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IN BRIEF

In Brief

Mayfield et al. Classification: Carpal Dislocations and Progressive Perilunar Instability

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History

According to Melsom and Leslie, the earliest description of perilunate dislocation was by Malgaigne in 1855, before the advent of radiography [7]. It later was described by Cousins, Destot, de Quervain, and others [7]. According to Melsom and Leslie [7] Tavernier reported the first series in 1906. Many years later, in 1968, the concept of the proximal row as an intercalated segment was described by Fisk [7]. In 1972, Linscheid et al. [4] modified the concept to develop models of dorsal and volar intercalated instability. The ligamentous pathoanatomy and classification of these injuries, however, had not been well described. In 1980, Mayfield et al. [5] performed a cadaveric study to better delineate the pathoanatomy and classify the degree of carpal instability after perilunate injury.

Purpose

Carpal dislocations are uncommon but can have substantial functional and economic impact. They tend to occur in young working-age men. The initial diagnosis frequently is missed and inadequate treatment leads to increased pain, stiffness, and advanced posttraumatic arthritis [1]. Immediate diagnosis, accurate understanding of the pathoanatomy, and anatomic reduction with internal fixation lead to improved scores of patient-reported pain and function and less posttraumatic arthritis [1]. Staging the severity of the injury with the classification described by Mayfield et al. [5] is used to guide treatment, aid communication, and provide some prognostic information for these potentially devastating injuries.

Staging System of Perilunate Instability by Mayfield et al.

Mayfield et al. [5] performed an anatomic study on 32 cadaveric wrists loaded to failure in a position of wrist extension, ulnar deviation, and intercarpal supination. This produced 13 perilunate dislocations and two lunate dislocations. Through radiographic evaluation and dissection of the specimens, four distinct stages of injury emerged. The progressive ligamentous injury around the lunate was referred to as progressive perilunar instability (Fig. 1).

In the first stage of this classification, the scapholunate articulation is disrupted [5] (Fig. 1, Numeral I). Radiographically, this was associated with scaphoid rotation and scapholunate dissociation. Ligaments injured included the radioscaphoid, radiocapitate, and scapholunate interosseous ligaments (Table 1).

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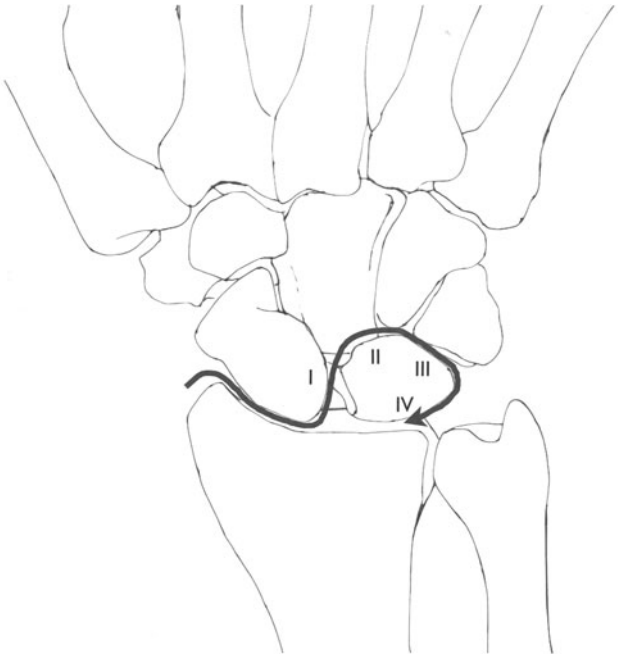

Fig. 1 The classification of Mayfield et al. is shown as illustrated in their original cadaveric study. Numerals I to IV = classification stages. (Modified and reproduced with permission by American Society for Surgery of the Hand from Mayfield JK, Johnson RP, Kilcoyne RK. Carpal dislocations: pathomechanics and progressive perilunar instability. *J Hand Surg Am.* 1980;5:226–241. Copyright American Society for Surgery of the Hand [1980]).

The second stage of progression involves capitolunate joint disruption in addition to the scapholunate injury [5] (Fig. 1, Numeral II). Radiographs may show capitate subluxation or dislocation. Dissection revealed radial collateral ligament injury in addition to the ligaments disrupted in Stage I (Table 1).

The third stage of progression is perilunate dislocation [5] (Fig. 1, Numeral III). The lunotriquetral joint is now also disrupted. Radiographically, the capitate is dislocated dorsally, the triquetrum and scaphoid are malrotated, there may be triquetrolunate diastasis, and there may be a volar triquetral fracture. In addition to the previously described ligaments, the palmar radiotriquetral ligament is torn and the ulnotriquetral ligament injured to a variable extent.

The fourth stage of progression is lunate dislocation [5] (Fig. 1, Numeral IV). The capitate is still dislocated dorsally from the lunate, but now the radiolunate joint is disrupted and the lunate is dislocated volarly from the lunate fossa on radiographs. Cadaveric dissection shows all the previously described ligament injuries with the addition of dorsal radiocarpal ligament tear (Table 1).

Based on the observed pattern of progressive perilunar instability, Mayfield et al. [5] described a reduction technique that reversed the mechanism that was applied to all the specimens. Longitudinal traction and ulnar deviation were performed to recreate the carpal separation, followed

Table 1. Summary findings of Mayfield et al. [5]

Parameter	Stage I	Stage II	Stage III	Stage IV
Radiographic findings	Scaphoid rotation	Capitate dislocation	Malrotated triquetrum and scaphoid	Lunate dislocation
			Triquetrolunate diastasis	
			Dislocated triquetrum	
			Volar triquetral fracture	
Joints disrupted	Scapholunate	Scapholunate	Scapholunate	Scapholunate
		Capitolunate	Capitolunate	Capitolunate
			Triquetrolunate	Triquetrolunate
				Radiolunate
Ligaments torn or attenuated	Radioscaphoid	Radioscaphoid	Radioscaphoid	Radioscaphoid
	Scapholunate interosseous	Scapholunate interosseous	Scapholunate interosseous	Scapholunate interosseous
	Radiocapitate	Radiocapitate	Radiocapitate	Radiocapitate
		Radial collateral ligament	Radial collateral ligament	Radial collateral ligament
			Palmar radiotriquetral	Palmar radiotriquetral
			+/−Ulnotriquetral	+/−Ulnotriquetral
				+/−Dorsal radiocarpal

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by intercarpal pronation and then radial deviation and palmar flexion.

After reduction, palmar flexion of the wrist approximated the palmar ligaments. This was consistently associated with dorsal subluxation of the proximal pole of the scaphoid [5]. Extension restored more normal scapholunate relationships but allowed considerable separation of the torn palmar ligaments. It was believed this paradox likely accounted for the variable results with closed reduction [5].

It continues to be unclear which intercarpal or radiocarpal ligaments require direct repair and which heal by restoration of the osseous relationships.

Confirmation/Validation

Despite widespread use of the classification of Mayfield et al. for perilunate injuries, no published evidence specifically validates its clinical use. Because of the systematic way in which cadaveric wrists were loaded to failure, imaged radiographically, and dissected, the internal validity of the classification system is good. Meade et al. [6] confirmed this by performing cadaveric sequential ligament sectioning studies and found much of the same ligamentous/radiographic correlation.

In terms of external validity, however, Mayfield et al. [5] recognized wrist extension, ulnar deviation, and intercarpal supination are not likely the sole mechanisms by which perilunate dislocations occur. Minor variations in mechanism lead to other injury patterns. The authors referenced their own unpublished work that used a similar mechanism and created scaphoid fractures and other greater arc variant injuries [5].

In terms of utility, reliability, or accuracy as a clinical tool in perilunate instability, we are not aware of any studies that validate the Mayfield et al. classification.

Limitations

When Mayfield et al. [5] proposed their classification, they believed additional loading studies were needed. The classification is limited to the most common pattern of acute perilunate instability, in which radial-sided ligaments are torn and separated and the capitate dislocates dorsally. It does not include transscaphoid variants, ulnar-sided injuries, or volar dislocations of the capitate.

Johnson [2], a coauthor of the classification, introduced the concept of greater and lesser arc injuries later in 1980, allowing description of transscaphoid variants. Viegas et al. [8] reported a separate classification system to describe ulnar-sided perilunate injury in 1990. Herzberg et al. [1] described a classification system for acute perilunate injury that added the possible, but rare, volar perilunate dislocation and attempted to quantify the degree of lunate displacement but otherwise did not address the limitations of the classification of Mayfield et al.

More comprehensive classification systems of carpal instability also exist. Larsen et al. [3] presented a classification of carpal instability that classifies multiple aspects from chronicity to etiology. This and other classifications, however, remain largely conceptual and are similarly unvalidated.

Conclusions/Uses

The description of progressive perilunar instability by Mayfield et al. has contributed substantially to our understanding of the pathoanatomy in acute perilunate injury and has helped guide operative treatment, which follows the dislocated joints and torn ligaments. Open reduction, direct ligament repair, and internal fixation reportedly improve patient-reported pain, function, and radiographic arthrosis [1]. However, the system is limited to radial-sided injury occurring in wrist extension, ulnar deviation, and supination. Further study may better delineate the utility, reliability, and accuracy of the system in clinical use.

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