5 mm drill hole was placed in the sternum and a second was placed
23 in the medial aspect of the clavicle. A semitendinosus hamstring allograft was looped between
24 the two holes and then tied in a square knot anteriorly. #5 high strength suture was used as
25 cerclage as well. (Figure 1) 9 of 10 patients (90% follow-up) were available at an average of 3.3
26 +/- 0.84 years postoperative. The average age of patients at the time of surgery was 42 years
27 (range, 20 to 73). Patients were evaluated postoperatively with outcome scores (VAS pain,
28 ASES, SST), a question regarding tenderness at the SC joint, a question regarding residual
29 instability and overall patient satisfaction (yes/no).

30

31 **Results**

32 The average functional outcome scores for the SST, VAS pain and ASES score was 11.8, 0.9 and
33 94.8. 3 of 9 patients reported some residual tenderness located to the sternoclavicular joint. No

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34 patients reported any residual instability of the sternoclavicular joint. 8 of 9 patients reported
35 they were satisfied with the procedure. No patients required reoperation and there were no
36 complications.

37

38 **Conclusion**

39 Single loop allograft reconstruction of the sternoclavicular joint provides reliable pain relief,
40 functional improvement and joint stability for patients with chronic sternoclavicular joint
41 instability. The simplicity of the procedure eliminates the need for small, multiple drill holes
42 which may lead to fracture between tunnels or the use of a small, thin graft.

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44 **Level of Evidence:** Therapeutic, Level IV – retrospective case series

45 **Keywords:** allograft; sternoclavicular joint instability; functional outcomes

46

47 **Introduction**

48

49 Sternoclavicular joint (SCJ) dislocations are uncommon and only account for 2 – 3% of all
50 dislocations of the shoulder girdle.² Most dislocations occur anteriorly while only 5 to 27% occur
51 in a posterior direction.⁵ Anterior dislocations often do not require any acute treatment while
52 posterior dislocations will require either closed reduction or surgical stabilization due to the
53 proximity of vital structures posterior to the sternum.³ In the setting of persistent sternoclavicular
54 instability, a variety of methods have been described for reconstruction including local soft tissue
55 repair or augmentation with synthetic material, ligament reconstruction with autograft or
56 allograft or tendon transfer.⁵ A majority of ligament reconstruction techniques report the use of
57 autograft tendon and a modification of a figure of eight construct.^{4,6,7,10} There are few prior
58 reports of the results of allograft reconstructions or constructs utilizing a simpler reconstruction
59 pattern like a simple loop.⁷⁻⁹

60

61 A variety of ligament reconstruction techniques have been described but a strong emphasis has
62 been placed on utilizing a figure of eight construct because of its biomechanical properties.^{1,6,9,11}
63 Spencer et al compared a figure of eight reconstruction technique using a tendon graft to both
64 an intramedullary ligament reconstruction and a subclavius tendon transfer in a cadaveric
65 model.¹¹ The figure of eight fashion was found to be superior to both intramedullary ligament
66 reconstruction and subclavius tendon reconstruction with significantly greater load to failure
67 (anteroposterior) in the figure of eight reconstruction compared to the other techniques. No
68 other ligament reconstruction techniques were reported. Long-term clinical outcomes of this
69 surgical technique utilizing an autograft have been reported with 90% survivorship at 5 years

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70 with excellent return to sport and a low complication rate.⁶ Limitations of this technique
71 include the requirement for 4 smaller drill holes (2 in the clavicle and 2 in the sternum) which
72 may be challenging especially in smaller patients or with compromised bone stock. Also,
73 autograft requires a separate incision and potentially increased morbidity. A simple loop
74 reconstruction using allograft may be an easier, less morbid technique especially in cases of
75 smaller patients or limited bone stock.

76

77 The purpose of this study was to retrospectively review a series of patients undergoing single
78 loop allograft reconstruction for sternoclavicular instability treated by a single surgeon.

79 Functional outcomes, symptoms of residual instability, complications and reoperations were
80 collected. Our hypothesis was that single loop allograft reconstruction would result in excellent
81 outcomes and a low complication rate.

82

83 **Methods**

84 The operative logs of the senior surgeon (BLINDED) were reviewed for all patients undergoing a
85 sternoclavicular joint reconstruction over a 5-year period from 6/2012 to 6/2017. Inclusion
86 criteria including any primary sternoclavicular joint reconstruction using a single loop technique
87 between the medial clavicle and the sternum using an allograft tendon. Exclusion criteria
88 included any patient undergoing a revision procedure, if the reconstruction extended to the
89 first rib, if autograft was utilized or if the patients had less than a minimum of 2-year follow-up.
90 Hospital IRB approval was obtained prior to initiating the study.

91

92 Included patients were initially contacted by mail and then followed up by a phone call 2 weeks
93 later for recruitment. Patients completed questionnaires online using REDCap questionnaires
94 (Vanderbilt University - (8UL1TR000105 (formerly UL1RR025764) NCATS/NIH)). REDCap is a
95 secure, internationally implemented research collection electronic data capture program
96 created by Vanderbilt University and used extensively in post-surgical studies at the University
97 of Utah. Questionnaires included the Simple Shoulder Test (SST), the American Shoulder and
98 Elbow Surgeons (ASES) Score and a visual analog scale for pain (VAS pain). Patients were asked
99 a yes/no question if they were satisfied with the surgery along with a yes/no question if they
100 had any tenderness at the sternoclavicular joint. Patients were also asked to complete an
101 online assessment of their range of motion (abduction, forward flexion, external rotation in
102 abduction, external rotation at the side, internal rotation at the side) that has been previously
103 published for assessment of range of motion after shoulder arthroplasty.¹² Only patients with
104 greater than a minimum of 2-year follow-up were included.

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106 *Surgical Technique*

107 The loop allograft reconstruction utilized one tunnel in the clavicle and one tunnel in the
108 sternum with an allograft hamstring tendon graft and suture cerclage. (Figure 1) All surgical
109 reconstructions were performed in the supine position under general anesthesia. A thoracic
110 surgeon was present for the entire procedure and assisted throughout the procedures
111 especially with exposure posterior to the clavicle and sternum. A hockey stick incision is made
112 over the sternoclavicular joint approximately 6 cm in length. (Figure 2) The subcutaneous
113 tissues are dissected down to the joint. The sternal head of the sternocleidomastoid was
114 protected and not released. The clavicular attachment of the sternocleidomastoid along with
115 the pectoralis and the anterior and posterior sternoclavicular ligaments were circumferentially
116 dissected from the medial clavicle. Care was taken to not extend the dissection laterally more
117 than 2 cm to avoid disruption of the costoclavicular ligaments if still intact. The intraarticular
118 disc was removed and exposure of the anterior and posterior aspects of the medial clavicle and
119 the sternum were performed. A single 5.5 mm drill hole was then placed 1.5 cm from the joint
120 on both the sternal and clavicular side going through both the anterior and posterior cortexes
121 protecting vital structures posteriorly during drilling. (Figure 3) A 6 mm semitendinosus
122 hamstring allograft tendon was then passed from anterior to posterior through the sternal
123 tunnel and then back up from posterior to anterior through the clavicular tunnel. (Figure 4 and
124 5) Two #5 high strength sutures were also passed with the graft separately which would be
125 used as an internal brace during graft healing. The clavicle was then reduced to the sternum
126 and the high strength sutures were tied and then the graft was tied in a square knot. (Figure 6

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127 and Figure 7) #2 high strength figure of eight stitches were passed in each throw of the square

128 knot to improve strength of the construct. The muscular flaps were then closed over the

129 construct using #2 high strength suture.

130

131 **Results**

132 Ten patients underwent single loop allograft reconstruction during the study period and 9 of 10
133 (90%) were available for a minimum of 2-year postoperative follow-up. Outcomes were
134 collected at an average of 3.3 +/- 0.84 years postoperative (range: 2.4 to 4.9 years). Surgeries
135 were performed at an average of 41 +/- 20 months (range: 21 to 74 months) from injury. There
136 were 6 males and 3 females.

137

138 The average final postoperative functional outcome scores for the SST, VAS pain and ASES
139 score was 11.8+/-0.7, 0.9 +/- 1.2 and 94.8+/- 6.9. 3 of 9 patients reported some residual
140 tenderness located to the sternoclavicular joint. No patients reported any residual instability of
141 the sternoclavicular joint. 8 of 9 patients reported they were satisfied with the procedure. No
142 patients required reoperation and there were no complications.

143

144 In terms of self-reported range of motion and strength, the average shoulder abduction, forward
145 elevation, external rotation in 90 degrees of abduction and external rotation in adduction were
146 167+/- 16 degrees, 163+/- 24 degrees, 81 +/-15 degrees and 71+/-11 degrees. 4 patients reported
147 they could internally rotate to their low back, 4 patients reported they could internally rotate to
148 their mid back and 1 patient reported they could internally rotate to their upper back. All patients
149 stated they could raise a quart of water to shoulder height in both abduction and forward flexion.

150

151 **Discussion**

152 Sternoclavicular joint reconstruction using a single loop hamstring allograft reliably restores
153 stability with a low complication rate. Functional outcomes based upon shoulder specific
154 measures were extremely high and pain levels very low at mid-term follow-up. A minority of
155 patients reported some tenderness and there was a very high satisfaction rate with the procedure.
156 Range of motion and weight bearing was comparable to normal shoulder function at final follow-
157 up. The functional outcome scores are comparable to prior reports for autograft figure of eight
158 reconstructions reported in the literature supporting single loop allograft reconstruction is a
159 reasonable alternative.^{6,7}

160

161 Several authors have reported the clinical outcomes of sternoclavicular reconstruction using a
162 graft. Singer et al reported on 6 patients after autograft figure of eight reconstruction utilizing
163 the technique described by Spencer et al.^{10,11} The authors reported on 6 patients and reported
164 significant improvements in DASH scores with all patients returning to activity and sport
165 without restriction.¹⁰ Guan et al reported on a modification of the technique where only the
166 anterior cortex of the clavicle and sternum were drilled and reported excellent results in 6
167 patients using autograft hamstring with an average DASH score of 4.3.⁴ Petri et al reported on 19
168 patients undergoing reconstruction with 16 of them having the figure of eight autograft
169 technique.⁷ They did report that 3 patients had insufficient bone stock available for 2 holes in the
170 clavicle therefore a single loop autograft technique was used. The authors reported an average
171 final ASES score of 82 and noted significantly worse ASES scores in patients that were not
172 satisfied with the surgery (4 of 19 patients) although these four had other concomitant
173 preoperative injuries as well. [Petri 2016] The same group followed up on a similar cohort of

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174 patients with a minimum of 5 years follow-up and noted final ASES scores of 91 with low
175 complication rates and high return to sport.⁶ Allograft reconstruction has been reported using a
176 figure of eight construct in one series and reported comparable final ASES scores of 84 in 10
177 patients with no reconstruction failures.⁸ Comparing the current data using allograft, the results
178 are very similar to those reported in the literature for autograft and similar to the Sabatini et al
179 series using allograft.⁸ Also, the single loop construct did not appear to negatively impact the
180 stability or functionality of the construct at final follow-up.

181

182 A single-loop reconstruction has multiple advantages over a figure-of-eight reconstruction. First,
183 fewer holes must be drilled, and thus the risk for iatrogenic fracture is lower. Second, because
184 fewer holes must be drilled, the risk of insufficient osseous space available for these holes is
185 lower. Third, because fewer holes must be drilled, the neurovascular risk is lower. Fourth, if a
186 revision is required more native bone stock remains, allowing additional flexibility. Fifth, a
187 larger caliber graft can be used. Sixth, a shorter graft can be used, which allows a wider variety
188 of grafts to be used. Seventh, because the graft must make fewer turns, graft passage is easier and
189 there is less opportunity for the graft to be abraded and compromised.

190

191 There are several limitations to this study including a small sample size, no comparison cohort of
192 patients and no consistent preoperative functional outcome measures. Nevertheless, final
193 outcomes and range of motion were reported using self-assessed questionnaires and the
194 outcomes are comparable to prior reports of constructs in the literature.

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197 **Conclusion**

198 Single loop allograft reconstruction of the sternoclavicular joint provides reliable pain relief,
199 functional improvement and joint stability for patients with chronic sternoclavicular joint
200 instability. The simplicity of the procedure eliminates the need for small, multiple drill holes
201 which may lead to fracture between tunnels or the use of a small, thin graft.

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254 **Figure Legend**

255

256 Figure 1 – Sternoclavicular joint reconstruction using one 5.5 mm tunnel in the sternum and one
257 tunnel in the medial clavicle with #5 Fiberwire (Arthrex, Naples, FL) cerclage

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259 Figure 2 – Hockey stick incision over the sternoclavicular joint

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261 Figure 3 – Two 5.5 mm tunnels created for loop reconstruction (one in the sternum and one in
262 the medial clavicle) with shuttling sutures placed

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264 Figure 4 – Semitendinosus hamstring allograft passed from anterior to posterior through the
265 sternal tunnel

266

267 Figure 5 – Posterior to anterior passage of the graft through the clavicular tunnel

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269 Figure 6 – Tying of the high strength suture cerclages between the sternal and clavicular tunnels

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271 Figure 7 – Final reconstruction after graft tied in a square knot