

Isolated carpal bone dislocations are uncommon injuries, however all the carpal bones have been reported to dislocate in an isolated fashion when a localized, direct, or indirect force is concentrated over a single bone of the wrist [1, 2]. The most common dislocation of carpal bone is that of the lunate which was examined in detail in the chapter on perilunate injuries. Less common is the dislocation of pairs of adjacent carpal bones which will be discussed in brief later on.

Simple radiographs are usually sufficient to make the diagnosis and are greatly facilitated by identifying the Gilula's arcs. A CT scan may be helpful when in doubt, while arthroscopy may be used as both a diagnostic and a therapeutic modality if imaging modalities are nondiagnostic [10–12].

## 11.1 Scaphoid

Since the first description by Higgs in 1930 [3], only 32 [4] or 34 [5] cases of isolated scaphoid dislocation have been reported in the literature. The male to female ratio is approximately 7:1 [6, 7].

### 11.1.1 Evaluation

Wrist pain, swelling, and limitation of wrist motion are the usual complaints. A bony prominence is usually evident along the radial, palmar, or rarely dorsal aspect to the radius [6, 8]. Usually there are no signs of neurovascular involvement [6], but dislocations with palmar-ulnar direction could produce median nerve injury [9].

The percentage of cases with delayed diagnosis ranges between 48 and 50 % [6, 7]. Most of the delay in recognition is due to lack of awareness of this rare occurrence.

### 11.1.2 Classification

Dislocation of the scaphoid bone may occur after an apparently successful reduction of a major carpal dislocation or it may occur as a primary condition [13]. Richards et al. in 1993 [14] categorized scaphoid dislocations as simple (isolated to the scaphoid) or complex (a combination of scaphoid dislocation with axial carpal dislocation). Others, characterized these injuries as Type I (isolated anterolateral dislocation of the proximal pole); and Type II (scaphoid dislocation associated with an axial derangement of the capitate-hamate joint) [1, 2, 15, 16].

Leung et al. [7] have proposed a classification scheme for isolated dislocations of the scaphoid:

1. **Primary versus secondary:** The primary type results directly from the injury. The secondary type represents a residual dislocated scaphoid after closed [5, 17] or self-reduced perilunate dislocation.
2. **Simple versus complex:** The simple type only involves the scapholunate and radioscapoid articulation, whereas disruptions of the distal carpal row including the capitate and hamate

and middle/ring metacarpal articulations are classified as a complex type [11, 14, 18, 19].

3. **Partial versus total:** Partial dislocations retain some soft tissue attachments (usually distal), while complete dislocations have lost all soft tissue attachments.
4. **Direction of dislocation:** In partial dislocations, the proximal pole can be dislocated volarly (in ulnar, radial, or neutral direction), dorsally or purely radially.

A case of total dislocation in volar direction was reported by McNamara and Corley in 1992 [20], while one case of total dorsal dislocation of the scaphoid was reported by Amaravati et al. in 2009 [21].

Horton et al. [10] described a case of complex or type II dislocation and after reviewing the literature they found only 11 similar cases. Variants of a complex type of injury could be the combination of scaphoid dislocation with dislocation of the hamate [22] or with fracture of the hamate [23].

Lee et al. [5], after reviewing the literature, found 34 cases of isolated scaphoid dislocation. There were 26 palmar (14 in palmar-radial, 9 in neutral, 1 in proximal, and 2 in palmar-ulnar direction), 5 radial, and 3 dorsal dislocations.

Other carpal injuries that might be associated with scaphoid dislocation can be easily overlooked such as chip fractures of other carpal bones [21, 24–26].

### 11.1.3 Mechanism

The majority of cases result from traffic accidents especially motorcycle injuries, while the usual mechanism of injury is the application of an indirect force resulting in a dorsiflexion and ulnar deviation [8, 24, 27] or a twisting injury to the wrist [7]. Scarcer injury mechanisms reported are blast injuries [28], entrapment of the wrist [6] or following a penetrating injury with a sharp object [29]. In addition, the position of the wrist during injury, may be related to the direction of dislocation of the proximal pole of the scaphoid [7].

For type I injuries, a violent hyperpronation injury has been implicated with the wrist in dorsiflexion and ulnar deviation while grasping a fixed object, causing SL dissociation followed by the enucleation of the proximal pole of the scaphoid [1, 4, 15]. For type II injuries a high-energy axial compressive load along the 3rd and 4th metacarpals, creating enough shear stress to the capitate-hamate joint to disrupt its strong ligament attachments has been implicated [1]. Others have proposed that with hyperdorsiflexion, the proximal pole of the scaphoid slides down the volar slope of the radius and is ejected volarly. If the energy of injury is not dissipated, the capitate abuts the radial dorsal rim and the shearing force between the capitate and hamate is transmitted distally between the middle and ring metacarpals [16, 30].

Leung et al. [7] considered scaphoid dislocation as an extreme form of scapholunate dissociation representing one end of a spectrum of scapholunate injuries. Both are the result of a similar mechanism of injury and the only clinical difference between dorsal partial dislocation of the scaphoid and chronic scapholunate dissociation with DISI, is that the contact between the proximal pole of the scaphoid and the radius is lost in the former.

### 11.1.4 Pathoanatomy

The severity of the dislocation depends on the number of ligaments that have been disrupted. In partial palmar dislocation of the scaphoid, the SLI, RSL, and the RSC ligaments are disrupted while in total dislocation, all ligaments attached to the scaphoid are disrupted [7]. Szabo et al. [12], based on arthroscopic and surgical findings of 3 patients, postulated that the sequence of ligamentous failure in scaphoid dislocations begins in the radiopalmar aspect of the proximal pole of the scaphoid with the RSC and SLI ligaments failing first, followed by the LRL and ultimately by the ST ligament (Fig. 11.1a–n).

In complex or type II dislocations the ligamentous injuries are more extensive, including mainly the intercarpal capitolunate, the SLI, DRC, DIC, RSC, and LRL ligaments [10].

### 11.1.5 Treatment

Treatment ranges from closed reduction and casting, to percutaneous fixation after closed or open reduction and to open reduction and ligament reconstruction with internal fixation. Closed reduction is usually accomplished in most cases when treated acutely, by traction and direct manual pressure of the scaphoid with the wrist being ulnarly deviated. However, unsuccessful attempts for closed reduction have been reported, necessitating open reduction [4, 6, 7, 12, 26, 31]. In cases of incomplete reduction, ligamentous material (usually the SLI ligament) invaginated into the SL interval is blocking the reduction [12].

Case reports have described successful treatment with closed reduction and immobilization in a cast as definitive treatment, in cases of partial dislocation of the scaphoid detected early [18, 23, 24, 26, 27, 32, 33]. A scaphoid plaster is usually applied for 4–6 weeks. Closed reduction, percutaneous K-wires fixation, and cast application have also been reported, although these methods were not always successful [34]. However, many publications have advocated an open reduction, ligament repair, and internal fixation through a dorsal [1, 12, 26, 34–37] or volar approach [4, 6–9, 19, 20, 38]. In contrast to treatment for simple scaphoid dislocation, which is frequently treated with closed reduction, in cases with complex dislocations, reduction of the scaphoid alone is insufficient to stabilize the carpus with associated axial carpal disruption. Open reduction is necessary to fix the unstable radial half of the carpus to the stable ulnar half [11].

Most reported cases, have achieved good to excellent results [15]. The patients have returned to their prior activities with only moderate limitations, while there is a nearly universal loss of range of wrist motion [10].

The most significant risk factors in poor prognosis are delayed diagnosis and treatment, particularly if more than 2–3 weeks, although successfully treated delayed cases have recently been described [35]. Excision of scaphoid [37], proximal row carpectomy [13, 21], or partial wrist fusion [9] have been applied in cases of late diagnosis. The longer the delay, the worse the prognosis will be. Potential complications following an isolated scaphoid dislocation are residual carpal instability [19, 20, 31], stiffness and posttraumatic arthrosis.

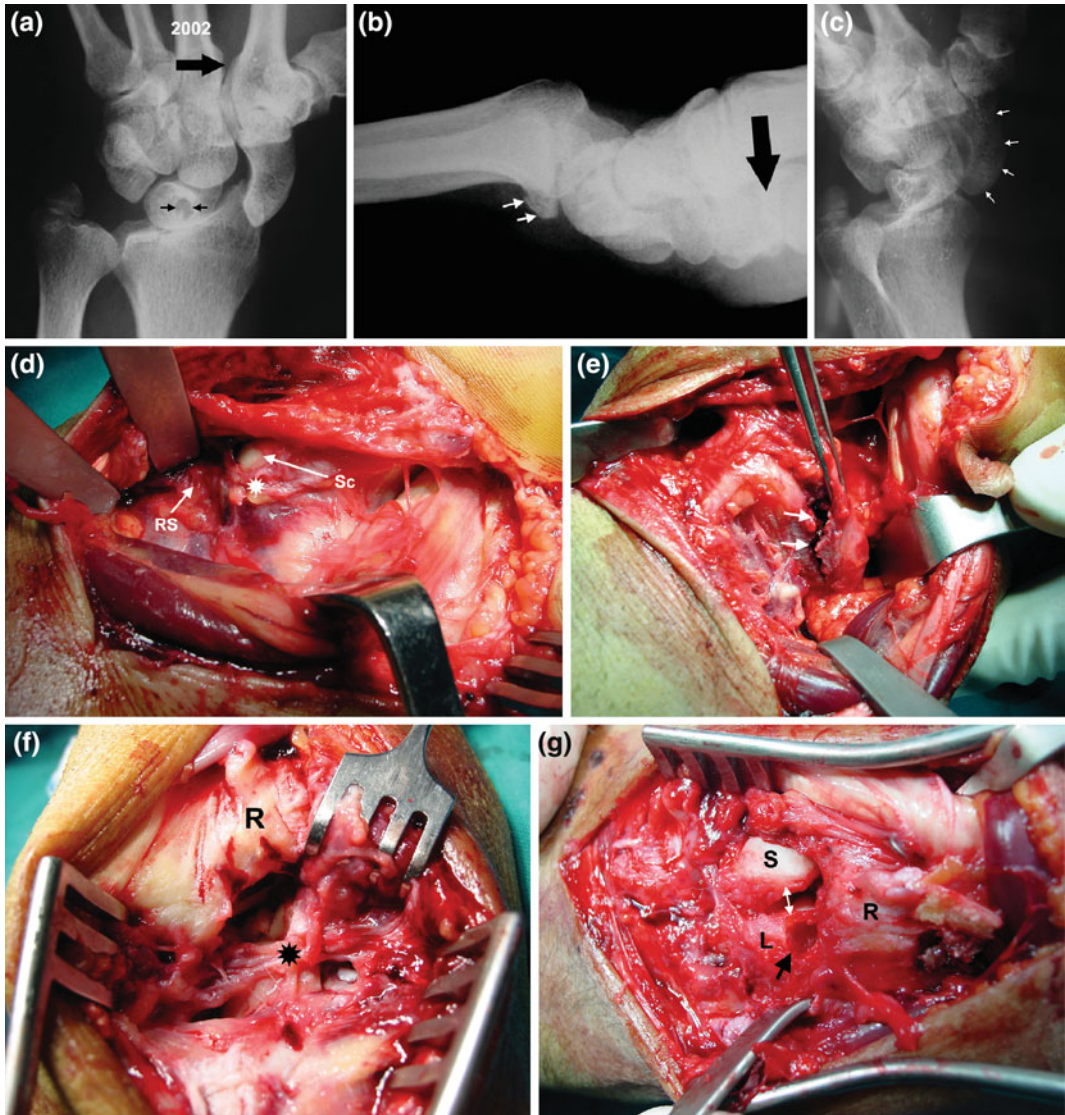
Although transient radiological features of early avascular necrosis have occurred, in none of the cases reported has there been any evidence of permanent avascular necrosis [1, 7, 10, 24]. In partial dislocations, vascularity of the scaphoid is partly maintained by intact distal soft tissue attachments, while in cases of complete dislocation it is proposed that there are intact intraosseous channels inside the intact scaphoid bone that allow rapid revascularization from the surrounding soft tissues [7]. However, Szabo et al. [12] reported that one out of three of their patients showed avascular necrosis with fragmentation of the proximal pole of the scaphoid after 20 months follow-up.

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## 11.2 Triquetrum

Dislocation of the triquetrum has rarely been described in the context of perilunar injuries [39, 40]. These cases probably constitute a variant of reverse perilunar instability, where the force is applied to the hypothenar area and the disruption propagates around the triquetrum disrupting the ligaments from its distal (triquetrohamate), proximal (ulnotriquetral) and radial (lunotriquetral) articulation.

Both dorsal [40–43] and volar dislocations [44, 45] of the triquetrum have been documented. With so few cases, the exact mechanism of injury remains obscure. Usually, a major fall, a motor vehicle accident, or a crush injury has been implicated. During the frequently mentioned mechanism, with a fall on the outstretched hand and the wrist in dorsiflexion and



**Fig. 11.1** Male, 54-years old, car accident. A case of primary, simple, partial volar-radial scaphoid dislocation was recognized (**a, b, c**). The wrist was radially and volarly displaced. An accidental, unrelated cyst in the lunate was obvious (*arrows*) (**a**); and a concomitant fracture of the ulnovolar radial rim was indicated (*arrows*) (**b**); the volar approach revealed the dislocation of the proximal pole of the scaphoid in radiovolar direction and the ruptured volar RSC and LRL ligaments (*asterisk*) (*RS* radial styloid, *Sc* scaphoid) (**d**); *arrows* indicate the fractured ulnovolar fragment (**e**); dorsal approach revealed the attenuated dorsal intercarpal ligament which was detached from the dorsal scaphoid (*asterisk*), while the wrist was volarly displaced

(*R* radius) (**f**); the dorsal approach also indicated the rupture of the SL ligament (line with *arrows* on each end) and the evacuated cyst of the lunate (*arrow*) (*S* scaphoid, *L* lunate, *R* radius) (**g**); a wire-loop was used to fixate the ulnovolar fragment (**h**); bone anchors were used for the reattachment of the SL ligament and the volar RC ligaments to the radius; the scaphoid was stabilized with K-wires to the lunate and capitate; cancellous bone grafts were placed to the lunate cyst. Postoperative X-rays (**i, j**). Two years later, the patient was pain free with good ROM, while the radiologic appearance was satisfactory (**k, l**); 7 years postoperatively, stenosis of the scapho-capitate joint was obvious, while the patient was complaining for weather-change symptoms (**m, n**)

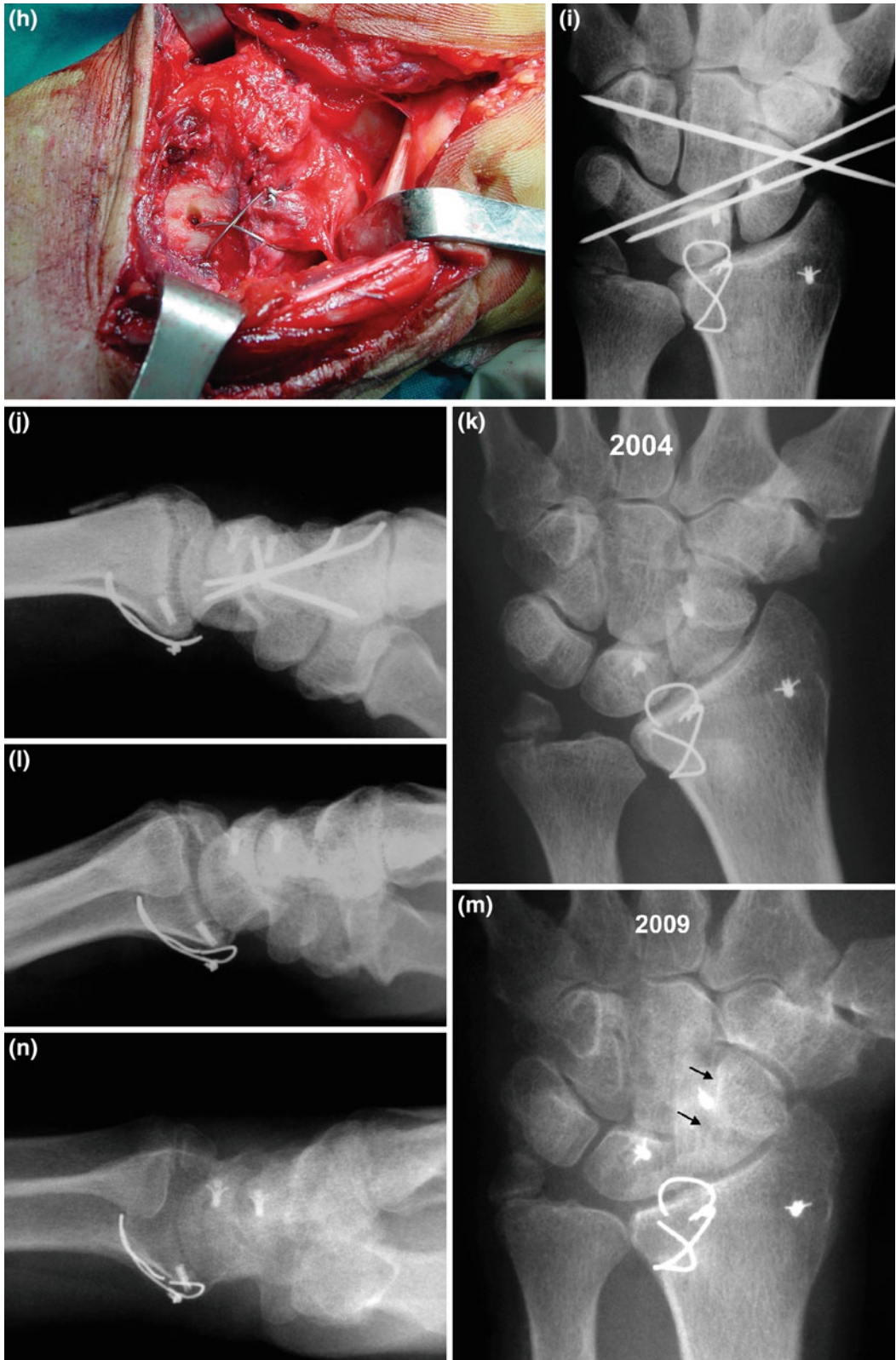


Fig. 11.1 (Continued)

ulnar deviation, the triquetrum is thought to become covered by the lower end of the ulna, avoiding dorsal displacement and favoring volar dislocation [42]. In addition, with forced wrist hyperextension, the proximal pole of the hamate rides dorsally on the triquetrum, exerting a palmar force leading to a palmar dislocation of the triquetrum [45]. However, the higher frequency of dorsal dislocations makes more likely the mechanism of injury to be the direct impact to the hypothenar area. Dorsal dislocation may also be produced by wrist hyperflexion and pronation [43], secondary to a perilunar dislocation or a variant of an ulnar axial loading injury [40].

In many of the reported cases the diagnosis was delayed [41, 44, 45]. On examination, swelling will be noted about the ulnar aspect of the wrist and if the dislocation is dorsal, it may be possible to palpate the displaced triquetrum. The volar displacement is associated with transient median nerve compression [15, 44, 45]. Usually, PA lateral and oblique views are adequate for radiographic evaluation, with the lateral view providing information on the direction of the dislocation.

Treatment has included triquetrum excision [44, 45], open reduction and internal fixation [40, 41, 43], and closed reduction without fixation [42], all with reasonably good clinical results, although in two cases signs of instability (VISI [43] and ulnar translation [45]) were found. In any case, excision of the triquetrum must be avoided, since significant stabilizing ligaments are attached to the bone, which in addition, has an important proprioceptive role. Although closed reduction and percutaneous pinning could be attempted, we believe that open reduction is required. The approach is dictated by the direction of dislocation, although combined palmar and dorsal approaches may be necessary, followed by K-wire fixation of the reduced triquetrum with ligament repair. There have been no reported cases of avascular necrosis following treatment for a triquetral dislocation [28].

### 11.3 Pisiform

Pisiform dislocation is an extremely rare injury and has been reported in isolation [46, 47], in combination with distal radial fractures [48, 49] or with hamate dislocation [50–52]. The possible relationship between pisiform subluxation and distal radius fractures has also been mentioned [53]. In children, two cases of pisiform dislocation associated with a distal radius fracture have been reported [48, 54]. Displacement of the pisiform has been reported distally, ulnarly, and proximally [15, 36, 55].

Since the pisiform has a flat articular surface articulating with the triquetrum, it relies mainly on its many soft tissue attachments for stability. These include: the attachment of flexor carpi ulnaris tendon, abductor digiti minimi, extensor retinaculum, transverse carpal ligament, pisometacarpal and pisohamate ligaments, and the joint capsule to the triquetrum (Fig. 11.2). Mechanical testing has showed the soft tissues around the pisotriquetral joint to be strongest proximally and distally and weakest medially [56]. The ulnar nerve and the volar branch of the ulnar artery are located in the immediate vicinity to the pisiform with the nerve being medial to the artery and closer to the pisiform.

Two possible mechanisms have been postulated [15, 28, 46, 54]. One is a direct blow to the ulnar aspect of the wrist and the other is strong eccentric contraction on the flexor carpi ulnaris with the wrist in extension. Fall from height, traffic accidents, and lifting heavy objects have been implicated. Pulling of the FCU, as well as forced wrist hyperextension can disrupt the thin capsule of the pisotriquetral joint, and the FCU tendon's distal continuation or the pisohamate and pisometacarpal ligaments. If these ligaments are damaged, the function of the FCU becomes impaired, with the pisiform retracting proximally [57].

The diagnosis should be based on the injury mechanism and the presentation of pain, swelling, and tenderness over the ulnar border of the

wrist, while a painful restriction of all wrist movements is a usual finding. Frequently a characteristic depression is found at the base of the hypothenar eminence, where the pisiform bone should lie [46, 55]. Ulnar neuropathy may also be caused by pisotriquetral joint instability [55, 56].

Posteroanterior, lateral, and oblique radiographs are usually adequate for diagnosis. X-ray features of the pisotriquetral joint including parallelism, width of the joint space and symmetry have been suggested to be diagnostically relevant [53]. Oblique view is taken with the ulnar side of the wrist placed against the plate, with the forearm in about 15° of supination. Comparison films with the contralateral wrist may be needed.

Treatment includes immobilization after a closed reduction [48, 55, 58], open reduction with internal fixation, closed reduction and pinning [59], and resection of the pisiform either initially [46, 57, 60–63] or secondarily in cases of persistent pain or recurrent dislocation [47].

The manipulation for closed reduction usually requires maximum wrist flexion with direct pressure to relocate the bone [28, 58]. The reduction can be aided by placing the forearm in pronation [55]. There are some differences in opinion regarding the position of the wrist immobilization. The following variants have been proposed: a below elbow cast with the wrist in 30–40° of dorsiflexion and slight radial deviation for 3–4 weeks [58], a radially deviated short arm cast for a minimum of 3 weeks [46], a dorsal splint holding the wrist flexed and the forearm pronated for 3 weeks [55] or a long arm plaster splint in 25° of dorsiflexion for 3 weeks [59].

It has been stated [64] that excision of the pisiform decreases wrist flexion strength without functional deficit or loss of range of motion and that the soft tissue's confluence over the pisiform allows for subperiosteal pisiform excision and repair of the tissues without disturbing the FCU insertion. Excision of the pisiform is consistently the most successful treatment for pain without functional deficit [47, 65, 66].

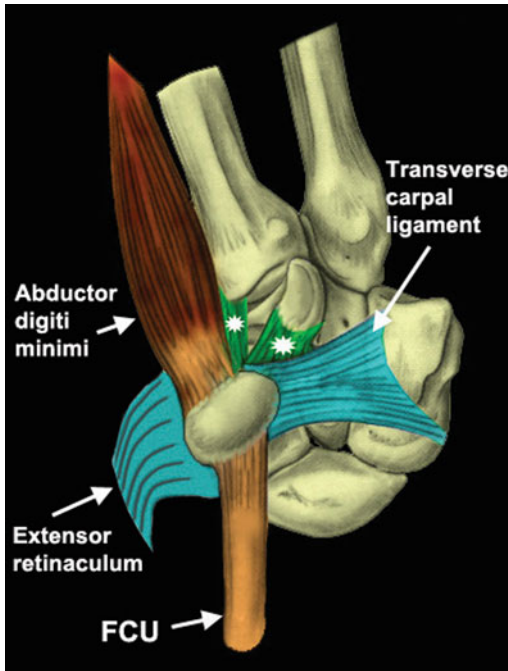
## 11.4 Trapezium

The trapezium may dislocate in isolation or together with the thumb metacarpal. Incomplete dislocation, in which the trapezium remains attached to the base of the first metacarpal should be categorized as a peritrapezium axial-radial dislocation [1]. True volar isolated dislocations of the trapezium are very rare and are thought to be caused by a direct blow to the dorsolateral aspect of the wrist or as a consequence of a hyperextension-supination injury to the radial-deviated wrist [1, 15]. Dorsal radial dislocations are described as the result of hyperflexion of the first metacarpal combined with an axial compression force [67, 68]. Crush injuries and motor vehicle accidents are the most commonly reported causes of these injuries.

Palmar and dorsal radial dislocations have been described [68–71]. However, Garcia-Elias [72] after reviewing the literature, found that only six cases have been reported of true isolated dislocations with complete enucleation of the bone and were all palmarly displaced.

Clinically, depending on the mechanism an open wound may be present at the thenar area [73–75]. With isolated dislocation, a palpable mass may be present at the base of the thumb. Pain, instability, and limited range of motion of the first CMC joint may be noted [28]. Palmar dislocation of the trapezium has been associated with avulsion of the recurrent motor branch of the median nerve [75]. Diagnosis is best confirmed by radiographs, while the posteroanterior axial oblique view is used to evaluate the trapezium with the surrounding bones [76].

In acute cases, open reduction and K-wire fixation are thought to be the treatment of choice [68, 69, 74, 75, 77] and whenever possible, repair of the periarticular ligamentous structures should be accomplished [28]. Closed reduction and percutaneous pinning could also be attempted or in cases of delayed diagnosis, excision of the trapezium has been applied [70, 78].



**Fig. 11.2** The soft tissues stabilizing the pisiform to the flat articular surface of the triquetrum (*asterisks* pisohamate and pisometacarpal ligaments, *FCU* flexor carpi ulnaris)

Since the trapezium receives its blood supply from nutrient arteries entering the bone from three surfaces and has consistent intraosseous anastomoses, the risk of avascular necrosis is negligible.

## 11.5 Trapezoid

The trapezoid has been described as the keystone of the proximal carpal arch with its palmar surface narrower than the dorsal, while it is attached to the surrounding bones by strong ligaments. It has been stated [36, 79] that Gay in 1869 was the first to describe a case of trapezoid dislocation and since that time there have been 25 [79] or 26 [36] reported cases in the literature, while a literature review by De Tullio [80] revealed only 24 published cases since 1962. Frequently, the dislocation of the trapezoid is

associated with other fractures or dislocations of the hand or constitutes a part of the axial-radial dislocations of the wrist [81]. Both palmar [80, 82, 83] and dorsal [84–86] isolated dislocations of the trapezoid have been reported. Less than 10 of these dislocations were displaced volarly with one having caused an attritional rupture of flexor tendons in a case whose diagnosis was missed for 4 months [82] and another presented with acute carpal tunnel syndrome [79].

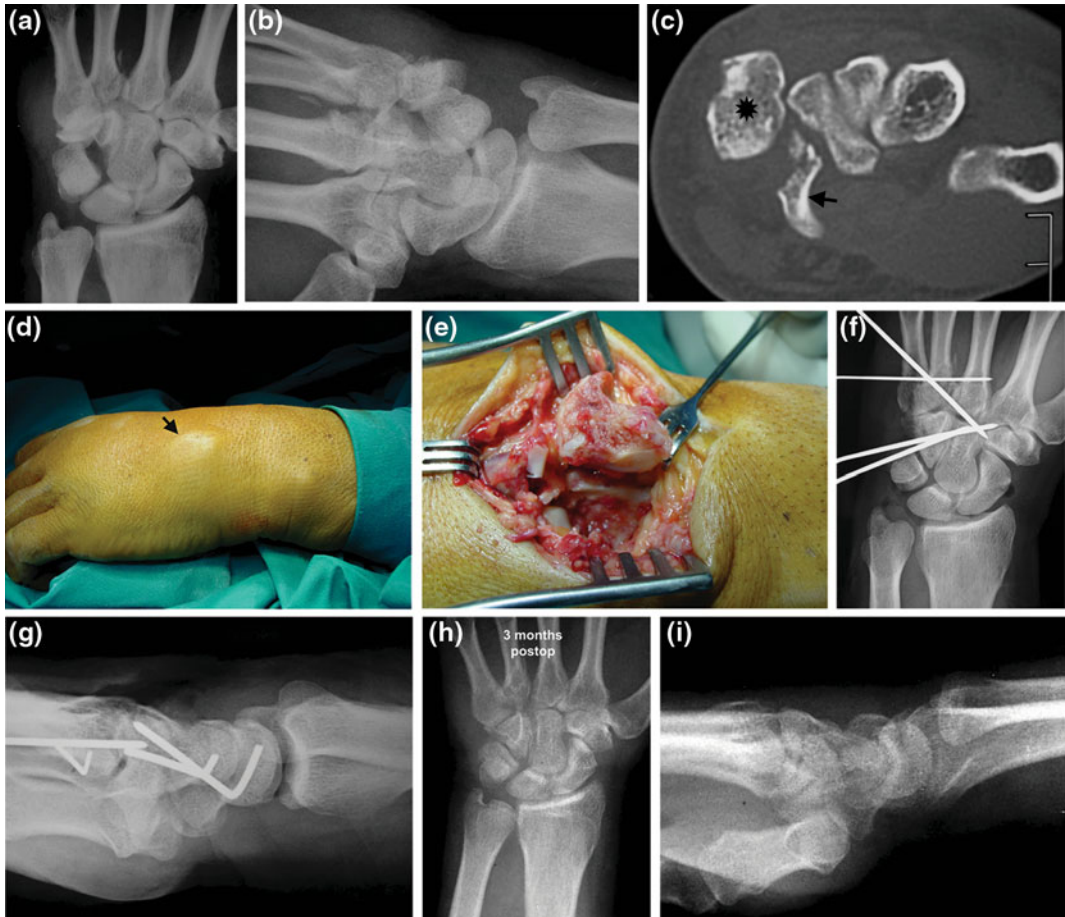
There is no clear explanation as to how a wedge-shaped bone which is wider dorsally, dislocates palmarly, but a direct blow to the dorsum of the wrist has been implicated [1]. The more common dorsal dislocations may be produced by direct trauma or indirectly from a blow to the second metacarpal with the wrist flexed [28].

In acute cases, pain, considerable swelling, and limited motion of the fingers are noticed, while vascular or neurological damage has not been reported. With dorsal dislocation an osseous prominence is palpated at the base of the index finger metacarpal, while a palmar dislocation will not have such an obvious presentation [28]. Diagnosis of trapezoid dislocation is confirmed by standard posteroanterior, lateral, and oblique radiographs looking for an empty space at the base of the second metacarpal. When necessary, tomograms or a CT scan may be necessary.

Treatment for dorsal dislocation of the trapezoid has included closed reduction [87, 88] or open reduction with a dorsal approach [84, 86] and pinning with K-wires.

Closed reduction of a palmar dislocation is ineffective because of the shape of the trapezoid [82, 83], thus open reduction is always necessary with combined [79] or with only dorsal approach [80, 83]. Few cases were treated with excision of the trapezoid [81, 82], which resulted in the proximal migration of the second MC and the development of degenerative changes to the midcarpal joint. A reasonable alternative in difficult cases is a primary limited fusion [82, 89]. The trapezoid has nutrient vessels that enter its palmar





**Fig. 11.3** Male, 62-years old, car accident. The wrist injury remained initially undiagnosed and was treated with a below elbow splint. Routine examination of the X-rays 10 days later revealed a dorsal dislocation of the hamate, associated with proximal migration of the 5th metacarpal (**a**, **b**); a CT scan indicated the dorsal dislocation of the main portion of the hamate (*asterisk*)

with a fractured hamulus (*arrow*) (**c**); a painful osseous swelling of the dorsum of the wrist was apparent (*arrow*) (**d**); during exploration the main portion of the hamate was found beneath the subcutaneous tissue, devoid of any soft tissue attachments (**e**); postoperative X-rays (**f**, **g**); radiographic appearance 3 months later (**h**, **i**)

and dorsal surfaces, while there are no intraosseous anastomoses between the palmar and dorsal systems. Thus, the trapezoid is at risk in cases of dislocation and cases with findings of avascular necrosis have been reported [15, 82, 86].

## 11.6 Capitate

True isolated dislocation of the capitate is an extremely rare injury. It requires disruption of the interosseous ligaments to the adjacent

trapezoid and hamate, disruption of the ligaments of the third CMC joint distally, and disruption of the radiocapitate and capitolotriquetral ligaments proximally [28]. To our knowledge, only one such case has been reported by Cherucci et al. [90], who described a total volar dislocation of the capitate after a crush injury of the hand in a metal press. In the majority of the reported cases, the dislocated capitate is associated with other carpal injuries. Most commonly the capitate dislocates in a volar direction [90–94] and in one case only it dislocated in dorsal direction [95].

Lowrey et al. [93] reported a case of volar capitate dislocation associated with other multiple carpal injuries. Hirata et al. [91] described a case with dorsal dislocation of the third CMC joint, associated with volar rotational subluxation of the capitate from its distal (CMC), and proximal (LC) articulation. This case constitutes a combination of types IIa and IIIId injuries, according to Garcia-Elias's classification for CMC injuries. Walker and Pradhan [95] described a case with dorsal dislocation of the capitate and the third metacarpal. This case could be a type IIIId injury according to previous classification for CMC injuries. Ruijters and Kortmann [94] reported a volar dislocation of the capitate associated with a fracture of the lunate in the coronal plane, constituting a case of volar perilunate injury. Lee et al. [92] described a case of volar dislocation of the capitate associated with dislocation of the ulnar side of the carpometacarpal joint.

Dislocation of the capitate usually resulted after a crush injury [90, 91] or a motorcycle accident [93, 95]. Clinical findings are dependent on the mechanism of injury while the diagnosis is sometimes difficult to establish using standard radiographs. In the case presented by Checcucci et al. [20], a definitive diagnosis was obtained only after a CT scan.

The majority of cases presented in the literature were treated with open reduction and fixation with K-wires, except for the case presented by Walker and Pradhan [95], which was reduced with closed manipulation under general anesthesia and immobilization in a below elbow cast for 8 weeks. Short-term results were generally good but early development of degenerative changes [93] or instability findings [91] have been reported.

## 11.7 Hamate

Isolated dislocation of the hamate bone is an extremely rare injury, with only eight cases reported in the literature since the first description by Buchanan in 1882 [96]. Most cases of hamate dislocation have been described as part

of more complex injuries or in association with other carpal bones' dislocation [22, 50, 97] or constituting cases of axial-ulnar derangements, with the hamate being displaced along with the 4th and 5th metacarpals [98] (Fig. 11.3a–i). Dislocation of the hamate requires disruption of the triquetrohamate ligament, pisohamate ligament, and capitolunate interosseous ligament as well as disruption of the 4th and 5th CMC joints.

Both volar [96, 99, 100] and dorsal [101, 102] dislocations of the hamate have been reported. The usual mechanism of injury is a direct impact by a sharp tool or indirect trauma by hyperextension [15, 28, 36].

On physical examination, there is painful palmar or dorsal swelling on the ulnar aspect of the wrist, with or without a palpable bony prominence. Nerve damage does not seem to be common, however, given that the ulnar neurovascular bundle is in close proximity, injury to this structure might be anticipated [28, 101].

Diagnosis is usually made by conventional X-ray examination. Posteroanterior (PA) and lateral neutral rotation views of the wrist are adequate for diagnosis. In the PA view, most noticeable is a gap distal to the triquetrum, while the lateral view reveals the direction of the dislocation. A CT scan is usually necessary to unveil the true extent of the damage e.g., fracture of the hook of the hamate [96]. Since 50 % of hamates lack an intraosseous anastomosis of its nutrient vessels, the risk of avascular necrosis is a possible complication, although it has not been reported so far.

Treatment alternatives include: closed reduction [99, 102], closed reduction and percutaneous fixation [98], open reduction with [96, 100] or without internal fixation [101] and excision [103, 104]. The small number of cases reported does not allow inferences about the best treatment. However, closed reduction (when feasible) with percutaneous pinning under image intensifier, open reduction with the approach depending on the direction of the dislocation, and pinning of the hamate to the metacarpals, the capitate and triquetrum, seem to be the indicated methods of treatment.

## 11.8 Pairs of Dislocated Wrist Bones

Carpal dislocation may occur in units of adjacent bones. These unusual patterns of dislocation are most likely the result of direct trauma [28]. When adjacent bones of the proximal carpal row are dislocated, they probably constitute variants of perilunate dislocations or reverse perilunate dislocations. On the contrary, when adjacent bones of the distal carpal row are dislocated, they possibly represent cases of axial dislocations. The most common pattern is combined dislocation of scaphoid and lunate. Other reported patterns of adjacent bone dislocations are: triquetrum and lunate [39], hamate and pisiform [50–52], capitate and hamate [97], trapezium and trapezoid [105], trapezoid and capitate [106]. A case of dislocation of non-adjacent carpal bones (scaphoid and hamate) has been reported by Sakada et al. [22]. Extremely rare are cases of three carpal bone dislocations, such as: trapezium, capitate and hamate [107] or lunate, triquetrum and hamate [108].

**Scaphoid and lunate:** Domeshek et al. [109] in a review of the literature found only 17 reported cases that involved simultaneous dislocation of the scaphoid and lunate. In 11 of these cases, the two carpal bones dislocated as a unit, while in 6 cases the dislocation was of divergent type. All reported cases had dislocated in a palmar direction, sometimes producing symptoms from the median nerve [110–112]. Most of the cases resulted from high-energy injuries (fall from height or motor vehicle accident) and the mechanism of injury is thought to be extreme dorsiflexion with ulnar deviation [109, 111, 113, 114]. A direct blow to the dorsum of the wrist has also been reported [115]. Various treatment methods have been applied: closed reduction and casting [116], closed reduction and percutaneous pinning [115], open reduction and cast immobilization, open reduction, ligamentous repair and percutaneous pinning [110, 111, 117]. Late wrist malalignment [116, 118–120] and avascular necrosis [112, 120] are the main concerns of these injuries. The

recommended treatment is open reduction with combined approach, repair of the volar LT ligament and the SLI ligament (in divergent type of dislocation), and stabilization with K-wires of the scapholunate, scaphocapitate and lunotriquetral joints.

## References

1. Garcia-Elias M (2011) Isolated carpal bone dislocations. In: Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH (eds) Green's operative hand surgery, chap 15, 6th edn. Elsevier Churchill Livingstone, Philadelphia, pp 519–520
2. Melsom DS, Leslie IJ (2007) Carpal dislocations. *Curr Orthop* 21:288–297
3. Higgs SL (1930) Two cases of dislocation of the carpal scaphoid. *Proc R Soc Med* 23:1337–1339
4. Kiliç M, Kalali F, Ünlü M (2012) Isolated carpal scaphoid dislocation. *Acta Orthop Traumatol Turcica* 46(1):68–71
5. Lee BJ, Kim SS, Lee SR et al (2010) Palmar scaphoid dislocation associated with dorsal Perilunate Dislocation: case report. *J Hand Surg [Am]* 35(5):726–731
6. Chloros GD, Themistocleous GS, Zagoreos NP et al (2006) Isolated dislocation of the scaphoid. *Arch Orthop Trauma Surg* 126:197–203
7. Leung YF, Wai YL, Kam WL et al (1998) Solitary dislocation of the scaphoid. From case report to literature review. *J Hand Surg [Br]* 23(1):88–92
8. Amamilo S, Uppal R, Samuel A (1985) Isolated dislocation of carpal scaphoid. *J Hand Surg [Br]* 10(3):385–388
9. Takami H, Takahashi S, Ando M (1992) Dislocation of the carpal scaphoid associated with median nerve compression. *J Trauma* 33:921–924
10. Horton T, Shin AY, Cooney WP III (2004) Isolated scaphoid dislocation associated with axial carpal dissociation: an unusual injury report. *J Hand Surg [Am]* 29(6):1102–1108
11. Sides D, Laorr A, Greenspan A (1995) Carpal scaphoid: radiographic pattern of dislocation. *Radiology* 195:215–216
12. Szabo RM, Newland CC, Johnson PG et al (1995) Spectrum of injury and treatment options for isolated dislocation of the scaphoid. A report of three cases. *J Bone Joint Surg Am* 77(4):608–615
13. Thompson TC, Campbell RD, Arnold WD (1964) Primary and secondary dislocation of the scaphoid bone. *J Bone Joint Surg Br* 46(1):73–82
14. Richards RS, Bennett JD, Roth JH (1993) Scaphoid dislocation with radial-axial carpal disruption. *Am J Roentgenol* 160:1075–1076

15. Grabow R (2006) Carpal Dislocations. *Hand Clin* 22:485–500
16. Polveche G, Cordonier D, Thery D et al (1995) A rare variety of dislocation of the carpus. External vertical dislocation: a case report and review of the literature. *Ann Chir Main* 14(3):159–166
17. Yamabe E, Nakamura T, Matsumura T et al (2008) Palmar dislocation of the scaphoid with dorsal perilunate dislocation. *J Hand Surg [Br]* 33(5):682–683
18. Buzby BF (1934) Isolated radial dislocation of carpal scaphoid. *Ann Surg* 100:553–555
19. Somford MP, Sturm MFAM, Vroemen JPAM (2010) Reconstruction of isolated scaphoid dislocation with carpal dissociation, associated with a carpal anomaly. *Strat Trauma Limb Recon* 5:105–110
20. McNamara MG, Corley FG (1992) Dislocation of the carpal scaphoid. An 8 year follow-up. *J Hand Surg [Am]* 17(3):496–498
21. Amaravati RS, Saji MJ, Rajagopal HP et al (2009) Neglected dorsal dislocation of the scaphoid. *Indian J Orthop* 43(2):213–215
22. Sakada T, Ninomiya S, Ohmori M (1998) Simultaneous dislocation of the scaphoid and hamate bone. *J Hand Surg [Br]* 23(1):93–95
23. Taylor A (1969) Dislocation of the scaphoid. *Postgrad Med J* 45:186–192
24. Connell M, Dyson R (1955) Dislocation of the carpal scaphoid. Report of a case. *J Bone Joint Surg Br* 37(2):252–253
25. Fishman MC, Dalinka MK, Osterman L (1985) Case report 309. *Skeletal Radiol* 13:245–247
26. Inoue G, Maeda N (1990) Isolated dorsal dislocation of the scaphoid. *J Hand Surg [Br]* 15(3):368–369
27. Kuth J (1939) Isolated dislocation of the carpal navicular. A case report. *J Bone Joint Surg Am* 21(2):479–483
28. Idler R (2001) Carpal dislocations and instability. In: Watson HK, Weinzweig J (eds) *The Wrist*. Lippincott Williams & Wilkins, London, pp 203–229
29. Antuna SA, Antuna-Zapico JM (1997) Open dislocation of the carpal scaphoid: a case report. *J Hand Surg [Am]* 22(1):86–88
30. Andre S, Feuilhade de Chauvin P, Candau B et al (1981) Luxation radio-dorsale du scaphoïde. A propos d'un cas. [Posterior dislocation of the scaphoid: report of one case.]. *Rev Chir Orthop Reparatrice Appar Mot* 67(5):577–580
31. Murakami Y (1977) Dislocation of the carpal scaphoid. *The Hand* 9(1):79–81
32. Maki NJ, Chuinard RG, D'Ambrosia R (1982) Isolated complete radial dislocation of the scaphoid. *J Bone Joint Surg Am* 64:615–616
33. Milankov M, Somer T, Jovanovic A et al (1994) Isolated dislocation of the carpal scaphoid: two case reports. *J Trauma* 36(5):752–754
34. Kennedy JG, O'Connor P, Brunner J (2006) Isolated carpal scaphoid dislocation. *Acta Orthop Belg* 72(4):478–483
35. Akinci M, Yildirim AO, Kati YA (2012) Late-presenting, isolated, complete radial dislocations of the scaphoid treated with the Szabo technique. *J Hand Surg [Eur]* 37(9):901–903
36. Ruby L (1998) Isolated carpal dislocations. In: Cooney WP, Linscheid RL, Dobyns JH (eds) *The Wrist. Diagnosis and operative treatment*, vol 1. Mosby, ch 29, pp 696–708
37. Wani IH, Guptha N, Guptha R et al (2008) Isolated dislocation of carpal scaphoid: a case report. *IJOS* 10:1. doi:10.5580/156c
38. Engkvist O, Ekenstam F (1986) Closed dislocation of the scaphoid. A case report and review of the literature. *Scand J Plast Reconstr Surg* 20:239–242
39. Fowler JL (1988) Dislocation of the triquetrum and lunate: Brief report. *J Bone Joint Surg Br* 70(4):665
40. Ikpeme JO, Hankey S (1995) Dorsal dislocation of the triquetrum: a rare complication of perilunate dislocation. *Injury* 26(7):497–499
41. Bieber E, Weiland AJ (1984) Traumatic dorsal dislocation triquetrum: a case report. *J Hand Surg [Am]* 9(6):840–842
42. Goldberg B, Heller A (1987) Dorsal dislocation of the triquetrum with rotary subluxation of the scaphoid. *J Hand Surg [Am]* 12(1):119–122
43. Inoue G (1992) Dorsal dislocation of the triquetrum: a case report. *Ann Chir Main Memb Super* 11(3):233–236
44. Frykman E (1980) Dislocation of the triquetrum: case report. *Scand J Plast Reconstr Surg* 14:205
45. Soucacos PN, Hartofilakidis-Garofalidis GC (1981) Dislocation of the triangular bone. Report of a case. *J Bone Joint Surg Am* 63(6):1012–1014
46. Immerman WE (1948) Dislocation of the pisiform. *J Bone Joint Surg Am* 30:489–492
47. Minami M, Yamazaki J, Ishii S (1984) Isolated dislocation of the pisiform: a case report and review of the literature. *J Hand Surg [Am]* 9(1):125–127
48. Ashkan K, O'Connor D, Lambert S (1998) Dislocation of the pisiform in a 9-year-old child. *J Hand Surg [Br]* 23(2):269–270
49. Wagoner G (1930) Dislocation of the pisiform associated with fracture of the head of the radius and the styloid process of the ulna. *J Bone Joint Surg Am* 12(1):170–171
50. Gainor BJ (1985) Simultaneous dislocation of the hamate and pisiform: a case report. *J Hand Surg [Am]* 10:88–90
51. Pai CH, Wei DC, Hu ST (1993) Carpal bone dislocation: an analysis of twenty cases with relative emphasis on the role of crushing mechanisms. *J Trauma* 35:28–35
52. Matsumoto T, Tsunoda M, Yamaguchi S et al (2005) Traumatic dislocation of the hamate and pisiform: a case report and review of the literature. *J Orthop Trauma* 19(4):282–285
53. Vasilas A, Grieco RV, Bartone NF (1960) Roentgen aspects of injuries to the pisiform bone and pisotriquetral joint. *J Bone Joint Surg Am* 42:1317–1328

54. Cohen I (1922) Dislocation of the pisiform. *Ann Surg* 75:238–239
55. Sharara KH, Farrar M (1993) Isolated dislocation of the pisiform bone. *J Hand Surg [Br]* 18:195–196
56. Penvy T, Rayan GM, Egle D (1995) Ligamentous and tendinous support of the pisiform: anatomic and biomechanical study. *J Hand Surg [Am]* 20:299–304
57. Goriainov V, Bayne G, Warwick DJ (2010) Traumatic dislocation of the pisiform: a case report. *J Orthop Surg* 18(3):389–390
58. Singh A, Kumar V, Jain G et al (2010) Isolated dislocation of pisiform bone—a rare case. *IJMU* 5(2):65–67
59. Kwon O, Choi SP, Won HY (2007) Acute isolated pisiform dislocation. A case report. *J Korean Orthop Assoc* 42:688–691
60. Ishizuki M, Nakagawa T, Itooh S et al (1991) Positional dislocation of the pisiform. *J Hand Surg [Am]* 16(3):533–535
61. Levante S, Ebelin M (2002) Traumatic dislocation of the pisiform bone: a case report and review of the literature. *Chir Main* 21(4):264–268
62. McCarron RF, Coleman W (1989) Dislocation of the pisiform treated by primary resection. A case report. *Clin Orthop* 241:231–233
63. Muniz AE (1999) Unusual wrist pain: pisiform dislocation and fracture. *Am J Emerg Med* 17(1):78–79
64. Arner M, Haberg L (1984) Wrist flexion strength after excision of the pisiform bone. *Scand J Plast Reconstr Surg* 18:241–245
65. Carroll RE, Coyle MP (1985) Dysfunction of the pisotriquetral joint: Treatment by excision of the pisiform. *J Hand Surg [Am]* 10:703–707
66. Gómez CL, Renart IP, Pujals JI et al (2005) Dysfunction of the pisotriquetral joint: degenerative arthritis treated by excision of the pisiform. *Orthopedics* 28(4):405–408
67. Boe S (1979) Dislocation of the trapezium (multangulum majus): a case report. *Acta Orthop Scand* 50(1):85–86
68. Sherlock DA (1987) Traumatic dorsoradial dislocation of the trapezium. *J Hand Surg [Am]* 12(2):262–265
69. Brewood AF (1985) Complete dislocation of the trapezium: a case report. *Injury* 16(5):303–304
70. Goldberg I, Amit S, Bahar A et al (1981) Complete dislocation of the trapezium (multangulum majus). *J Hand Surg [Am]* 6(2):193–195
71. Ichikawa T, Inoue G (1999) Complete dislocation of the trapezium. Case report. *Scand J Plast Reconstr Surg Hand Surg* 33(3):335–337
72. Garcia-Elias M, Geissler WB (2005) Carpal instability. In: Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH (eds) *Green's operative hand surgery*, chap 14, 5th edn. Elsevier Churchill Livingstone, Philadelphia, pp 535–604
73. Mumtaz MU, Drabu NA (2009) Open complete dislocation of trapezium with a vertically split fracture: a case report. *Cases Journal*. doi: [10.1186/1757-1626-2-9092](https://doi.org/10.1186/1757-1626-2-9092)
74. Seimon LP (1972) Compound dislocation of the trapezium. A case report. *J Bone Joint Surg Am* 54(6):1297–1300
75. Siegel MW, Hertzberg H (1969) Complete dislocation of the greater multangular (trapezium). *J Bone Joint Surg Am* 51(4):769–772
76. Yin Y, Mann FA, Gilula LA (1996) Positions and techniques. In: Gilula LA, Yin Y (eds) *Imaging of the wrist and hand*, chap 5. WB Saunders, Philadelphia, pp 93–158
77. Ahmad MH, Midha VP (1991) Dislocation of the trapezium: open reduction by the dorsal approach. *Injury* 22(5):410–411
78. Peterson CL (1950) Dislocation of the multangulum majus or trapezium (and its treatment in two cases with extirpation). *Arch Chir Neerlandicum* 2:369–376
79. Larson BJ, DeLange LC (2005) Traumatic volar dislocation of the trapezoid with acute carpal tunnel syndrome. *Orthopedics* 28(2):165–167
80. De Tullio V, Celenza M (1992) Isolated palmar dislocation of the trapezoid. *Int Orthop* 16:53–54
81. Lewis HH (1962) Dislocation of the lesser multangular. Report of a case. *J Bone Joint Surg Am* 44(7):1412–1414
82. Inoue G, Inagaki Y (1990) Isolated palmar dislocation of the trapezoid associated with rupture of the flexor tendon. A case report. *J Bone Joint Surg Am* 72(3):446–448
83. Kopp JR (1985) Isolated palmar dislocation of the trapezoid. *J Hand Surg [Am]* 10:91–93
84. Ostrowski DM, Miller ME, Gould JS (1990) Dorsal dislocation of the trapezoid. *J Hand Surg [Am]* 15(6):874–878
85. Peterson TH (1940) Dislocation of the lesser multangular: report of a case. *J Bone Joint Surg Am* 22(1):200–202
86. Stein AH (1971) Dorsal dislocation of the lesser multangular bone. *J Bone Joint Surg Am* 53(2):377–379
87. Bendre DV, Baxi VK (1981) Dislocation of trapezoid. *J Trauma* 21:899–900
88. Meyn MA, Roth AM (1980) Isolated dislocation of the trapezoid bone. *J Hand Surg [Am]* 5(6):602–604
89. Goodman ML, Shankman GB (1984) Update: Palmar dislocation of the trapezoid: a case report. *J Hand Surg [Am]* 9:127–131
90. Checcucci G, Bigazzi P, Zucchini M et al (2011) Isolated complete volar dislocation of the capitate: a case report. *Hand Surg* 16(3):353–356

91. Hirata H, Sasaki H, Ogawa A et al (1997) Rotary dislocation of the capitate: a case report. *J Hand Surg [Am]* 22(1):89–90
92. Lee JH, Ehara S, Furumachi K (1999) Volar dislocation of the capitate. *Radiat Med* 17(5):363–364
93. Lowrey DG, Moss SH, Wolff TW (1984) Volar dislocation of the capitate: report of a case. *J Bone Joint Surg Am* 66:611–613
94. Ruijters R, Kortmann J (1988) A case of translunate luxation of the carpus. *Acta Orthop Scand* 59:461–463
95. Walker RW, Pradhan R (2000) Dorsal dislocation of the capitate. *J Hand Surg Br* 25(4):403–405
96. Simunovic F, Jurk V, Stark GB et al (2012) Volar dislocation and hook fracture of the hamate: a case report. *Hand Surg* 17(3):387–390
97. Rosh AJ, Schwartz DT (2012) Isolated capitate and hamate dislocation. *J Emerg Med* 42(6):151–152
98. Awan BA, Robertson GA (2000) Hamate bone dislocation: a case report. *J KAU Med Sci* 8:117–123
99. Duke R (1963) Dislocation of the hamate bone. Report of a case. *J Bone Joint Surg Br* 45(4):744
100. Gunn RS (1985) Dislocation of the hamate bone. *J Hand Surg [Br]* 10:107–108
101. Geist DC (1939) Dislocation of the hamate bone. Report of a case. *J Bone Joint Surg Am* 21(1):215–217
102. Zieren J, Agnes A, Müller JM (2000) Isolated dislocation of the hamate bone. Case report and review of the literature. *Arch Orthop Trauma Surg* 120:535–537
103. Ferraro C (1974) Su un caso di lussazione dell'uncinato. *Clin Ortop* 25:274–276
104. Johannsen S (1926) Ein fall von luxation des os hamatum. *Acta Radiol* 7:9
105. Clarke SE, Raphael JR (2010) Combined dislocation of the trapezium and the trapezoid: a case report with review of the literature. *Hand* 5:111–115
106. Ho RW, Chang CS, Lam F et al (1990) Palmar dislocation of the trapezoid and the capitate. A case of traumatic peritrapezoid pericapitate axial dislocation of the carpus. *J Med Sci* 10(6):385–390
107. Chim H, Yam AKT, Chin AYH et al (2007) Complex carpal dissociation with open, complete, and divergent trapezium, capitate, and hamate dislocation: a case report. *J Hand Surg [Am]* 32(9):1363–1366
108. Lundkvist L, Larsen CF, Juul SM (1991) Dislocation of the lunate, triquetral, and hamate bones. Case report. *Scand J Plast Reconstr Surg Hand Surg* 25(1):83–85
109. Domeshek LF, Harenberg PS, Rineer CA et al (2010) Total scapholunate dislocation with complete scaphoid extrusion: case report. *J Hand Surg [Am]* 35:69–71
110. Arora J (2005) Transulnar styloid palmar scapholunate dislocation with median nerve injury. *Arch Orthop Trauma Surg* 125:120–123
111. Chalidis B, Dimitriou C (2010) Palmar dislocation of the scapholunate bone-ligament-bone complex. *J Hand Surg [Br]* 35(4):322–324
112. Coll GA (1987) Palmar dislocation of the scaphoid and lunate. *J Hand Surg [Am]* 12:476–480
113. Brown R, Muddu B (1981) Scaphoid and lunate dislocation: a report on a case. *The Hand* 13(3):303–307
114. Komura S, Yokoi T, Suzuki Y (2011) Palmar-divergent dislocation of the scaphoid and the lunate. *J Orthop Traumatol* 12:65–68
115. Raemisch ME, Rotman MB (2004) Palmar dislocation of the scaphoid and lunate as a unit. *Orthopedics* 27(11):1199–1201
116. Sarrafian SK, Breihan JH (1990) Palmar dislocation of scaphoid and lunate as a unit. *J Hand Surg [Am]* 15(1):134–139
117. Healey DC, Giachino AA, Conway AF (2002) Periscaphoid perilunate dislocation of the wrist. *J Bone Joint Surg Am* 84(7):1201–1204
118. Baulot E, Perez A, Hallonet D et al (1997) Scaphoid and lunate palmar divergent dislocation. Apropos of a case. *Rev Chir Orthop Reparatrice Appar Mot* 83:265–269
119. Gordon SL (1972) Scaphoid and lunate dislocation: report of a case in a patient with peripheral neuropathy. *J Bone Joint Surg Am* 54(8):1769–1772
120. Kupfer K (1986) Palmar dislocation of scaphoid and lunate as a unit: case report with special reference to carpal instability and treatment. *J Hand Surg [Am]* 11:130–134