

## Surgical management of perilunate dislocations

Cary Fletcher\*

Department of Orthopaedics, St. Ann's Bay Hospital Jamaica, Jamaica

\*Corresponding Author: Cary Fletcher, Orthopaedic Surgeon, Department of Orthopaedics, St. Ann's Bay Hospital Jamaica, Jamaica.

Received: November 10, 2015; Published: November 12, 2015

### Abstract

The purpose of this review was to describe the kinematics of the wrist including a detailed anatomical description of the intrinsic and extrinsic carpal ligamentous supports, carpal instability, the mechanism of injury of perilunate dislocations and surgical treatment options. The surgical treatment options discussed included closed reduction and pinning and open treatment plus or minus ligamentous repair. For open treatment the arguments for and against a dorsal approach, volar approach and a combined approach are all discussed. It is now universally accepted that early surgical intervention gives the best results however the most efficacious approach remains debatable. It does appear however, that the volar only approach with an associated ligamentous repair is gaining acceptance as the most optimal approach.

**Keywords:** Perilunate; Dislocation; Surgical Management

**Abbreviations:** WHO: World Health Organisation; K-wire: Kirshner wire; DASH: Disabilities of the Arm, Shoulder and Hand; VAS: Visual Analogue Score

### Introduction

Perilunate injuries can severely disrupt normal wrist function [1,2]. It is not uncommon for them to be under diagnosed [1,2,3]. Younger patients undergoing high energy trauma are most commonly affected. This has a significant clinical and economic impact [1,3]. Prompt diagnosis is required for initiation of appropriate intervention [2] but the appropriate surgical treatment remains debatable [3]. A review of the recent literature on the surgical management of perilunate dislocations was conducted using Pubmed as a search engine with a focus on the different surgical approaches. The WHO initiative Hinari was also utilised to gain free access to numerous online journals.

### Discussion

Perilunate dislocations involve a circumferential disruption of the soft tissues around the lunate [4]. There is a wide continuum of injuries for this problem ranging from minor ligamentous strains around the lunate, to complete dislocation of the lunate [1]. Due to severe disruptions of the carpal anatomy [4, 5], there is often carpal instability [6].

The true incidence and prevalence are difficult to define precisely [3] but they are considered to be relatively uncommon [4,7,8]. The peak incidence is in the 3<sup>rd</sup> decade, and comprises about 10% of all wrist injuries [3]. They typically result from high energy mechanisms of injury either directly or indirectly [1,2,9,10]. A direct mechanism is one in which energy is dissipated to the dislocating bone, whereas in an indirect mechanism, the deforming forces are applied a distance away from the injured point [1].

On impact, the wrist is usually in an attitude of extreme extension, ulnar deviation and carpal supination [5,8,11,12]. The dislocation of the capitate head from the concavity of the distal lunate is usually dorsal [2,7,13].

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**Citation:** Cary Fletcher. "Surgical management of perilunate dislocations". *EC Orthopaedics* 2.5 (2015): 168-173.

Anatomically, the carpus is composed of eight carpal bones arranged in proximal and distal rows, where the scaphoid acts as a connecting rod between the two rows [14]. The radiocarpal joint is an elliptical joint with a simple function. The midcarpal joint is more complex. Both wrist flexion and ulnar deviation occur at the radiocarpal joint whereas extension and radial deviation occur in the midcarpal joint [14].

Wrist kinematics maintains joint congruency throughout all ranges of motion [3]. The wrist functions to position the hand in space for gripping and grasping activities, achieved mechanically by the unique complex arrangement of bony and ligamentous structures [15]. The geometry of individual carpal bones, as well as ligamentous interconnections which control movement of one bone with respect to each other, determine wrist stability [15]. The anatomy of the carpal ligaments must be understood to perform successful reconstruction [3,4,12].

The ligaments are divided into extrinsic or intrinsic as well as dorsal and volar [3]. The intrinsic ligaments attach carpal bones to each other whereas extrinsic ligaments are extra-articular and often best appreciated arthroscopically [3]. The most common instabilities involve injuries to the intrinsic ligaments [15]. Johnson [11] divided the wrist into greater and lesser arcs. Lesser arc injuries are confined to ligamentous injuries around the lunate.

Of the extrinsic ligaments, the volar ligaments are the strongest and are the major stabilizers of the radiocarpal joint [8]. They include the radioscapholunate, radioscaphocapitate, long radiolunate and short radiolunate ligaments [8]. The volar ulnar ligaments include the ulnocapitate, ulnotriquetral and ulnolunate ligaments. These link the ulna to the carpal bones [8]. The scapholunate and lunotriquetral ligaments are the most important intrinsic ligaments of the proximal row, as they provide a complex link in proximal carpal inter-relationship. The distal intraosseous ligaments allow minimal movement at the distal row [3].

The scapholunate ligament has three parts: dorsal, volar and proximal [16,17]. The dorsal portion is the thickest and broadest part whereas the volar portion is not as strong [16,17]. Mayfield, *et al.* [18] found in their cadaveric study that solely sectioning the scapholunate ligament did not cause scapholunate separation and additional sectioning of the radioscapholunate ligament was required. The large volar radiotriquetral, ulnolunate and ulnotriquetral ligaments stabilize the proximal carpus to the distal ulna and radius volarly [8,18]. The distal row is connected to the distal radius solely by the radioscaphocapitate ligament volarly. The connecting rod between the two rows, the scaphoid, is stabilised to the distal radius by the radioscaphoid ligament. During hyperextension injuries where volar ligaments are under tension, the ligament ruptures leading to destabilisation of the distal carpal row which permits separation of the carpal rows through the potential area of weakness, the Space of Poirer [8,18].

Mayfield, *et al.* [19] in his cadaveric study shed insight into the sequence of events during the spectrum of perilunate injury. He stated that during impact from a fall on the forward outstretched hand, the force through the wrist produces a supination injury. This force starts radially, and then passes either through the scaphoid or scapholunate interval with ligamentous disruption. Mayfield, *et al.* [19] described four stages during the spectrum of injuries. Stage 1 is a progressive rupture of the scapholunate ligament from volar to dorsal, stage 2 is a dissociation at the lunocapitate joint and tear at the Space of Poirer resulting in a dorsal dislocation of the capitate, stage 3 is a lunotriquetral ligament disruption with the rest of the carpus being displaced, usually dorsally and the final stage is a complete ligamentous disruption with the lunate forced downward by the proximal capitate resulting in lunate dislocation through the Space of Poirer.

Diagnosis is frequently delayed [1,3] with up to 25% being missed initially [20]. Prompt, early diagnosis and appropriate management is required for a favourable outcome [10]. Immediate attempt at closed reduction is required in all cases and emergent open reduction is required in cases where closed reduction has failed [4,5,8, 14]. Once closed reduction is achieved, definitive surgery may be delayed [2,21,22]. Closed reduction is easier when patients present with injuries less than one week old [23]. Once swelling permits, early surgery is preferred [2] by some authors. Primary reduction reduces pain and swelling and improves range of motion [2]. Wagner [14] believed that closed reduction permits accurate reduction without significant ligamentous stripping. Other authors believe that closed reduction alone rarely produces adequate alignment. This predisposes the wrist to persistent carpal instability [9,24]. After successful closed reduction, further stabilization to maintain an accurate reduction is often required [3,4], because residual scaphoid subluxation

occurs secondary to disruptions of the radioscaphocapitate ligament [9]. Accurate reduction is essential to allow restoration of the normal intercarpal relationship and obtain a stable useful wrist [14]. Some believe that open reduction is necessary to achieve and maintain an accurate reduction [1].

Percutaneous pinning and immobilisation is a well recognised treatment option [3,7,19]. K-wires are temporarily placed in the carpal bones, to achieve a reduction which is then maintained by definitively passing K-wires across the scapholunate, lunatatriquetral and lunatocapitate joints. This is supplemented with a cast and at six to eight weeks, the wires may be removed but splinting continues for a further six weeks to allow ligaments to heal [3]. If this fails, fusion is a possible salvage procedure [7].

Recent literature has suggested that closed reduction, pinning and casting without ligamentous repair, often leads to a high rate of recurrent instability, carpal incongruity and arthritis [8]. Ogunlusi, *et al.* [10] followed three patients (31-40 years old) who were treated with closed reduction, plaster and physiotherapy after nine weeks. At eight months follow-up. Two patients were said to have very good functional outcome and the other had good functional outcome. A good functional result was not clearly defined however. Despite the low patient numbers Ogunlusi recommended closed treatment as standard treatment. Chari [25] achieved a good result in his case report of a bilateral perilunate dislocation managed with closed reduction, four weeks of casting and mobilisation at ten weeks. Other reports have found that it is difficult to achieve a good result in patients who had neither pinning or repair done [26].

Bellot, *et al.* [27] upon reviewing 16 pure dislocations found no difference in outcome in terms of treatment type (open versus closed, pinning versus no pinning and repair or no repair). He acknowledged his sample was small but the trend suggested that closed reduction did not consistently avoid the development of carpal instability. Minami, *et al.* [28] found that patients with a gap between the scaphoid and lunate greater than 3 mm had poor clinical results. Carpal instability invariably leads to poor outcome, commonly wrist stiffness [27].

At five years, a ten patient, retrospective review was carried out on a National Football League team. Seven lunate and three perilunate dislocations were treated with a variety of techniques including open versus closed, pin placement, casts only and variable immobilisation time. Four out of five patients who returned to play the same season were treated with closed reduction and percutaneous pinning only. It was felt that none of the treatment options were clearly superior to one another or detrimental [29]. This small study mainly looked at return to play as their most important outcome measure and lacked objective scoring assessments.

Inoue and Kuwahata [30] found no difference between patients with ligamentous repair and those without, once there was stabilisation via percutaneous pinning in his retrospective study of 14 patients. He however advocates for direct repair of the scapholunate ligament plus K-wire fixation. Adkinson and Chapman [24] stated that there is a low probability of achieving successful long term results using closed reduction alone with or without fixation. Many feel that there are inherent problems with closed reduction and pinning, and prefer to perform an open procedure with ligamentous repair [2].

Despite there being a general agreement that surgery gives the best outcome, there is still controversy as to the best surgical exposure because success has been reported with different approaches [4, 8]. There are supporters of the isolated dorsal approach [21,31,32,33], the isolated volar approach [34] and the combination of both [1, 30,35]. The optimal approach however is still debatable [3] because the majority of published studies consist of only short and medium term results [30].

Although it may be argued that open reduction allows for treatment of subtle injuries e.g. small osteochondral fractures which may need reattachment, or other ligamentous injuries which may be accurately repaired at the time, this does not guarantee a superior outcome [3]. Varying beliefs of different authors highlighted the controversy in the study by Sauder, *et al.* [4] where one author favoured the dorsal approach and another favoured the combined approach. One author favoured the dorsal alone approach because he felt it allowed adequate visualisation for accurate carpal reduction in neurologically intact patients. He further argued that the most critical part of the scapholunate ligament is dorsal and this is most readily repaired in this approach. The senior author felt an additional ulna volar approach should be routinely performed to repair the disrupted volar capsule and it allowed for carpal tunnel decompression [4].

The volar approach allows important volar ligaments to be repaired, as well as carpal tunnel decompression and allow repair of the volar lunotriquetral and the intrinsic radioscaphocapitate ligament [3].

The dorsal approach not only exposes the scapholunate interval, but also the lunotriquetral, midcarpal and radiocarpal joints, while preserving the integrity of other dorsal structures [1,22]. Repair of the dorsal scapholunate ligament as well as the dorsal lunotriquetral ligament may be performed using the dorsal approach [2,3]. Others have felt that the lunotriquetral ligament is usually too severely torn for primary repair [2,22], however Gelberman, *et al.* [33] routinely attempts to repair this ligament with direct suture or suture anchor. It has been argued that the combined approach offers the advantages of both approaches [2,20,22].

Trumble and Verheyden [35] utilised the combined approach with an intraosseous suture wiring technique as fixation. Over a four year period, his scapholunate angle was maintained and fifteen out of twenty two patients had a high satisfaction rate. All returned to some form of work but only ten returned to the same job. The wrist flexion extension arc and grip strength averaged 80% and 77% respectively compared with the opposite side. It was concluded that pain relief, functional motion and grip strength were all acceptable. Of note, sixteen patients required hardware removal because of cerclage wire breakage also using the combined approach. Weil, *et al.* [1] advocated the use of intraosseous cerclage wiring as well to maintain the scapholunate angle. He further stated that K-wires did not appear to adequately compress the scapholunate interval compared with intraosseous wiring during the critical period of ligament healing. While there has been a trend towards open reduction and direct ligament repair [3,20,30], it is uncertain as to whether the apparent superior results is due to greater accuracy of reduction or the effect of direct repair [3].

Herzberg, *et al.* [20] in advocating the combined approach stated that the major determinant of a poor result was a failure to address each component of the injury. Despite various proponents for the combined approach, Ogun, *et al.* [32] felt that the presence of median nerve symptoms should not be an indication for a volar incision because nerve recovery is definite. This contrasts the view of those who felt that because the dislocation may be associated with median and ulnar nerve neuropathy, neurological symptoms was an indication for urgent decompression [5,8,11]. Currently, there is still no evidence of superiority of the combined approach compared to the dorsal approach alone in this setting [30].

Recently, arthroscopically aided closed reduction and percutaneous pinning has allowed ligament repair to be performed with limited exposure which aids in minimising soft tissue dissection and the development of subsequent adhesions [1,36]. Arthroscopy allows for the dynamic examination of the carpus and can detect subtle injuries via manual testing with the probe, of the volar and intercarpal ligaments [1]. Utilisation of this procedure has allowed athletes a quicker return to sports.

Whether surgery is performed closed or open, there is increasing evidence that earlier mobilisation, without compromising ligament healing is key to achieving good outcome [3]. Despite appropriate treatment many authors have found that the prognosis is often guarded in terms of permanent partial loss of wrist motion and grip strength [30]. Although the prognosis is often guarded in several studies, Basar, *et al.* [37] was able to achieve an excellent result in 5 patients and good results in 4 patients utilising a volar only approach and concluded that a dorsal approach was unnecessary. K-wire stabilisation and ligamentous repair followed by K-wire removal at 6 weeks with subsequent rehabilitation was the protocol used in that study. The results were assessed using the DASH, VAS and Modified Mayo Wrist scores. Takase also performed a volar only approach with ligamentous repair of disrupted or elongated ligaments in 16 patients with perilunate injuries. None of the patients had pain at rest, instability or osteoarthritic changes. The majority of the patients had a favourable Evans score. Both of these studies had a very good means of assessing their results objectively which enhanced the reliability of the evidence. It cannot be understated that if very good outcomes can be achieved with a volar only approach, one can avoid the potential additional morbidity of a dorsal approach and a shorter surgical time compared to a combined approach.

### Conclusion

Although it is generally agreed that surgery is the best mode of treatment for traumatic perilunate injuries, the best surgical approach remains debatable. Early diagnosis and prompt surgical intervention, utilising the principles of accurate reduction and stable internal fixation with ligamentous repair allows for the most optimal result. Several authors have advocated for the combined approach

based on the theoretical advantage of addressing pathologies on both sides. However, a volar only approach with ligamentous repair has demonstrated the ability to effectively restore the normal carpal relationship, provide acceptable grip strength and functional wrist motion whilst avoiding carpal collapse and post traumatic arthritis.

### Acknowledgement

Thank you to Kaye Patrice Lambert Fletcher for invaluable technical assistance for this paper.

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**Volume 2 Issue 5 November 2015**

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