

Radiographic Evaluation of Chronic Static Scapholunate Dissociation Post Soft Tissue Reconstruction

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Abstract

The purpose of this study was to examine the radiographic outcomes of dorsal intercarpal ligament capsulodesis (DILC), documenting the time to carpal collapse postoperatively. From January 2008 to January 2011, 12 patients were identified with chronic scapholunate (SL) dissociation. The average follow-up period was 15.8 months. Paired *t*-tests were used preoperatively, one month after pin removal, and at final follow-up to determine significance in radiographic outcomes. The Disabilities of the Arm, Shoulder, and Hand (DASH) survey was administered to patients before and after surgery to assess subjective levels of pain, function, and satisfaction. Intraoperatively all deformities were reduced completely. One month after pin removal, the mean SL gap was 3.3 mm, the SL angle was 74°, the radiolunate (RL) angle was 17°, and the lunatocapitate (LC) angle was 8°. Only the SL angle improved; the other measurements remained unchanged. At final follow-up, the mean SL gap was 3.6 mm, the SL angle was 78°, the RL angle was 20°, and the LC angle was 10°. SL angle worsened, but with no statistically significant difference. The other radiographic measurements remained unchanged at final follow up. Wrist flexion and extension decreased from 76% and 69% of the contralateral side to 62% and 56% of the contralateral side after surgery. Grip strength was 64% of the contralateral side before surgery and 83% after surgery. Visual Analog Scale (VAS) results improved from 6.3 to 1.7, and DASH scores improved from 39 to 8 after the surgery. DILC cannot withstand large and repetitive forces. Carpal collapse recurred within a short time after DILC. However, our small patient numbers and short term follow-up preclude any conclusions with respect to clinical efficacy of this procedure. Limitations of this study include the fact that this is a retrospective study with no control group. In addition, it represents a single-surgeon series, which introduces a source of bias and carries the risk of technical and methodological flaws, which may have contributed to the observed radiographic outcomes.

Keywords

- ▶ chronic scapholunate dissociation
- ▶ reconstruction of scapholunate ligament
- ▶ radiographic evaluation scapholunate reconstruction

Scapholunate (SL) dissociation is the most common type of carpal instability¹ and is a leading cause of wrist arthritis.² Chronic scapholunate instability can be divided into dynamic and static types.³ Patients with dynamic instability present

with tenderness over the scapholunate interval and a positive scaphoid shift test but normal radiographs. They are diagnosed with the help of arthroscopy or dynamic radiographs.⁴ Patients with static instability are diagnosed using standard

posteroanterior (PA) and lateral radiographs.³ Static instability can also be diagnosed by clinical exam and arthroscopy. The treatment of chronic static SL dissociation remains controversial.¹ Patients with chronic static SL dissociation usually have complete detachment of the dorsal SL ligament with elongation of the secondary stabilizers.⁵ Several surgical procedures have been recommended for the treatment of this stage of scapholunate dissociation, including limited arthrodesis,⁶ capsulodesis,^{7,8} tenodesis,⁵ proximal row carpectomy,⁹ and bone–ligament–bone reconstruction.¹⁰

Blatt⁷ described an indirect soft tissue reconstruction using a flap of wrist capsule based on the radius inserted into the distal pole of the scaphoid. In this procedure, the capsular flap crosses the radiocarpal joint, thus limiting scaphoid flexion. The procedure is not designed to decrease the scapholunate gap directly. Seeking to address these problems, Berger et al¹¹ and Szabo et al¹² introduced dorsal intercarpal ligament (DILC) capsulodesis (DILC) for chronic SL dissociation. Both sets of authors believed the DILC was a reasonable surgical option because it did not cross the radiocarpal joint. Some studies noted that carpal alignment became progressively worse after DILC.^{11,12} The purpose of this study was to examine the failure rate of DILC in maintaining radiographic stability of the scapholunate joint over time and to determine whether this affected the clinical outcomes.

Materials and Methods

A retrospective review of charts was done reviewing patients who presented and were treated surgically for chronic scapholunate dissociation between 2008 and 2011 in our clinic. The average patient age was 42 years (range: 20–66). There were 10 male and 2 female patients. Static SL dissociation was seen on the left side in 2 patients and on the right side in 10 patients. The time from injury to surgery averaged 8 months (range: 3–19). The average follow-up period after surgery was 15.8 months (range: 13–34).

Patients who were reviewed for this study were more than 18 years of age and had been clinically diagnosed with chronic SL dissociation for more than 6 weeks. Eight cases had a dorsal intercalated segment instability (DISI) deformity, which was diagnosed by using the radiolunate angle, which was more than 15°. Patients underwent soft tissue reconstruction with a DILC. The exclusion criteria consisted of the following: a patient less than 18 years of age, a patient who received any other form of reconstruction or salvage procedure to restore the scapholunate alignment, and patients with evidence of lunotriquetral tears, triangular fibrocartilage complex (TLCC) injuries, or preexisting radiocarpal or midcarpal arthritis.

Our review revealed 12 patients who were treated with a DILC. We used the Garcia-Elias classification and patients with Stage 4 (complete SL disruption with carpal collapse, easily reducible) scapholunate dissociations were chosen for the soft tissue reconstruction.⁵ All patients had evidence of a chronic SL dissociation and had presented with wrist pain and functional limitations. A chronic injury was defined as having wrist pain for more than 6 weeks. Isolated SL ligament injury was verified through wrist arthroscopy or magnetic reso-

nance imaging (MRI). Nine patients had an MRI, two patients underwent arthroscopy, and only one had both preoperatively. All patients had static SL instability, defined as an SL gap wider than 3 mm and an SL angle greater than 60° on static PA and lateral radiographs. We recorded grip strength (Jamar Dynamometer on the second setting), Visual Analogue Scale (VAS), and Disabilities of the Arm, Shoulder, and Hand (DASH) score both preoperatively and at final follow-up. PA and lateral radiographs were performed to measure the SL gap, the SL and radiolunate (RL) angles, and revised carpal height ratio.

The SL gap was measured in the middle of the flat medial facet of the scaphoid.¹³ The SL angle is formed by the line tangential to the proximal and distal convexities of the palmar aspect of the scaphoid and the line perpendicular to a line connecting the palmar and dorsal tips of the lunate.¹⁴ The RL angle is formed by the longitudinal axis of the radius and the line perpendicular to a line connecting the palmar dorsal tips of the lunate.¹⁴ Revised carpal height ratio was calculated by measuring the carpal height and dividing it by the height of the capitate.¹⁵

Surgical Techniques: DILC

A dorsal longitudinal skin incision was made over the wrist, and the third extensor compartment was partially opened. The extensor pollicis longus and finger extensors were retracted to expose the dorsal capsule. After exposure of the capsule, a Berger ligament-sparing capsulotomy technique was used. The SL joint was exposed. To facilitate reduction of the scaphoid and lunate, two Kirschner wires (K-wires), 0.045 inch, were inserted into the scaphoid and lunate to be used as joysticks. While the reduction was maintained, three or four K-wires were drilled percutaneously through the scapholunate, scaphocapitate, lunotriquetral, and/or triquetrohamate joints. The DILC was released partially from its insertion onto the scaphoid and trapezium and shifted proximally over the SL joint, leaving it attached to the triquetrum. A bony trough was prepared on the proximal pole of the scaphoid. At the base of the trough a mini-Mitek suture anchor (Depuy Mitek Inc, Roseville, CA) was drilled into place. A second mini-Mitek suture anchor was inserted into the dorsal aspect of the lunate. Then 2–0 nonabsorbable sutures attached to the anchor were used to pull the scapholunate portion of the dorsal intercarpal ligament as tightly as possible (Fig. 1). After surgery, patients were placed in a short-arm thumb spica splint for 2 weeks followed by a short-arm cast until K-wire removal at 8 weeks. Range-of-motion exercises and strengthening therapy began after wire removal.

Results were reviewed clinically and radiologically. Grip strength and range of motion were compared with the contralateral side with grip strength evaluated 3 months after surgery and at each follow-up afterwards. Radiographs were evaluated preoperatively, 1 month after K-wire removal, and at final follow-up, varying from 13 to 34 months, for signs of carpal arthritis and changes in the SL gap, SL angle, RL angle, lunatocapitate (LC) angle, and revised carpal height ratio. Analysis of statistical

Table 1 Radiographic parameters

Parameter	Preoperative		1 month after pin removal		p Value*	Final clinical follow-up		p Value#	p Value [†]
	Mean	SD	Mean	SD		Mean	SD		
SL gap (mm)	4.0	1.8	3.3	1.4	>0.05	3.6	1.7	>0.05	>0.05
SL angle (°)	80	9	74	9	<0.05	78	10	<0.05	>0.05
RL angle (°)	17	9	17	10	>0.05	20	12	>0.05	>0.05
LC angle (°)	8	7	8	7	>0.05	10	8	>0.05	>0.05
Revised carpal height ratio	1.5	0.1	1.5	0.1	>0.05	1.5	0.1	>0.05	>0.05

*Preoperative versus 1 month after pin removal

#1 month after pin removal versus final clinical follow-up

†Preoperative versus final clinical follow-up

significance for all data was performed using a paired *t*-test for actual values. A *p* value ≤ 0.05 was reported as a statistically significant difference.

Results

The mean SL gap preoperatively was 4.0 mm. Intraoperatively the gap was reduced to 2 mm or less successfully. The mean SL gap 1 month after pin removal was 3.3 mm. The mean SL gap at the last follow-up was 3.6 mm. These values have been illustrated in ►Table 1. The scapholunate angle was 80°, 74°, and 78° preoperatively, one month after pin removal, and after final follow-up, respectively. The other radiological parameters that were analyzed—RL angle, LC angle, and the revised carpal height ratio—also returned to their preoperative levels at final follow-up, as illustrated in ►Table 1.

Grip strength was increased by 16 pounds from 56 preoperatively to 72 at final follow-up. At final follow-up the grip strength was 83% of the contralateral side. Mean flexion was considerably reduced at final follow-up to 47° from a preoperative level of 57°. Extension was reduced from a preoperative level of 52° to a final follow-up level of 42°. The VAS score improved considerably from a mean score of 6.3 preoperatively to 1.7 at final follow-up. DASH scores improved from a preoperative level of 39 to a final follow-up level of 8 (►Table 2).

Discussion

Chronic static SL dissociations remain a problem in terms of management and surgical options. The DILC capsulodesis (DILC) described in this paper is one of the soft tissue procedures commonly used.⁵

The early clinical results of the soft tissue reconstruction were satisfactory;^{5,12,16} however, these results were not maintained in the long run. Szabo et al presented their method of capsulodesis done on 22 wrists. They had follow-up between 1 and 4 years, and their results showed holding up of the scapholunate gap on final follow-up.¹² Garcia-Elias et al published their results of a new three-ligament tenodesis in 2006. This new procedure was performed on 38 patients with good clinical outcomes over an average follow-up of 46 months. However, they did not clearly publish any postoperative radiographic data.⁵ Chabas et al published their experience with a modified Brunelli technique performed in 19 wrists with an average follow-up of 37 months. They did record radiographic data and presented a final followup SL gap of 2.4 mm.¹⁶ Their preoperative gap was 2.8 mm. They noticed an increase in the SL angle in the group with a follow-up greater than 36 months.

Wyrick et al noted that 60% of static SL dissociation patients had continued pain with activities of daily living after scapholunate repair and dorsal capsulodesis.¹⁷ The SL and capitulate (CL) angles were not markedly improved at

Table 2 Functional outcomes

Parameter	Preoperative		Final clinical follow-up	
	Mean	Ratio of contralateral	Mean	Ratio of contralateral
Grip strength (Lb)	56	64%	72	83%
Flexion (°)	57	76%	47	62%
Extension (°)	52	69%	42	56%
VAS	6.3		1.7	
DASH	39		8	

an average of 30 months follow-up. Only six out of seventeen patients had satisfactory radiographic reduction. Thus, the researchers concluded that ligament repair and dorsal capsulodesis could not be recommended for static SL instability. Moran et al¹¹ and Deshmukh et al¹⁸ have also reported similar results after treatment for both static and dynamic SL dissociation with dorsal capsulodesis.

Gajendran et al¹⁹ presented results of dorsal capsulodesis at an average follow-up over 7 years demonstrating radiographic deterioration in most cases, as 14 of 16 (88%) wrists showed an increase in scapholunate angle, and 9 of 16 (56%) wrists showed an increase in scapholunate gap. Radiographic evidence of arthrosis was also seen in 8 of 16 wrists. They concluded that the D1CL capsulodesis does not stop the radiographic progression or arthrosis in the long run, but it is still a reasonable option for chronic static SL dissociations with absence of arthritis. Moran et al²⁰ compared the results of dorsal capsulodesis and tenodesis at a mean follow-up period of 38 months. Their findings included the loss of wrist range of motion without successful elimination of pain in many patients. They also noted that carpal alignment became progressively worse over time with both procedures, suggesting that the reconstructions in both cases failed to remain intact biomechanically over the course of time.

In our study the radiographic deterioration of the scapholunate interval occurred almost immediately (1 month after K wire removal). The other radiographic parameters, such as the scapholunate angle, radiolunate angle, and carpal height, returned to the preoperative values as well.

The etiology of the chronic static scapholunate dissociation, as mentioned earlier, may be due to the stretching-out of secondary stabilizers, namely the scaphotrapezotrapezoid (STT) ligament, scaphocapitate (SC) ligament, radioscapocapitate ligament, and the D1CL,^{21,22} and morphology of the lunate.²³ The scaphoid is oblique to the longitudinal axis and tends to rotate into flexion. The lunate is palmarly wedge-shaped in configuration and tends to extend under axial compression load.^{24,25} Based on calculations by An et al,²⁶ the total force transmitted by the metacarpals to the carpal can reach values greater than 10 times the applied force on the fingers. Such forces are both the consequence of an external load being transferred along the different digital rays and the results of the action of specific muscles and ligaments necessary to achieve joint stability.

Under such repetitive compression axial load, soft tissue reconstruction of the scapholunate intercarpal ligament without secondary stabilizer is hard to sustain for a longer period of time. In our study, we noticed an immediate failure to maintain the scapholunate gap. One positive outcome of these procedures was the improved DASH and VAS scores observed. One of the drawbacks of this study is the short follow-up period. Although the short follow-up period is not enough to determine full success of the surgery, it is enough to prove that the surgery fails to hold the SL joint. Our desire was to look specifically at the radiographic recurrence of the SL gap, for which a 3-month period is sufficient.

An ideal reconstructive procedure should be able to achieve a pain-free wrist with preserved range of motion and grip strength while maintaining the normal relationship between the carpal bones. None of the prevailing techniques for the reconstruction of chronic static SL dissociation are satisfactory. It is prudent to anticipate the prognosis of such a repair. Future studies in this area of wrist surgery need to focus on developing ways to prevent stretching of the ligament to ensure a more sustainable repair. Such a repair needs to hold the SL gap and withstand tensile forces across the wrist.

Conflict of interest

None

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