Original Article

Scapholunate ligament reconstruction using the palmaris longus tendon and suture anchor fixation in chronic scapholunate instability

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Abstract

Background: Multiple reconstruction techniques have been described in the management of chronic scapholunate (SL) instability, either based on the capsulodesis or tenodesis principle. It is uncertain which surgical method produces the best patient outcomes. We describe results of a technique using palmaris longus (PL) tendon for surgical reconstruction of the SL ligament and provide functional outcomes scores.

Materials and Methods: We surgically reconstructed the SL ligament using a PL tendon graft secured with Mitek® bone anchors. Surgical technique with photographs is provided in the main text. Functional outcomes were measured using the disabilities of the arm, shoulder, and hand and Mayo wrist scores. Patient satisfaction was assessed using a simple measure.

Results: Eleven patients attended mid-term followup (mean 45.8 months post-surgery) and had functional outcomes and satisfaction of this procedure that compared favorably to case series that used tenodesis for chronic SL ligament injuries. Almost all patients (n = 10) were able to return to regular employment. The majority of patients (n = 10) were satisfied with their primary reconstruction procedure.

Conclusion: This technique avoids the use of drill holes to weave tendon through bone, uses an easy to access graft, and exploits the superior pullout strength of anchors while offering satisfactory functional outcomes that are comparable to alternative tenodesis techniques.

Key words: Anchor fixation, palmaris longus, reconstruction, scapholunate, chronic scapholunate instability
MeSH terms: Wrist joint, ligaments, joint instability, lunate bone, carpal bones

Introduction

The management of chronic scapholunate (SL) instability is highly variable.[1] The major surgical reconstruction principles that are described in the literature are based on capsulodesis or tenodesis. The SL ligament can be reconstructed to manage Stage 3, 4, and 5 SL ligament injuries [Table 1].[2]

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Capsulodesis include the Blatt[3] and Mayo[4] approaches, and several case series have reported successful use of these, or modified, techniques.[5-7] Dobyns *et al*. first described the utilization of portions of tendon to reconstruct the SL linkage in 1975.[8] Palmer *et al*. reported the use of several different donor tendons based on the tenodesis principle,[9] including extensor carpi radialis longus or brevis, palmaris longus (PL), flexor carpi radialis (FCR), abductor pollicis longus, extensor digiti quinti, and extensor carpi ulnaris. Brunelli advocated tenodesis using FCR,[10] a method further modified by Van Den Abbeele *et al*.[11] and Garcia-Elias *et al*.[2] while Weiss proposed the use of composite tissue grafts using the bone retinaculum bone autograft technique of reconstruction.[12]

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Table 1: Garcia-Elias stages of scapholunate ligament injuries

SL dissociation stage	1	2	3	4	5	6
Is there a partial rupture with a normal dorsal SL ligament?	Yes	No	No	No	No	No
If ruptured, can the dorsal SL ligament be repaired?	Yes	Yes	No	No	No	No
Is the scaphoid normally aligned (radioscaphoid angle ≤45°)?	Yes	Yes	Yes	No	No	No
Is the carpal malalignment easily reducible?	Yes	Yes	Yes	Yes	No	No
Are the cartilages at both RC and MC joints normal?	Yes	Yes	Yes	Yes	Yes	No

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SL=Scapholunate, RC=Radiocarpal, MC=Midcarpal

Suture bone anchor fixation has been shown to possess sufficient pullout strength for tendon and ligament fixation in the hand.[13] They have been used in acute and chronic SL ligament injuries with acceptable results.[14-17] We present a surgical technique for ligament reconstruction, which uses the PL tendon as a free tendon graft, secured with suture bone anchors, for the management of Stage 3 and 4 chronic SL ligament injuries. We also present the functional and satisfaction outcomes at mid term review for a cohort of patients treated using this method.

Materials and Methods

Patient selection and study design

Patients who had previously had SL reconstruction for an isolated SL ligament injury were retrospectively identified and invited for clinical review. The injury was identified clinically and radiologically. Patients were excluded if the surgical technique described herein was not followed or had <2 years followup since primary surgery. Reasons for this technique not being followed include absent PL tendons (bilaterally) or associated fractures of the scaphoid or lunate at the time of acute injury. According to the Health Research Authority tool used in the National Health Service (UK), this study was not deemed to require ethical approval.[18]

At clinical review, patients completed a questionnaire to record hand dominance, occupation prior to ligament rupture, significant medical history, date of injury, injury side, injury mechanism, concomitant injuries, intervention history, age at surgery, followup period since ligament reconstruction, occupation at time of clinical followup, and whether they would recommend their primary operation to a friend if they sustained the same injury (as a surrogate of satisfaction).

Functional assessment was the range of wrist movement (measured with a goniometer) and grip strength (measured using a Jamar dynamometer [Sammons Preston, Inc., Bolingbrook, IL, USA]). Disabilities of the arm, shoulder, and hand (DASH)[19] and Mayo wrist scores[20] were subsequently calculated; both these scores are validated patient outcome scores. A higher DASH score indicates greater disability while a higher Mayo wrist score indicates better function. No radiological studies were performed.

Applied anatomy

Lister's tubercle is the landmark in the dorsal approach to the scaphoid. The dorsal superficial branch of the radial nerve runs in the radial skin flap of the wound and so it is important to protect this with careful retraction. If the incision is too distal, the nerve is at risk as it crosses from the radial to ulnar aspect of the wound. The 3rd extensor compartment (extensor pollicis longus [EPL]) is identified, and the retinaculum needs to be divided and the tendons retracted to give access to the capsule. A capsulotomy is required to give access to the scaphoid and lunate.

Operative procedure

The patient is positioned supine with an upper arm tourniquet. A 5 cm longitudinal incision is made centered over Lister's tubercle. EPL is identified, and the interval between the EPL and the extensor digitorum communis entered. The dorsal wrist capsule is identified and cut in line with the incision [Figure 1a]. The SL joint was identified and SL dissociation confirmed [Figure 1b]. Once dissociation is confirmed, carpal surfaces are inspected to rule out significant arthritis and if no repairable stump found, the PL tendon is harvested. The distal part of the PL tendon is identified at its insertion into the flexor retinaculum on the palmar aspect of the wrist, mobilized through a small transverse incision, but not detached. Tension is applied to the PL tendon and its proximal part identified. A separate small transverse incision is made and the PL tendon mobilized. Once both ends of the PL tendon were identified and mobilized, the distal tendon is cut and pulled proximally, before cutting the proximal end and submerging the freed tendon in sterile solution until required. The two incisions are closed with monofilament nylon.

The scaphoid is prepared for the anchors using bony nibblers to create a surface, preferably on the nonarticular surface; the lunate requires minimal preparation. Two Mitek® Mini QUICKANCHOR Plus (DePuy Mitek, Raynam, MA, USA) anchors (size 1.8 mm × 5.4 mm) are inserted into the scaphoid and a further two into the lunate as shown in Figure 1c. It is important that the drilling and subsequent insertions of the anchors are in the same plane, thereby maximizing bony purchase and minimizing the risk of fracture. The anchors are placed in a slightly oblique position to each other thereby resisting rotational forces between the scaphoid and lunate. The PL tendon is then sutured to the scaphoid anchors in its

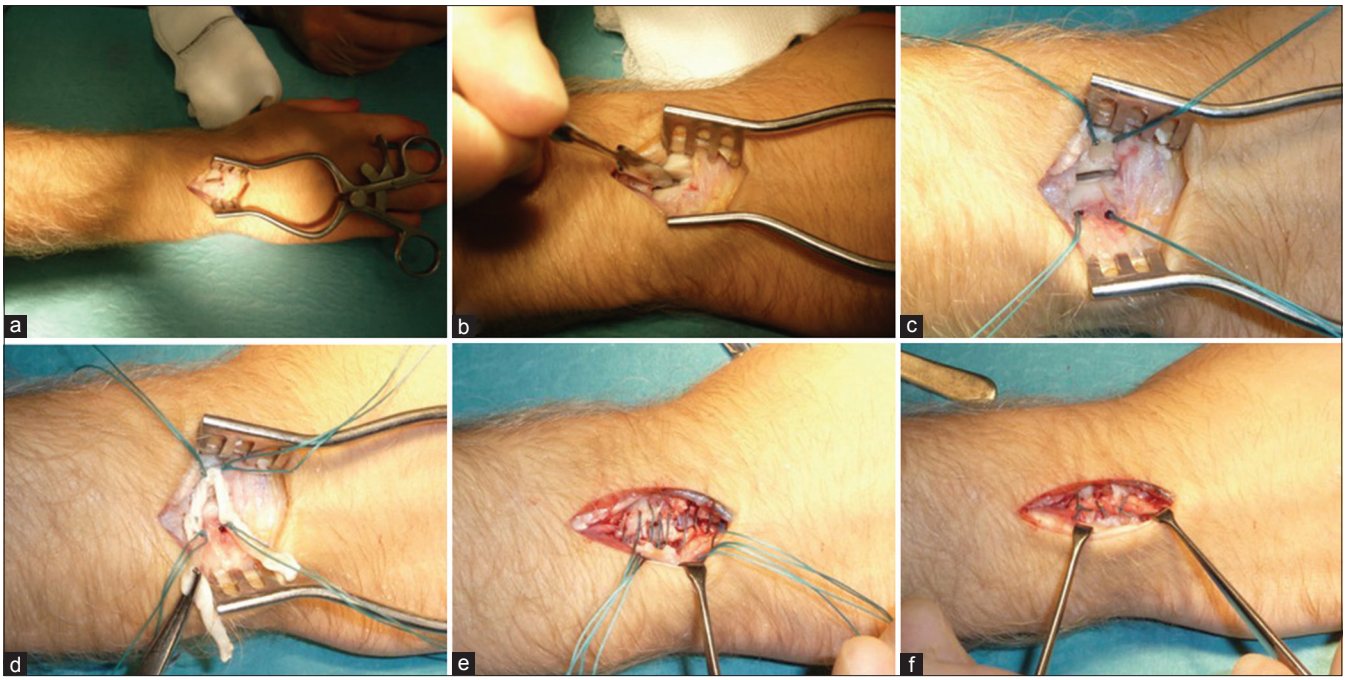

Figure 1: (a) Clinical photograph (peroperative) showing dorsal wrist capsule identified and cut (b) Scapholunate joint identified and scapholunate dissociation confirmed (c) Two suture bone anchors inserted into scaphoid and two anchors into the lunate (d) Palmaris longus tendon sutured to scaphoid anchors in its middle portion and the tails sutured to lunate anchors (e) Dorsal capsule reefed and double breast closure (f) Final dorsal capsule closure

middle portion and the tails tightly sutured to the lunate anchors [Figure 1d], with excess tendon trimmed. The dorsal capsule is then reefed and a double breast closure performed using Ethibond® (Ethicon, Somerville, NJ, USA) sutures [Figures 1e and 1f].

The wound is closed using nylon and dressed with nonmedicated tulle gras (such as Jelonet® [Smith and Nephew PLC, London, UK]), blue gauzeand wool. A short arm dorsal splint is applied for 2 weeks followed by a short arm full cast for 6 weeks. Cast removal is followed with gentle physiotherapy as comfort allows.

Results

Eleven patients who underwent an SL reconstruction with PL and suture bone anchors over a 10-year period attended for clinical review.

At clinical review, patients completed a questionnaire to record hand dominance, occupation prior to ligament rupture, significant medical history, date of injury, injury side, injury mechanism, concomitant injuries, intervention history, age at surgery, followup period since ligament reconstruction, occupation at time of clinical followup, and whether they would recommend their primary operation to a friend if they sustained the same injury (as a surrogate of satisfaction). The demographics, medical history, and mode of injury of these patients are summarized in Table 2. The mean age at surgery was 43.1 years (range 15–63 years) and the mean followup time was 45.8 months (range 24–84 months) from surgery. One patient required the Sauve-Kapandji procedure due to on going symptoms in the same wrist for a different pathology arising from the same incident. One patient (not presented due to inadequate followup) required scaphoid excision and four-corner fusion surgery at 18 months for continued symptoms. This scaphoid excision and four-corner fusion provided a pain-freewrist and allowed the patient to return to their manual job.

Functional assessment was the range of wrist motion (measured with a goniometer) and grip strength (measured in pounds [lbs] using a Jamar dynamometer [Sammons Preston, Inc., Bolingbrook, IL, USA]). DASH[19] and Mayo wrist scores[20] were subsequently calculated; both these scores are validated patient outcome scores. A higher DASH score indicates greater disability while a higher Mayo wrist score indicates better function. No radiological studies were performed. On average, in their injured hand, patients managed 75% grip strength and range of movement compared to the contralateral uninjured wrist. The mean DASH score was 29. Five patients achieved an excellent or good Mayo score while nine patients achieved a fair or above Mayo score. Almost all patients (n = 10) were able to return to regular employment. The majority of patients (n = 10) were satisfied with their primary reconstruction procedure [Table 3].

Table 2: Clinical details of patients

Patient	Age, gender, dominance	Occupation		Mechanism of injury	Relevant PMH	Injury to surgery	Reoperation
		Preinjury	Postinjury				
1	55, male, right	Factory worker	Factory worker	No specific injury to left	Left CTD	Can't remember	None
2	63, female, right	Office based	Retired	Fall onto left	Breast cancer	Cant' remember	None
3	50, female, left	Housewife	Housewife	Gymnastics injury to left	Hypertension	30-40 years	None
4	45, female, right	Office based	Student	Ice skating injury to left	RA, old distal radius fracture	9 months	None
5	55, male, right	Farmer	Farmer	Sheep ran into left hand	Nil	12 months	None
6	26, female, right	Care worker	Care worker	Fall onto left	Previous left shoulder cuff repair	8 months	None
7	32, male, right	Plasterer	Unemployed	Someone fell onto right hand	Nil	9 years	None
8	50, male, right	Office based	Model maker	Fall off bike onto right	Nil	24 months	Sauve-Kapandji
9	36, female, right	Office based	Office based	Fall onto right	Right TFCC debridement	36 months	None
10	15, male, left	Schoolboy	Joiner	Fall off trampoline onto left	Nil	21 months	None
11	47, male, right	IT	IT	Pushing up on bed injured right	Nil	17 months	None

PMH=Past medical history, CTD=Connective tissue disease, TFCC=Triangular fibrocartilage complex, IT=Information and technology

Table 3: Summary of patients' disabilities of the arm, shoulder, and hand and Mayo wrist scores and patient satisfaction

Patient	Followup (months)	DASH	Mayo (scores)					Jamar (lbs)		Recommend
			Over-all	Pain	Function	ROM	Grip	Left	Right	
1	48	14.2	85	20	25	0	15	25	28	Yes
2	30	29.2	65					10	18	Yes
3	60	4.3	100	25	25	25	25	70	18	Yes
4	42	57.5	40	0	25	5	10	35	73	Yes
5	36	1.7	85	20	25	25	15	108	127	Yes
6	24	79.2	65	15	25	10	15	62	85	Yes
7	54	75.8	10	0	0	10	0	122	28	No
8	84	10	85	20	25	15	25	111	100	Yes
9	36	24.2	75	15	25	10	25	58	58	Yes
10	60	19.2	75	20	25	25	15	87	97	Yes
11	30	3.3	90	25	25	15	25	135	143	Yes
Mean	45.8	29.0	70.5	16.0	22.5	14	17	74.8	70.5	

DASH=Disabilities of the arm, shoulder, and hand, ROM=Range of motion

Discussion

Our series reports mid term followup of patients receiving a new technique for SL reconstruction with acceptable validated patient derived outcome measures.

There is a paucity of evidence on the efficacy of different treatment methods for the management of SL ligament injuries as reported in a recent review.[21] The authors also point out that it is desirable that validated patient-derived outcome measures be used in addition to objective data to assess overall efficacy. The DASH and Mayo wrist scores, as used in this study, are widely used examples of such outcome measures.

A review of the literature reveals two principle methods of soft tissue reconstruction, namely capsulodesis and tenodesis. However, there has only been one study comparing the two approaches,[22] which showed no statistical difference in wrist motion and grip strength between patients treated by tenodesis (using the Van Den Abbeele modification) or capsulodesis (Mayo technique). In addition, there are other reported case series that use either a single capsulodesis[3-7] or tenodesis.[2,9-11,23-25]

We propose a tendon graft reconstruction method using the PL tendon and present the operative technique and results based on our experience to date. We have shown that using suture bone anchors to secure the PL tendon has a similar range of movement and grip strength over mid-term followup to tenodesis-based techniques. Our overall patient outcome scores are similar to case series based on the tenodesis principles. Ogunro's study[23] used the PL tendon for tenodesis, three studies used three-ligament tenodesis while the remaining two studies were based on the Brunelli technique. Although the range of movement and grip strength were comparable across all the tenodesis studies, functional outcome scores are lacking in these studies, and therefore meaningful comparisons are difficult.

Table 4: Summary of studies based on the tenodesis principle

	This study	Ogunro[23]	Garcia-Elias *et al.*[2]	Kalb[27]	Talwalkar *et al.*[26]	Brunelli and Brunelli[10]	Chabas *et al.*[24]
Tenodesis	PL + Mitek®	PL	Garcia	Garcia	Garcia	Brunelli	Modified Brunelli
Patients	11	10	38	12	162		19
Average age	43.1		36				43
Followup	45.8 months	3-18 year	46 months	10.5 months	48 months	24 months	37 months
ROM (%)	70-75		74-77		75	40-70	73-75
Grip (%)	75	70	65	80	80		78
DASH	29.0		-	25			30
Mayo	70.5			80			
	2 e, 3 g, 4 f, 2 p						
Satisfaction (%)	10 s				79 s		
	1 us				18 ND		
					18 us		

e=Excellent, g=Good, f=Fair, *P*=Poor, s=Satisfied, ND=No difference, us=Unsatisfied, PL=Palmaris longus, DASH=Disabilities of the arm, shoulder, and hand, ROM=Range of motion

Our satisfaction scores were favorable when compared to the study by Talwalkar *et al.*[26] with over 90% patients satisfied with the surgical outcome in our study. Interestingly, the functional outcome scores of those patients that were not satisfied did not universally show increased disability or decreased wrist function as would be expected. Factors other than functional outcome are likely to influence their satisfaction.

The risk of injury to the dorsal superficial branch of the radial nerve is present during any dorsal approach to the scaphoid. To minimize this risk, the incision should not extend too distal (more than 4 cm from Lister's tubercle). Careful retraction in the radial flap of the wound will also protect the nerve from inadvertent damage.

We did not experience any failures of the reconstruction technique or suture anchor fixation, but this always could be a theoretical scenario. By performing the reconstruction using our described technique, this does not prevent a conversion to either a capsulodesis or tenodesis reconstruction technique either intraoperatively (if anchor fixation is unsatisfactory) or postoperatively (if the technique fails or subsequent injury).

The advantages of our technique include the avoidance of drill holes to weave tendon through bone, thereby not compromising vascularity, and utilization of an easily accessible tendon graft that has minimal morbidity once harvested. Bony anchors have been shown to have superior pullout strength compared to sutures alone,[13] and we did not observe any failures relating to the anchor fixation. Although double-breasting the dorsal capsule is not essential for closure, we felt it added additional strength to the repair in a simple step. It is likely that this may have caused some immediate restriction to range of movement, but our results show that this did not extend into the medium-term. Our study was limited by our department capacity and offering only a single fixed appointment for this study followup. This was inconvenient for a number of patients and consequently limited the number of patients who could be assessed. Functional assessment may have been altered in patients who received further procedures following SL reconstruction. Ideally, it would have been beneficial to assess these patients before further surgery on the same extremity. We did not have ethical approval to subject patients to additional imaging such as X-ray. We accept that additional imaging would have added information such as identifying any persisting instability or alignment, which could help predict long term outcome. However, in the presence of good patient-reported outcomes at similar followup time frames to other studies, the dilemma would be whether any surgical intervention would be performed for radiological reasons alone. The strength in this study is that it also addresses the lack of validated patient-derived outcome measures in the existing literature.

The technique described here offers functional and satisfaction outcomes that are comparable with tenodesis case series [Table 4]. Future studies and trials need to objectively measure patient outcomes. More extensive comparative studies that assess differences in functional outcomes between the tendon graft technique described here and other described methods such as tenodesis and capsulodesis are required to establish which surgical treatment is superior for SL reconstruction in patients with chronic SL ligament injuries.

To conclude, this technique avoids the use of drill holes to weave tendon through bone, uses an easy-to-access graft, and exploits the superior pullout strength of anchors while offering satisfactory functional outcomes that are comparable to alternative tenodesis techniques.

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Conflicts of interest

There are no conflicts of interest.

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