Traumatic Mechanisms and Therapeutic Results of the Perilunate Injuries

K Takase, K Yamamoto

ABSTRACTS

Objective: *In this study, eighteen patients who have had perilunate injury with dislocation or fracture, were evaluated and the patho-mechanics and surgical treatment were studied.*
Subjects and Methods: *According to the Green and O'Brien's classification, type 1 injury occurred in one patient, type 2 in nine, type 4A in five, type 4C in one and type 4D in one. The other one case could not be classified using the Green and O'Brien's criteria.*
Results: *According to the Evans scoring system, good results were achieved in thirteen patients, fair results, in four, poor results in one and very poor results in none. When the patho-mechanics was estimated based on the Mayfield's criteria, seventeen patients were classified as stage 3. However, only one case was extremely unusual and should be classified as a subtype of stage 2.*
Conclusion: *The results were good in the majority of patients who had repair of perilunate injury.*

Keywords: Perilunate injury, progressive perilunate instability, scaphoid fracture, triquetrum fracture

Mecanismos Traumáticos y Resultados Terapéuticos en Lesiones Perisemilunares

K Takase, K Yamamoto

RESUMENS

Objetivo: *En este estudio, se evaluaron dieciocho pacientes que tuvieron lesión perisemilunar con dislocación o fractura, y se estudiaron la patomecánica y el tratamiento quirúrgico.*
Sujetos y Método: *Sobre la base de la clasificación de Green y O'Brien, se concluye que ocurrieron las siguientes lesiones: lesión de tipo 1 en un paciente, de tipo 2 en nueve, tipo 4A en cinco, tipo 4C en uno y tipo 4D en uno. El otro caso no se pudo clasificar usando criterios de Green y O'Brien.*
Resultados: *El sistema de puntuación de Evans, indica que se lograron buenos resultados en trece pacientes; resultados satisfactorios en cuatro; resultados pobres en uno; resultados muy pobres en ninguno. Cuando se estimó la patomecánica sobre la base de los criterios Mayfield, diecisiete pacientes fueron clasificados como fase 3. Sin embargo, sólo un caso fue sumamente raro y debe ser clasificado como subtipo de fase 2.*
Conclusión: *Los resultados fueron buenos en la mayoría de los pacientes que tuvieron reparación de lesión perisemilunar.*

Palabras claves: Lesión perisemilunar, inestabilidad perisemilunar progresiva, fractura del escafoides, fractura del piramidal

West Indian Med J 2011; 60 (1): 73

INTRODUCTION

All perilunate fracture-dislocations combine ligament ruptures, bone avulsions and fractures in a variety of clinical forms. Two mechanisms of the injury may result in carpal dislocation: direct and indirect. Most dorsal perilunate dislocation is the result of an indirect mechanism of injury, usually consisting of extreme extension of the wrist joint associated with various degrees of ulnar deviation and radiocarpal or midcarpal supination (1). Also, many factors may influence the occurrence of the various types of injury: age, differences in the direction and magnitude of the deforming forces and differences in the position of the wrist joint at the time of impact. Mayfield *et al* (2) presented detailed reports about perilunate instability, which was one of the unusual injuries. In this study, the 18 patients who have had perilunate injury with dislocation or fracture were evaluated and the patho-mechanics and surgical treatment were studied.

From: Department of Orthopedic Surgery, Tokyo Medical University, 6-7-1 Nishishinjuku Shinjuku-ku Tokyo 160-0023, Japan.

Correspondence: Dr K Takase, Department of Orthopedic Surgery, Tokyo Medical University 6-7-1 Nishishinjuku Shinjuku-ku- Tokyo 160-0023, Japan Fax: +81-3-3342-5295, e-mail: k-takase@muf.biglobe.ne.jp

SUBJECTS AND METHODS

The subjects consisted of eighteen patients (sixteen males and two females). Their ages at the time of surgery ranged from 20 to 65 (mean 31.4) years. The affected side was the left in ten cases and right in eight cases. Of eighteen patients, ten patients had dorsal perilunate dislocation with or without scaphoid fracture (including simultaneous occurrence on both sides), five had dorsal perilunate dislocation with a scaphoid fracture and radial styloid fracture; one had dorsal perilunate dislocation with pseudarthrosis of the scaphoid and a triquetrum fracture (Figs. 1, 2); one had dorsal perilunate dislocation with or without scaphoid and capitate fracture, and one had combined scaphoid and lunate fracture with displaced bone fragment of the lunate from the intercarpal joint without dislocation. When these eighteen patients were evaluated based on the Green and O'Brien's classification (3), type 1 injury occurred in one patient, type 2 in nine, type 4A in five, type 4C in one and type 4D in one. A com-bined scaphoid and lunate fracture with the displaced bone fragment of the lunate from the intercarpal joint without dislocation could not be classified using that classification (Table 1).

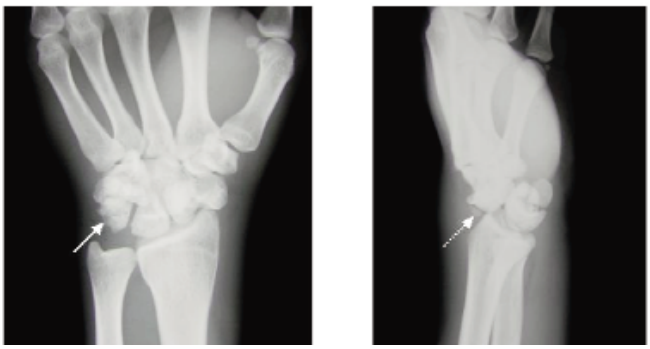

Fig. 1: The dorsal perilunate dislocation with pseudarthrosis of the scaphoid and the triquetrum fracture. The plain radiographs revealed a triquetral fracture (white arrow) and a transscaphoid-transtriquetral perilunate dislocation (white dotted arrow).

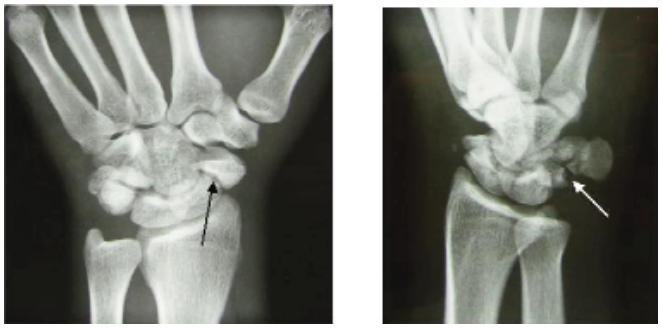

Fig. 2: Radiographic findings after a closed reduction. This film revealed the pseudarthrosis of the scaphoid (black arrow) that was divided into two fragments and revealed the smooth surface and sclerotic shadow in both gap sites of that bone. The triquetrum had completely fractured (white arrow).

Table 1: The presentation of case study

No.	Age	Affected side	Type of injury	Green & O'Brien
1.	29	Left	Transscaphoid dislocation	2
2.	20	Left	Transscaphoid dislocation	2
3.	49	Left	Transscaphoid dislocation with radial styloid fracture	4A
4.	23	Left	Transscaphoid dislocation	2
5.	32	Right	Transscaphoid dislocation	2
6.	21	Left	Transscaphoid dislocation	2
7.	25	Left	Transscaphoid dislocation with radial styloid fracture	4A
8.	20	Right	Transscaphoid dislocation	2
9.	20	Left	Transscaphoid dislocation	2
10.	31	Left	Transscaphoid dislocation	2
11.	23	Right	Combined scaphoid and lunate fracture	Unknown
12.	29	Left	Perilunate dislocation with pseudoarthrosis of the sacaphoid and the triquetrum fracture	4C
13.	32	Right	Transscaphoid dislocation	2
14.	65	Right	Perilunate dislocation	1
15.	34	Right	Transscaphoid dislocation with radial styloid fracture	4A
16.	48	Right	Transscaphoid dislocation with radial styloid fracture	4A
17.	29	Left	Perilunate dislocation with the scaphoid and the capitate fracture	4D
18.	34	Right	Transscaphoid dislocation with radial styloid fracture	4A

Almost all surgical procedures were performed using the palmal side incision, and then the elongated or disrupted ligaments or capsule were repaired. However, two patients, including one with dorsal perilunate dislocation without a scaphoid fracture and the other with dorsal perilunate dislocation with scaphoid and capitate fracture, were done using both palmal and dorsal side incisions. It is important to not only reduce the fracture or dislocation of the carpal bone, but also to repair the disrupted soft tissues. Internal fixation to the scaphoid or the capitate was performed using variable full threaded screws. The other carpal bones or tip fracture of the lunate were fixed using micro-screws. The bone graft from the ipsilateral iliac bone was only performed on the one patient with dorsal perilunate dislocation with pseudarthrosis of the scaphoid and triquetrum fracture. The duration of postoperative follow-up was between 12 and 144 months (mean 56 months). Therapeutic results were assessed according to the scoring system of Evans *et al* (4). Also, the radiographic findings, the range of motion at the wrist joint and the grip strength were evaluated pre-operatively.

RESULTS

No patient had pain with activity or at rest. There was no osteoarthritic changes or instability on the radiographic findings of the wrist joint. Seventeen patients achieved union at the fracture site of the carpal bones. However, bone union in the patient with the dorsal perilunate dislocation with pseudarthrosis of the scaphoid and a triquetrum fracture was achieved in the triquetral fracture but not in the pseudarthrosis of the scaphoid after the first operation. Thus, revi-

sion surgery using vascularized bone grafts from the second metacarpal bone was performed. By four months after the revision surgery, bone union had been achieved in the pseudarthrosis of the scaphoid (Fig. 3). When the therapeutic

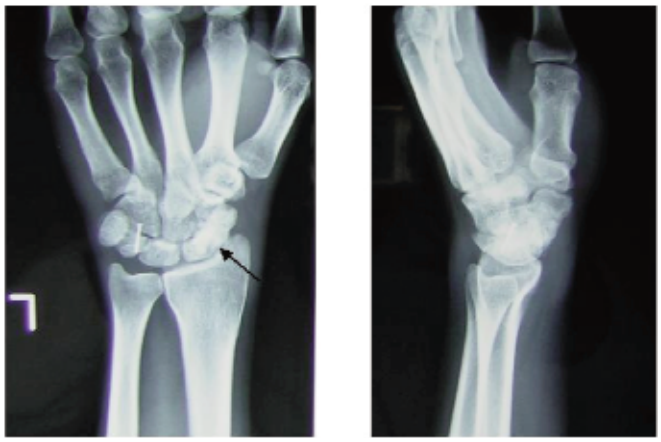

Fig. 3: Radiographic findings at 4 months after revision surgery. The bone union had been achieved in the pseudarthrosis of the scaphoid (black arrow).

results of the eighteen patients were evaluated based on the Evans scoring system, good results were achieved in thirteen patients, fair results in four, poor results in one and very poor results in none. At the final evaluation, flexion-extension ranged from 70 to 170 (mean: 129.7) degrees. When dorsiflexion and palmar flexion were assessed separately, one was 40 to 90 (mean: 70.8) degrees and the other was 20 to 85 (mean: 58.9) degrees. Grip strength was restored to a range of 49.5 to 96.2% (mean 76.3) of that on the unaffected side (Table 2).

Table 2: The therapeutic results

No.	Gender	Dorsal-extension (degrees)	Palmar-flexion (degrees)	Grip strength (% of non-affected	Evans' criteria side)
1.	M	60	50	46 kg (92%)	Good
2.	M	90	80	45 kg (98%)	Good
3.	M	50	30	23 kg (65%)	Fair
4.	M	80	80	32 kg (89%)	Good
5.	M	85	85	35 kg (94%)	Good
6.	M	70	60	38 kg (95%)	Good
7.	M	60	40	28 kg (68%)	Fair
8.	M	90	80	43.5 kg (102%)	Good
9.	M	80	80	42.6 kg (98%)	Good
10.	M	70	60	37 kg (86%)	Good
11.	M	70	80	48 kg (96%)	Good
12.	M	70	20	33 kg (73%)	Good
13.	F	60	55	17 kg (77%)	Good
14.	M	40	30	25 kg (63%)	Poor
15.	M	60	60	27 kg (75%)	Good
16.	F	80	60	17 kg (85%)	Good
17.	M	90	70	26 kg (50%)	Fair
18.	M	70	40	37 kg (69%)	Fair

DISCUSSION

All perilunate fracture-dislocations combine ligament ruptures, bone avulsions and fractures in a variety of clinical forms. The most frequent is the dorsal trans-scaphoid perilunate dislocation. Herzberg *et al* (5) and Lacour *et al* (6) have reported that when these dislocations are associated with scaphoid fractures, the fracture site is in the waist area of the scaphoid bone in about 60% or more of cases. The reason being, they suggested, that the scapho-lunate ligament is difficult to be injured and the proximal fragment of the scaphoid has a tight connection to the lunate bone. However, in rare cases, these dislocations have also been associated with capitate fractures or triquetrum fractures. In 1956, Fenton (7) reported a case of simultaneous fractures of the capitate and the scaphoid, and he called it the "naviculo-capitate fracture syndrome". Moreover, Vance (8) reported 21 cases of simultaneous fractures of the capitate and the scaphoid as "scapho-capitate fractures" and classified them into six types. However, only 12 of the cases were associated with perilunate dislocations. A search of the literature found only 43 cases of these "scapho-capitate fractures" as of 1996. Fenton and Vance considered hyperextension of the wrist and forced ulnar flexion to be the mechanism of injury in cases of capitate fracture associated with the trans-scaphoid perilunate dislocations. Also, they stated that the capitate fracture is attributable to the addition of a collision between the neck of the capitate and the dorsal end of the radius, and to the exposure to shear force. Mayfield *et al* have suggested that most carpal dislocations around the lunate are the consequence of a similar patho-mechanic event, the so-called progressive perilunate instability (PLI). According to their concepts, four stages of progressive carpal destabilization exist. On the other hand, cases associated with separation between the lunate and triquetrum in trans-triquetrum perilunate dislocations have been reported as stage 3 in the Mayfield's classification (PLI) but Garcia-Elias *et al* (9) have reported that 1/4 of these case reports were associated with triquetral fractures.

Mason *et al* (10) reported a case of translunate, perilunate fracture-dislocation. This injury represented dorsal perilunate dislocation of the carpus with an associated transverse fracture of the lunate. There was also a comminuted fracture of the radial styloid and an avulsion fracture of the ulnar styloid. He suggested that a postulated direct volar blow to the lunate would account for the transverse lunate fracture. The lunate is driven dorsally against the dorsal lip of the radius, resulting in a shear fracture of the lunate. The proximal lunate fragment would retain its strong attachment to the distal radius and ulna. The fracture site, then, represents a weak spot at which a dorsal carpal dislocation occurs. Alt *et al* (11) reported the first case of dorsal trans-scaphoid-transtriquetral perilunate dislocation in pseudarthrosis of the

scaphoid. He suggested that the pseudarthrosis of the scaphoid with a loss of scaphoid function as a mechanical tie-rod of the carpus is most likely responsible for this complex injury. The scaphoid discontinuity without pre-existing ligamentous carpal instability may lead to complex perilunate injury in minor trauma.

When the patho-mechanics in our cases was assessed based on Mayfield's criteria, seventeen patients were classified as stage 3. However, in the rare case of a combined scaphoid and lunate fracture with the displaced bone fragment of the lunate from the intercarpal joint without dislocation (Fig. 4), we considered the mechanism of the injury as a subtype of stage 2 in Mayfield's classification (PLI), that a lunate fracture, palmar joint capsule and palmar intercarpal ligament rupture occurred without any dislocation. As the distal carpal row was forced into hyperextension, the scapho-trapeziol-capitate ligaments pulled the scaphoid into extension. The lunate could not extend as much as the scaphoid, as it was directly constrained by the short radiolunate ligament (Fig. 5a). When the scapholunate torque reached a certain point, the scapholunate ligaments pulled the dorsal pole of the lunate causing the avulsion fracture. Just before the opening of an anatomical "weak " spot between the capitate and lunate, such as in a perilunate dislocation, axial compression in the direction of the long axis of the capitate was imposed as a shearing force on the palmar pole of the lunate bone. A palmar pole fracture of the lunate bone associated with 1/3 of the palmar joint surface occurred (Fig. 5b). The additional forced hyperextension of the wrist caused the rupture of the joint capsule on the palmar side and the palmar intercarpal ligament in the same manner. As a result, the bone fragment displaced from the lunate-capitate joint through the gaps in the joint capsule and the ligament. Based on the above, even in the absence of dislocation, this injury pattern may represent a form of palmer transcaphoid translunate dislocation (Fig. 4).

Fig. 4: A combined scaphoid and lunate fracture with the displaced bone fragment of the lunate from intercarpal joint without dislocation. (a), (b) The plain radiographs revealed scaphoid (black arrow) and lunate fractures (white arrow), but there was no clear evidence of dislocation. (c) Computed tomography on the lunate revealed a palmar pole fracture (white dotted arrow) and a dorsal pole fracture such as an avulsion fracture (thick white dotted arrow).

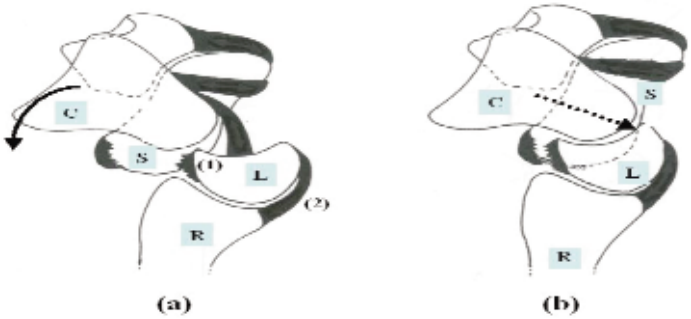

Fig. 5: The mechanism of a combined scaphoid and lunate fracture with the displaced bone fragment of the lunate from intercarpal joint without dislocation. (a) As the distal carpal row was forced into hyperextension (thick black arrow), the scapho-trapeziol-capitate ligaments pulled the scaphoid into extension. When the scapho-lunate torque reached a certain point, the scapholunate ligaments (1) pulled the dorsal pole of the lunate causing the avulsion fracture. (b) Just before the opening of an anatomical "weak " spot between capitate and lunate, such as in a perilunate dislocation, axial compression (thick black dotted arrow) in the direction of the long axis of the capitate was imposed as shearing force on the palmar pole of the lunate bone. The palmar pole fracture of the lunate bone associated with 1/3 of the palmar joint surface occurred. (R: the radius, L: the lunate, S: the scaphoid, C: the capi-tate, 1: the dorsal scapholunate ligament, 2: the short radiolunate ligament).

REFERENCES

1. Mayfield JK. Wrist ligamentous anatomy and pathogenesis of carpal instability. Orthop Clin North Am 1984; **15:** 209–16.
2. Mayfield JK, Johnson RP, Kilcoyne RK. Carpal dislocation: Pathomechanics and progressive perilunar instability. J Hand Surg 1980; **5:** 226–41.
3. Green DP, O'Brien ET. Classification and management of carpal dislocations. Clin Orthop 1980; **149:** 55–72.
4. Evans G, Burke FD, Barton NJ. A comparison of conservative treatment and silicone replacement arthroplasty in Kienböck's disease. J Hand Surg 1986; **11:** 98–102.
5. Herzberg G, Comtet JJ, Lincheid RL, Amadio PC, Cooney WP, Stalder J. Perilunate dislocations and fracture-dislocations: A multicenter study. J Hand Surg 1993; **18A:** 768–79.
6. Lacour C, de Peretti F, Barraud O, Giboin P, Pequignot JP, Argenson C. Perilunate dislocations of the carpus: Value of surgical treatment. Rev Chir Orthop Reparatrice Appar Mot 1993; **79:** 114–23.
7. Fenton PL. The naviculo-capitate fracture syndrome. J Bone Joint Surg 1956; **38A:** 681–4.
8. Vance RM, Gelberman RH, Evans EF. Scaphocapitate fractures. J Bone Joint Surg 1980; **62A:** 271–6.
9. Garcia-Elias M, Irisarri C, Henriquez A, Abanco J, Fores J, Lluch A et al. Perilunar dislocation of the carpus. A diagnosis still often missed. Ann Chir Main 1986; **5:** 281–7.
10. Mason GC, Bowman MW, Fu FH. Translunate, perilunate fracture-dislocation. Orthopaedics 1986; **9:** 1001–4.
11. Alt V, Sicre G. Dorsal transscaphoid-transtriquetral perilunate dislocation in pseudarthrosis of the scaphoid. Clin Ortho Relat Res 2004; **426:** 135–7.