Clinical Article

Treatment of lunate and perilunate dislocations with a combined approach and anchor repair of the dorsal scapholunate interosseous ligament

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Abstract

Aim: To determine the outcome of patients with isolated lunate and perilunate dislocations treated with a combined approach and anchor repair of the dorsal scapholunate interosseous ligament.

Methods: A combined volar and dorsal approach with anchor repair of the dorsal scapholunate interosseous ligament was used to treat six patients with isolated lunate or perilunate dislocations. Patients were assessed using the Disabilities of the Arm, Shoulder and Hand Score (DASH) and Mayo Wrist Score; and radiologically using the scapholunate angle, radiolunate angle and the scapholunate gap at final follow-up.

Results: The mean time to surgery was 13.5 days. The mean time to final follow-up was 28.5 months.
At final follow-up, the mean Mayo wrist score was 78.3. The mean DASH score was 13.7.
The mean range of motion was 51° extension, 58° flexion, 11° radial deviation, 24° ulna deviation, 75° pronation and 78° supination.
The mean grip strength was 31.9 kg which represented 73.9% of the contralateral grip strength.
The mean scapholunate angle was 48°, the mean radiolunate angle was 9° and the mean scapholunate gap was 2 mm.

Conclusions: Vigilance with early diagnosis and appropriate treatment using this surgical technique results in good functional and radiological results for ligamentous lunate dislocations.

Introduction

The aim of our study was to evaluate the outcome of patients with isolated lunate and perilunate dislocations, using the combined approach to reduce and repair the dorsal scapholunate and volar lunato-triquetral ligaments.

Lunate dislocation can be a devastating injury if missed. When making a diagnosis of lunate dislocation history is important with special emphasis necessary on the mechanism of injury.

On examination swelling is generally moderate but can be severe. Look for abrasions or contusions and palpate for areas of maximum tenderness. Movement will usually be limited. Neurovascular examination for median and ulna nerve injury should be done.

A variety of X-ray views are recommended, with the minimum of a postero-anterior and a lateral view as shown in *Figures 1 and 2*:

1. Postero-anterior (PA) – All three Gilula's lines should be seen. The normal shape of the lunate is trapezoidal but may be triangular or pie-shaped if dislocated.
2. Lateral – This is very important as it shows the alignment of the radius, lunate, capitate and third metacarpal. The capito-lunate angle is collinear in less than 11% of the normal population and may range up to 15°. We did not use this measurement in our study.
   The scapholunate (SL) angle is the major determinant of scapholunate dissociation. The normal range is 30°–60° with definite SL dissociation if more than 80°.
   The radiolunate (RL) angle gives objective evidence of dorsal or volar tilt of the lunate and if more than 15° indicates dorsal or volar intercalated segment instability (DISI or VISI).
3. Scaphoid views (PA in ulna deviation)
4. 45° semipronated oblique
5. Other:
   - distraction views help to exclude missed injuries and better define bone injuries
   - stress views
   - MRI may be useful to delineate ligamentous injuries.

Lunate dislocation can be a devastating injury if missed

Isolated perilunate dislocations severely disrupt intercarpal ligaments and normal wrist biomechanics as described by Mayfield's classification and the lesser arc of injury concept as described by Johnson.

Mayfield *et al's* cadaver study helped to ascertain the sequence of injury progression and progressive perilunate instability in a counter-clockwise direction around the lunate:

Stage 1 – Scapholunate dissociation or scaphoid fracture. As the distal carpal row hyperextends, palmar midcarpal ligaments tighten and tear from palmar to dorsal as the lunate is held by the radiolunate ligaments. The scaphoid fractures if associated radial deviation constrains the proximal pole of the scaphoid.

Figure 1: Perilunate dislocation

Figure 2: Lunate dislocation

Stage 2 – Lunato-capitate dislocation occurs once the scapholunate joint is disrupted or a scaphoid fracture occurs. There are no substantial ligaments in the space of Poirier between the lunate and capitate.

Stage 3 – Lunato-triquetral disruption or triquetrum fracture occurs as the capitate displaces dorsally. The triquetral-capitate ligaments tighten separating the triquetrum from the lunate or causing a fracture of the triquetrum.

Stage 4 – Dislocation of the lunate occurs when all perilunate ligaments are torn, the capitate exerts a palmar translation force onto the lunate with the wrist in hyper extension and dislocates it volarly. This is the end stage of perilunate dislocation.[1]

Progressive perilunate instability reflects different stages of the same pathomechanic process.

These injuries are classified as a carpal instability complex (CIC) as they are either a derangement of carpal bones within the same row (carpal instability dissociative – CID) or between rows (carpal instability non-dissociative – CIND).

Isolated perilunate dislocations are rare. Lesser arc injuries as described by Johnson are purely ligamentous (as in our group of patients) while greater arc injuries involve a fracture of one or more of the bones surrounding the lunate.

Carpal kinematics plays an important role in perilunate dislocations. The proximal carpal row moves with varying degrees of synergism. The scapholunate angle in wrist flexion can be up to 76° and decreases to about 35° in extension. Proximal carpal bones move from a flexed position in radial deviation to an extended position in ulnar deviation. These complex movements ensure joint congruity and are important in understanding the injury pattern.[2]

The distal carpal row usually dislocates in a dorsoradial direction with the lunate dislocating in a volar direction as a result of wrist hyperextension and ulnar deviation.

Recently a trend towards open reduction and ligament repair has been advocated in an attempt to prevent persistent dissociation of either the dorsal interosseous scapholunate or volar lunato-triquetral ligaments and associated chronic instability or scapholunate advanced collapse.[3-6]

Carpal kinematics plays an important role in perilunate dislocations

After reduction of the lunate, successful fixation of the dorsal interosseous ligament can be achieved using anchor repair combined with K-wire stabilisation between the scaphoid and lunate with a second K-wire between either the scaphoid and capitate or triquetrum and lunate if the lunato-triquetral ligament is obviously disrupted when visualised intra operatively.

This article reviews the clinical and radiological results of six patients treated by the senior author using the same technique as described above.

Materials and methods

Between January 2002 and October 2005, ten patients with isolated lunate or perilunate dislocations involving the lesser arc were treated and followed up retrospectively. Four patients were excluded because they were lost to follow up. Six were available for final follow-up.

Ethics approval from the University of the Witwatersrand was obtained to perform the study.

The DASH questionnaire was used for a subjective assessment of outcome (normal=0/100). Thirty questions were asked relating to symptoms and ability to perform certain activities. An optional work and sports module was completed by most of the patients. For combined objective and subjective assessment the Mayo Wrist Score was used (normal=100/100). Grip strength was measured using a dynamometer (Jamar) and a percentage of the contralateral grip strength was calculated using three measurements. Extension, flexion, radial deviation, ulnar deviation, pronation and supination were measured using a hand-held goniometer. Pain was rated 1–4 using a verbal analogue scale. Functional status was assessed from none to severe disability.

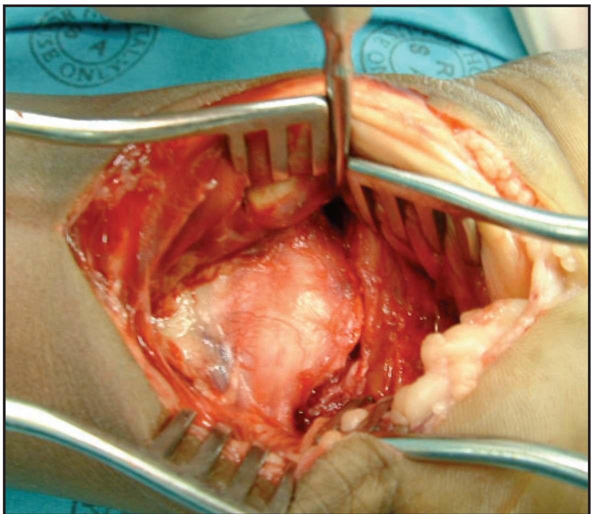

Figure 3: Flimsy volar scapho-capitate ligament

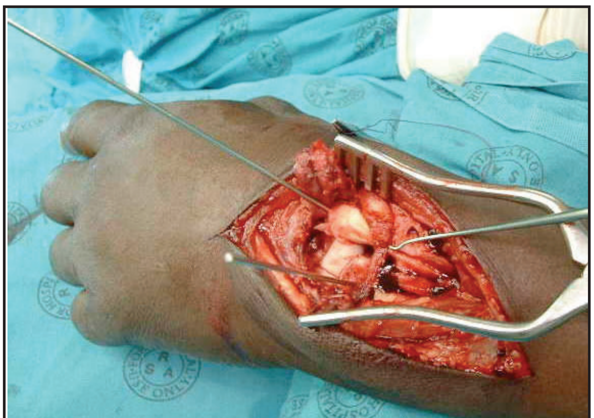

Figure 4: Use of dorsal K-wire reduction joysticks

Figure 5: Early postoperative X-rays. Note position of K-wires between scaphoid and lunate and scaphoid and capitate. Also note two suture anchors in lunate, repairing dorsal scapholunate ligament

Initial and final radiographs were assessed with special record made at final assessment of the scapholunate angle, radiolunate angle and the scapholunate gap.

The surgical technique described is similar to that used by Garcia-Elias[7] and case examples are shown in *Figures 3 and 4*. Initially an extended volar 'carpal tunnel' incision is done and extended distally as needed, routinely releasing the carpal tunnel and then reducing the lunate if not reduced prior to surgery. The thick volar extrinsic and intrinsic ligament complex covering scaphoid, lunate and triquetrum is repaired using interrupted 3/0 ethibond sutures. Special emphasis is placed on repairing the volar lunato-triquetral ligament which plays an important role in lunate stability.

A dorsal incision is then made between the third and fourth extensor compartments, retracting extensor pollicis longus radially and extensor digitorum communis ulnarly, exposing the carpal bones. Two 'Mitek' mini anchors are inserted into the dorsal aspect of either the lunate or scaphoid depending on the site of the avulsion.

A 1.4 mm K-wire is inserted through the scaphoid from the radial side to the proximal pole of the scaphoid. With the help of two more K-wire 'joy sticks' in the lunate and scaphoid, the scapholunate gap is reduced by flexing the lunate and extending the scaphoid. Once reduced the first K-wire is driven across the scaphoid into the lunate and the two joysticks are removed. The two anchor sutures are then tied. A second 1.4 mm K-wire is passed through the scaphoid to the capitate as an extra support. For those patients where there was substantial lunato-triquetral ligament injury, the second K-wire is driven from the triquetrum to the lunate from ulnar to radial. The K-wires were left long and bent for ease of removal after 6 weeks' follow-up.

Postoperatively the extremity is immobilised in a backslab for 10 days as shown in *Figure 5*. The wounds are then reviewed, sutures are removed and a below-elbow plaster cast applied for six weeks, after which time the K-wires are removed.

Physiotherapy range-of-motion exercises are initiated once the cast is removed after six weeks. One of the patients was non-compliant in that he did not return at 10 days for the application of his cast, but after six weeks in a backslab, he did return for removal of K-wires and at final review his outcome was excellent.

Table I: Summary of age, mechanism of injury, side affected, time to surgery and time to final follow-up

Case number	Age at final follow-up (years)	Mechanism of injury	Side affected	Time to surgery (days)	Time to final follow-up (months)
1	33.67	MVA	Left (non-dominant)	42	33
2	36	Assaulted	Right (dominant)	0	24
3	28.25	MVA	Left (non-dominant)	10	14
4	50.5		Right (dominant)	18	9
5	26.5	MVA	Left (non-dominant)	2	23
6	62	Fell from ladder	Left (non-dominant)	9	46
Mean	39.5			13.5	24.8

Results

Table I summarises age, mechanism of injury, side affected, time to surgery and time to final follow-up. All six patients were males. Four cases had anchors placed into the lunate and two into the scaphoid, depending on where the avulsion occurred.

Table II summarises grip strength, DASH and Mayo wrist scores. Case 1 was the only case that required a second procedure – he underwent reduction and combined approach six weeks post-injury. At six months postoperatively he had grade 4 pain and his wrist was fused using a dorsal plate. Detailed consultation was made with the patient who felt that this procedure best suited his daily needs which were for a strong grip in the injured non-dominant wrist. (He was employed as a building contractor and was fully functional three years post-injury.) He was not included in the range of movement and radiological measurements. All six patients had returned to the same jobs at final follow-up.

Tables III and IV summarise the range of movement and radiographic findings at final follow-up. At final follow-up there were no cases of post-traumatic Kienböck's disease. No VISI or DISI had occurred at final follow up. No cases of scapholunate dissociation (defined as scapholunate angle > 80° or scapholunate gap > 5 mm) had occurred. No cases of post-traumatic carpal tunnel syndrome had occurred.

Discussion

The ligamentous anatomy around the lunate is vital for perilunate stabilisation.

The carpal ligaments have no distinct edges separating adjacent ligaments and there are many variations in their size and shape.

The extrinsic ligaments (superficial and deep radiocarpal and ulnocarpal) are stiff and have a low ultimate yield resulting in mid-substance ruptures. The intrinsic ligaments have a larger area of insertion into cartilage than bone with fewer elastic fibres resulting in avulsion rather than rupture at the time of injury. The scapholunate interosseous ligaments consist of palmar and dorsal ligaments with a proximal fibrocartilaginous membrane. Dorsally the ligament is thick and stout with transversely oriented fibres playing a key role in scapholunate stability. It was these avulsed fibres which we attempted to repair with anchor sutures. The palmar ligament has longer obliquely oriented fibres allowing sagittal rotation between the scaphoid and lunate.

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Table II: Summary of grip strength, DASH and Mayo wrist scores

Case number	DASH score	Optional DASH score	Mayo wrist score	Grip strength (kg)	Grip strength (% of contralateral side)
1	17.6	43.8	65	38	79.2
2	0.8	0	100	45.3	93
3	24.2	50	70	29.3	55.6
4	0.9	0	90	36	97
5	–	–	85	28	72.4
6	25	37.5	60	14.7	46.4
Mean	13.7	26.3	78.3	31.9	73.9

Table III: Summary of range of motion at final follow-up

	Extension	Flexion	Radial deviation	Ulna deviation	Pronation	Supination
Mean	51°	58°	11°	24°	75°	78°
Range	40°–60°	30°–70°	5°–20°	10°–40°	70°–80°	70°–80°
Percentage contralateral side	78%	75%	69%	83%	99%	100%

Table IV: Summary of radiographic measurements at final follow-up

	Scapholunate angle	Radiolunate angle	Scapholunate gap
Mean	48°	9°	2 mm
Range	40°–60°	2°–16°	1–3 mm

There are scanty palmar and dorsal ligaments between the lunate and capitate which should not be repaired volarly as this may cause a reduction in wrist flexion.

The lunato-triquetral interosseous ligaments are palmar and dorsal, transverse and stout allowing very little movement.

On the volar aspect the scapholunate and lunato-triquetral ligaments are often fused, forming the scapho-triquetral ligament. This ligament fuses to the volar extrinsic ligament forming a thick volar ligament. This is the ligament complex that gets repaired.

The distal carpal row interosseous ligaments are relatively rigid. They cross dorsally between triquetrum, distal edge of lunate onto scaphoid, trapezium and trapezoid and palmar from the triquetrum-capitate-hamate complex to scapho-capitate and scapho-trapezium-trapezoid ligaments.[2]

Closed reduction requires 10 minutes of traction; the wrist is hyperextended while the operator's thumb stabilises the lunate volarly; then the wrist is flexed until the capitate snaps back into the lunate concavity. The wrist is then gradually extended again while the lunate is reduced dorsally with the thumb.

Closed reduction and percutaneous fixation is acceptable if perfect anatomic reduction is achieved. If not perfectly reduced, temporary K-wires can be driven from dorsally into the scaphoid and lunate as joysticks to aid reduction and then transversely across the snuff box from scaphoid into lunate and from triquetrum into lunate.

Since the late 1970s authors agree that closed reduction results in a high incidence of failure due to the fact that precise anatomical reduction and dorsal ligament repair is not possible.

Open reduction has many advantages:
- Recognition of damage is more precise.
- Intra-articular soft tissue interposition can be removed.
- Chondral fragments can be removed or fixed.
- Bony displacement can be more accurately reduced.
- Torn ligaments can be repaired.

The dorsal approach was used initially for fear that further vascular damage may be done to the lunate if approached from the volar aspect. In 1964 Campbell *et al*[8] used the dorsal approach in nine patients and the volar approach in four patients and found no AVN in the ones approached from the volar side. They still recommended the dorsal approach as it allowed better visualisation of the lunato-capitate joint and reduction of scaphoid subluxation. The palmar approach was recommended if median nerve decompression was indicated or the lunate was greatly displaced. In 1972 Linscheid *et al*[9] advocated the dorsal approach as it allowed adequate reduction and repair of the dorsal scapholunate ligament. In 1976 Talesnik[10] recommended using the volar approach as this is the site of major ligamentous damage. In 1982 Adkison and Chapman[6] recommended the dorsal approach for reduction and pinning without dorsal ligament repair.

Authors have compared results using the volar or dorsal approach alone or a combination of both with a remarkably similar number of satisfactory results for each group. Many have previously commented that the similarity of these groups is negated by the fact that they are made up of an inhomogenous group consisting of both lesser and greater arc injuries.[11] Our group of patients was homogeneous and consisted solely of lesser arc, ligamentous perilunate and lunate dislocations.

Inoue *et al* found that the combined approach allows a lesser traumatic reduction of a volarly dislocated lunate with release of the carpal tunnel at the same time. Acute carpal tunnel syndrome has been associated in up to 46% of cases. The volar approach also allows repair of the lunato-triquetral ligament complex. The dorsal component of the procedure ensures excellent reduction of both the scapholunate and lunato-triquetral articulations and subsequent repair of damaged ligaments. An associated fracture of the scaphoid can be fixed simultaneously.[12]

Trumble and Verheyden used a combined approach in 22 patients (lesser and greater arc injuries) with the addition of a cerclage wire to protect the scapholunate ligament repair.[13] Our results, although a smaller group of only lesser arc injuries, compared favourably to theirs without the need for a second operation to remove the cerclage wire.

Arthroscopically-assisted reduction with subsequent K-wiring has also been done but with this technique a dorsal incision is still required if the dorsal scapholunate ligament is to be repaired.

The advantage cited is that an already tenuous blood supply is preserved, facilitating the healing of ligaments.[14]

Timing of surgery is important. The five patients in our study that did well were all operated on within three weeks. The only one who did poorly and went on to wrist fusion had surgery done at six weeks. Although the numbers are small, we would recommend surgery being done as soon as possible. Once the patient presents late, the surgeon should consider a salvage procedure (wrist fusion, lunate excision or proximal row carpectomy) as initial surgical treatment.

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Conclusions

An early combined volar and dorsal approach for lunate and perilunate dislocations with anchor repair of the dorsal scapholunate ligament and repair of the volar scapho-lunato-triquetral ligament complex is a safe technique with excellent radiological results and good functional outcome at a mean final follow-up of just over two years. Our study group involved all lesser arc injuries making it more homogenous than any of the studies quoted above. We recognise that this is only a case series with small numbers and thus the statistical significance is effectually small.

This article was submitted to an ethical committee for approval. The content of this article is the sole work of the authors.

No benefits of any form have been derived from any commercial party related directly or indirectly to the subject of this article.

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