Delayed and Chronic Perilunate Dislocations

7.1 Definition

The time limits used to characterize perilunate injuries into acute, delayed, and chronic, could neither be strict nor specific. However, time restrictions must be set for therapeutic and prognostic reasons and also for the purpose of understanding each other. Thus, Herzberg [1] suggested that *acute injuries* should be considered as those injuries diagnosed within the first week, *delayed* should be those diagnosed 7–45 days after the injury and *chronic* as those diagnosed after the 45th day.

7.2 Diagnosis

The percentage of patients with perilunate injuries escaping diagnosis fluctuates between 16 and 25 % [2–4]. The majority of patients with neglected perilunate injuries present with distinct wrist dysfunction. Wrist pain, paresthesia, or even anesthesia of the median nerve distribution, significant reduction of grip strength, and range of motion, were usually the clinical picture of patients [5–7]. At a later stage, they may present with arthritis of the radiocarpal or midcarpal joints with different degrees of functional deficit and articular remodeling [8]. Patients examined several years after the accident, present symptoms of either carpal tunnel syndrome or rupture due to attrition of the flexor tendons [6, 9, 10] (Fig. 7.1a–k).

However, the symptoms are not always as obvious. There are patients with isolated wrist injury, who underestimated its importance and requested medical assistance later, usually complaining for carpal tunnel symptoms [11] (Fig. 7.2a–n). There are also patients who had experienced in the past a high-energy injury involving the wrist, which was missed. The following years they experienced mild or even no symptoms at the wrist, to which they had adapted and the wrist injury was radiologically diagnosed by chance, much later.

7.3 Treatment Options

In any case, delay in diagnosis constitutes an important factor affecting the long-term result [2, 11]. Herzberg et al. [4] reported that patients treated after a delay of more than 45 days had significantly worse clinical outcomes. Inoue and Shionoya [6] reported that cases treated after 2 months post-injury, had unsatisfactory results compared to patients treated within the first 2 months (average clinical score was 58 and 82 points, respectively).

Howard and Dell [12] suggested that closed reduction may be attempted up to 2 weeks following injury, they considered the time period between the second–sixth week the "gray area", while after the 6th week they supported that open reduction with combined approach is necessary. The question remains, what further
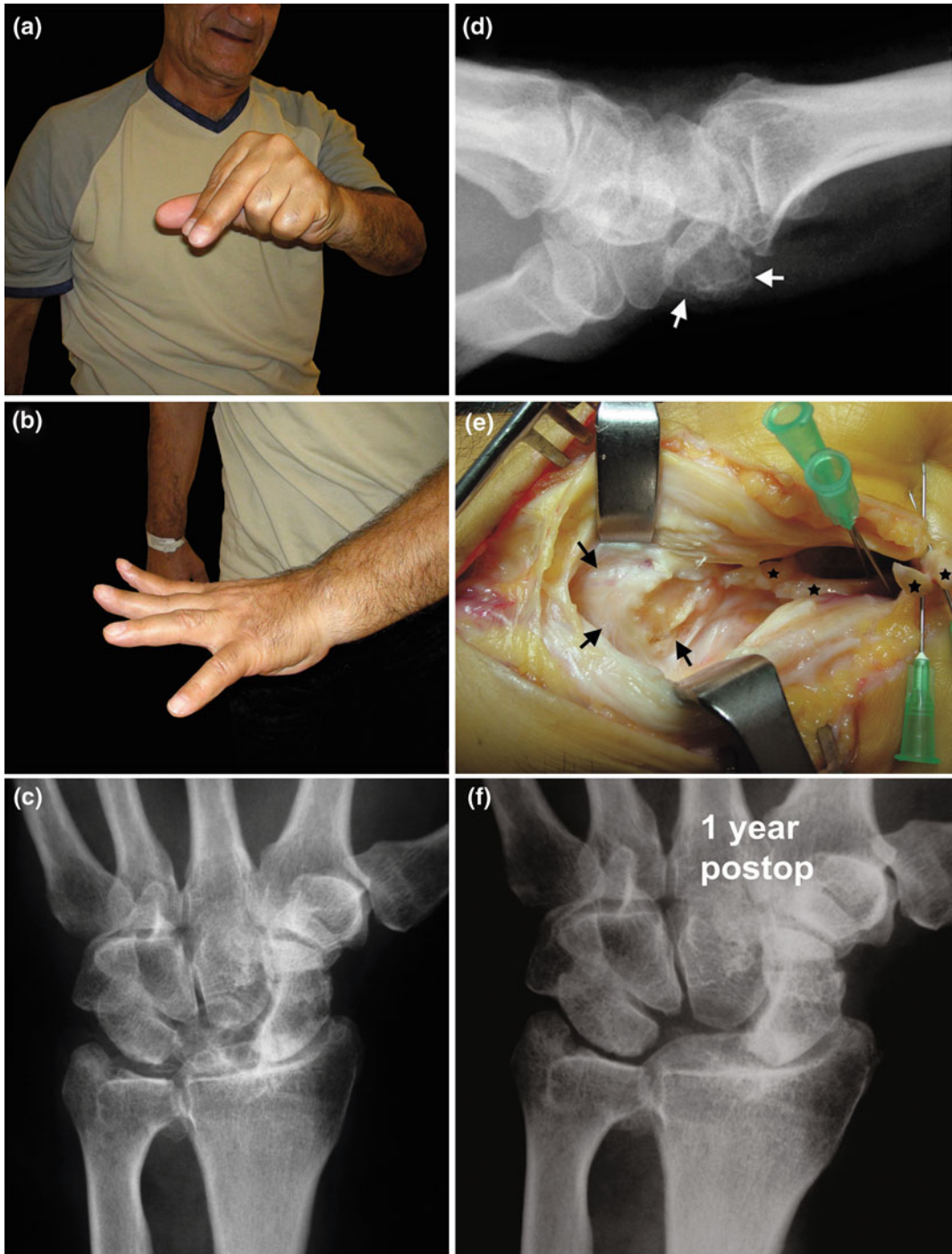
Fig. 7.1 Male, 63-years old. Reported finger hypesthesia at median nerve distribution and inability to flex the index and middle fingers (**a**, **b**), due to neglected palmar dislocation of the lunate, following a 20-year-old injury he vaguely remembered (**c**–**d**); excision of the lunate and reconstruction of the flexor tendons were performed. Palmar approach revealed the palmarly dislocated lunate (*arrows*) and attritional rupture of the deep and superficial flexors of the affected fingers (*asterisks*) (**e**); comparing the X-rays 1 and 4 years postoperatively, no carpal collapse was noticed (**f**–**h**); ROM 4 years postoperatively (**i**–**k**)
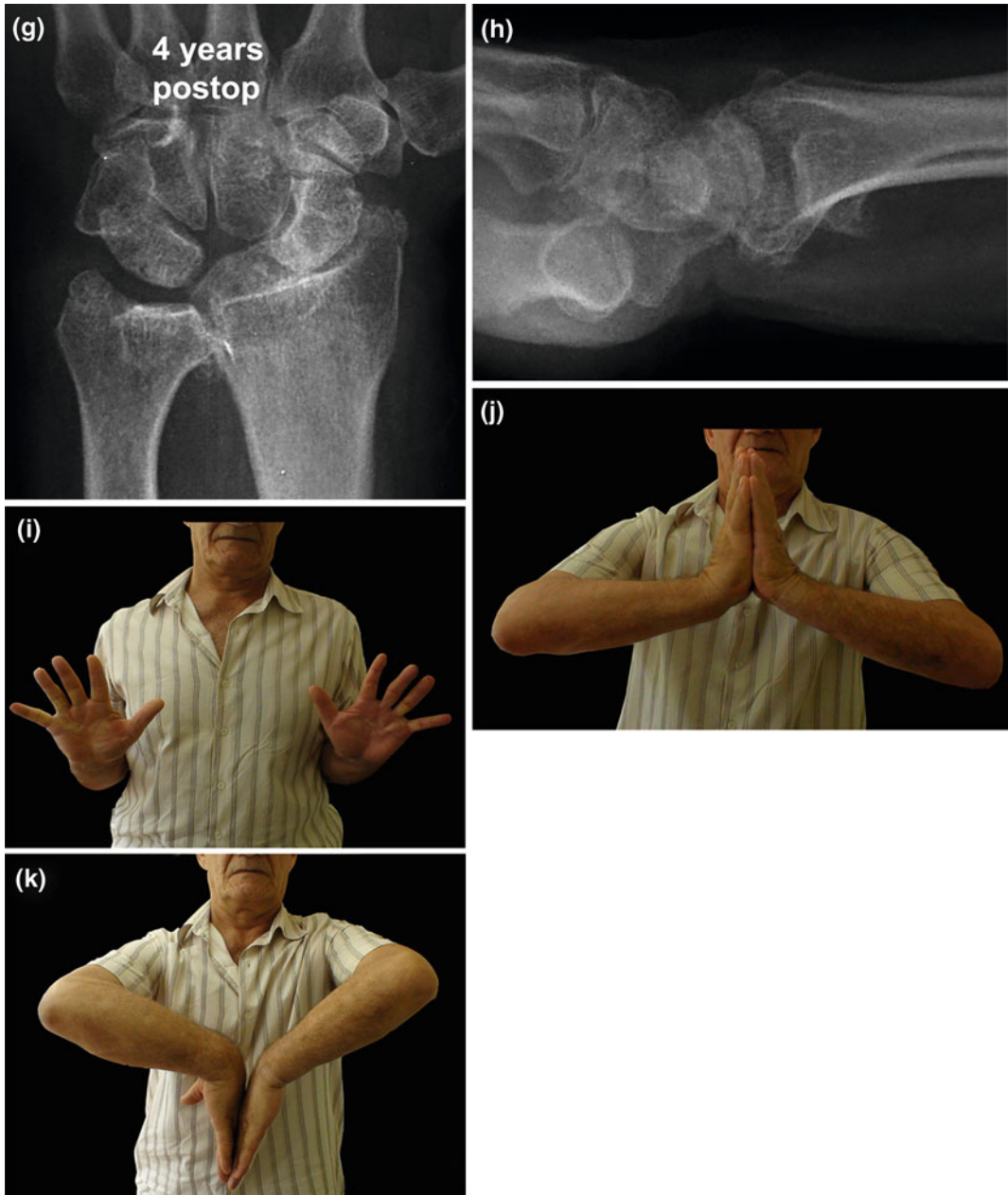
Fig. 7.1 (continued)

damage may be caused by our effort to perform close reduction to a month-old injury.

The upper time limit considered consistent with an acceptable result has been reported to be 6 weeks [13, 14], 8 weeks [6], 12 weeks [7, 15, 16], 18 weeks [17], and 5 months [5]. Others support the attempt of open reduction, regardless of the time that has intervened [12, 18, 19].

In literature, the most delayed open reductions attempted, were of a trans-scaphoid perilunate dislocation 8 months post-injury, where the condition of the cartilage of the lunate and
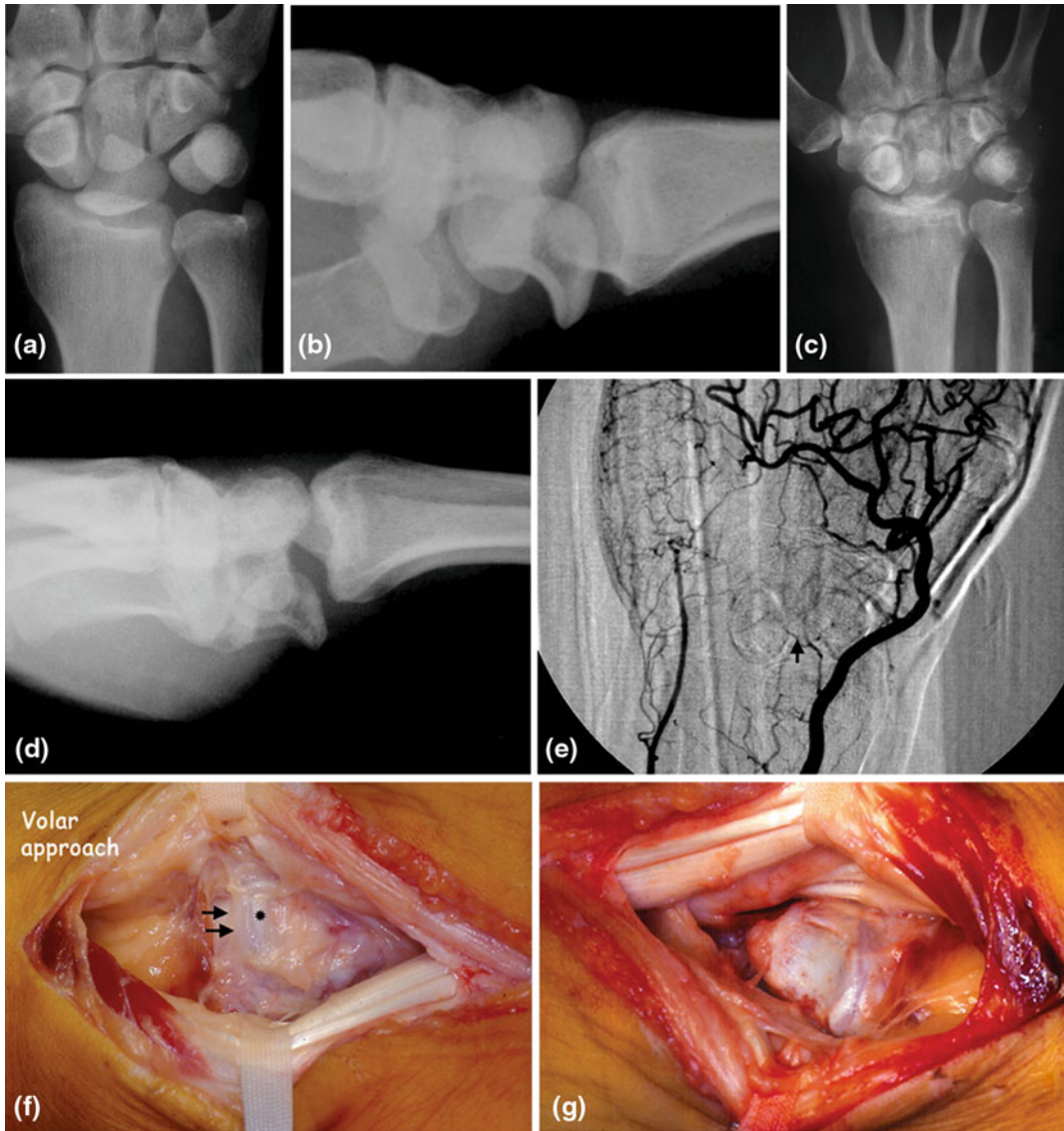
Fig. 7.2 Male, 52-years old, right-handed, with a 4-month old reported injury. It was initially considered a simple injury and a cast was applied. Fifteen days later he was subjected to carpal tunnel release due to numbness of the index and middle fingers. Three months later, pain and numbness continued, he therefore requested medical assistance and a palmar dislocation of the lunate was diagnosed. Initial X-rays (**a**, **b**); X-rays after 4 months indicated substantial osteopenia and the displacement of the lunate was upgraded from stage II to stage III (**c**, **d**); based on the arteriogram, vascularization of the lunate by a radial artery branch was presumed (**e**); palmar access exposed the palmar pole of the lunate (*asterisk*), while the distal articular surface was occupied by fibrous tissue (*arrows*) (**f**); its removal revealed cartilage denudation of the articular surface (**g**); dorsal access, following the raise of the capsular flap, revealed the presence of abundant scar tissue (*asterisk*) at the location of the lunate (**h**); following the removal of scar tissue, the lunate was reduced with difficulty and was particularly friable. Lunocapitate fusion with cancellous bone grafts from the distal radius was performed. Post-operative X-rays (**i**, **j**); the radiological result 3 years later, showing lunate fragmentation (**k**, **l**); the range of motion was satisfactory and the patient reported pain only after heavy manual work (**m**, **n**) (*S* Scaphoid, *C* Capitate, *H* Hamate, *T* Triquetrum, *R* Radius). With permission from [44]
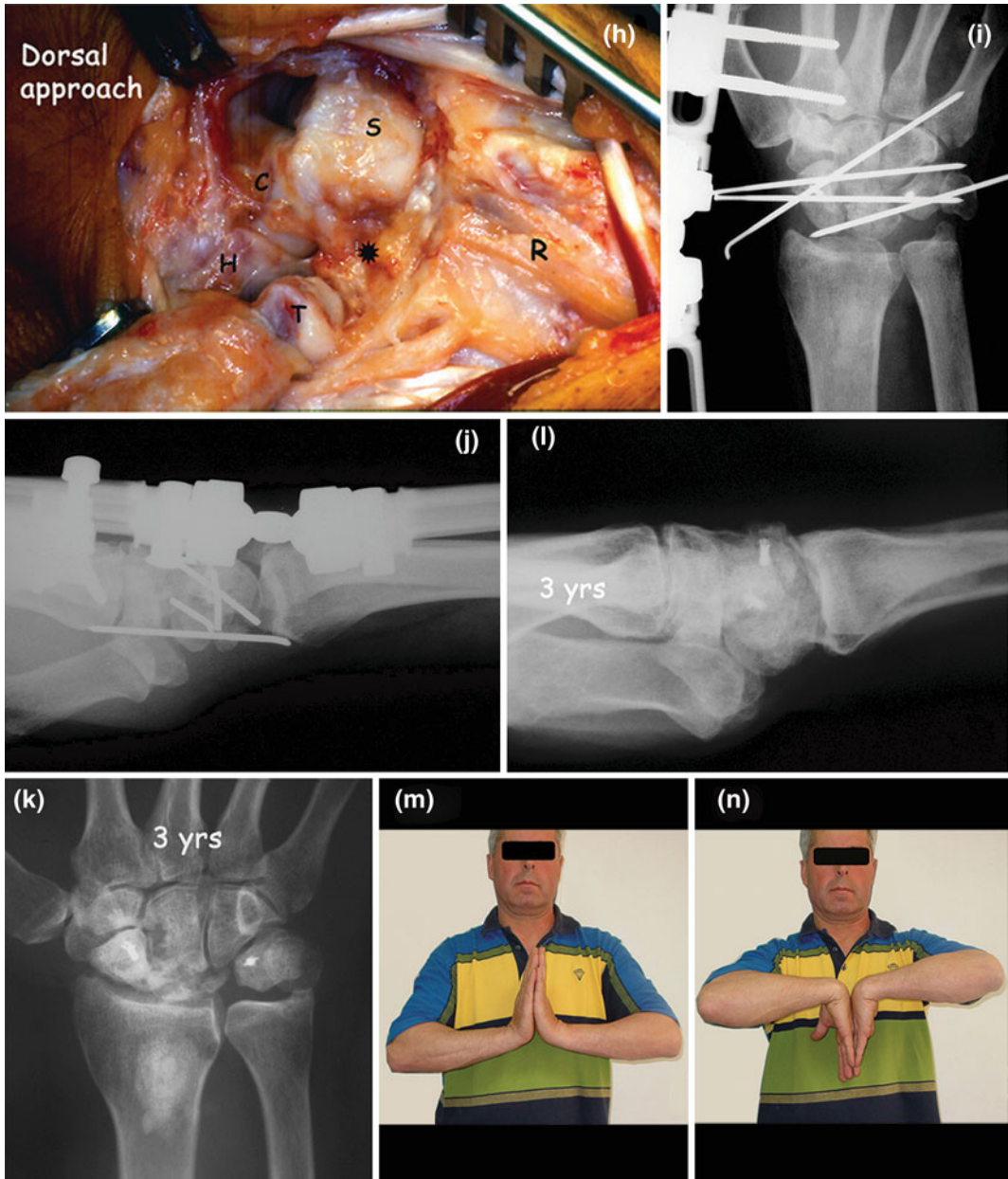
Fig. 7.2 (continued)

the scaphoid was found to be good and which presented with an excellent result after a 5 year follow-up [20]; also, a case with perilunate dislocation, treated with open reduction and internal fixation 35 weeks post injury, showed an excellent functional result after a follow-up of 19 months [7].

The treatment methods of chronic perilunate injuries vary in literature and involve open reduction and internal fixation [17], proximal

Table 7.1 Operative options depending on the condition of the articular cartilage of specific anatomical areas

Articular cartilage	Arthritis			Operative options
Head of capitate	No			Proximal row carpectomy
Distal lunate	No/Yes			
Radial fossae	No			
Head of capitate	Yes	No	No	Partial fusion
Distal lunate	No	Yes	No	
Radial fossae	No	No	Yes	
Head of capitate	Yes			Wrist fusion
Distal lunate	Yes			
Radial fossae	Yes			

row carpectomy [21–26], partial wrist fusions [11, 16, 27], wrist arthrodesis [28], and lunate excision [14, 29].

Siegert et al. [7] treated 15 patients with 16 chronic perilunate dislocations or fracture-dislocations with various methods and they noted that the level of improvement of patients who had wrist arthrodesis or proximal row carpectomy did not exceed that of ORIF. Unanimously, the results of isolated excision of a carpal bone (usually of the lunate) are not satisfactory [6, 7, 11, 15, 16, 23].

According to Inoue and Shionoya [6], when diagnosis is performed earlier than 2 months, an attempt for open reduction and fixation must be made. When however it is performed after 2 months post injury, the best results are achieved with proximal row carpectomy. Yao and Jagadish [30] and Jones and Kakar [31] advocated that any injury that has persisted for more than 4–6 weeks should not be primarily repaired and a salvage procedure should be performed, because contracture of the volar ligaments and irreversible carpal bone ischemia may preclude successful open reduction and ligament repair.

The longest period that a chronic perilunate injury must be treated with open reduction, is unknown. The word "must" instead of "may" is deliberately used, since any chronic dislocation can be reduced, regardless of the time that has intervened, but the result will not be a functional one. Hence the question that arises is: what is the time period that can intervene, in order for an

open reduction to be attempted on a chronic perilunate dislocation, so that the result is functional in the long term?

It should also be considered, that none of the cases of neglected perilunate dislocations mentioned in the literature presents disruption in the vascularity of the lunate at the time of diagnosis, regardless of the time intervened. Disruption in vascularity develops only after attempting open reduction and is not usually transient, but leads to fragmentation of the bone (Fig. 7.2a–n). Transient vascular compromise was noted postoperatively, in three out of four patients with chronic lunate and perilunate dislocations presented by Takami et al. [17]. Three cases (out of 14) presented by Dhillon et al. [5] with neglected volar lunate dislocations with 21–22 weeks of delay, developed avascular necrosis of the lunate after open reduction. A similar case of chronic lunate dislocation, which was operatively treated after 6 months of delay, was presented by Weir [32]. After a follow-up of 1 year, X-ray showed complete collapse and fragmentation of the lunate. A reported exception is the case by Gellman et al. [13], where a trans-scaphoid dorsal perilunate dislocation, neglected for 3 months, presented avascular changes of the lunate preoperatively. However, after open reduction and internal fixation, the patient regained a full, pain-free wrist motion with complete resolution of the roentgenographic changes of the lunate after a follow-up of 4 years.
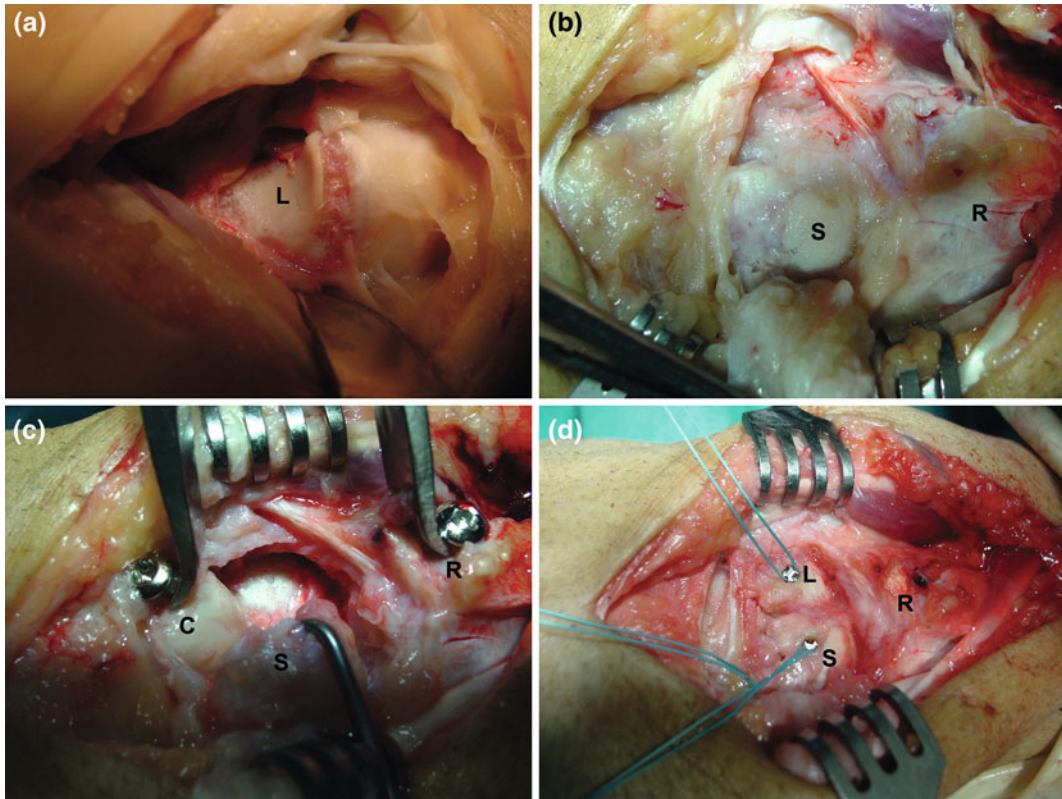
Fig. 7.3 A 4 months old lunate dislocation after volar approach (**a**); abundant scar tissue occupied the space previously located by the lunate (*dorsal approach*) (**b**); removal of the scar tissue and distraction of the joint with a lamina spreader using screws located at the radius and capitate (**c**); with the lunate reduced, insertion of bone anchors for capsuloligamentous reconstruction (**d**) (*L* Lunate, *S* Scaphoid, *C* Capitate, *R* Radius)

Hence, the atraumatic technique required for maintaining the precarious vascularity of dislocated bones, comes frequently in contrast with the manipulations required for the reduction of the chronically dislocated wrist.

Both patient-related and injury-related variables influence decision making [11]. As for the latter, mainly three factors must be taken into consideration during the reduction of a neglected perilunate dislocation:

1. The contraction of the capsuloligamentous structures and the development of scar tissue.
2. The condition of the articular cartilage (especially of the distal lunate) that has eroded during time.
3. The friability of the dislocated lunate, which has become osteopenic as it does not withstand physiologic loads for a long time.

Evidently, the severity of each of the above factors varies among patients and among injuries. The contraction of the capsuloligamentous structures can most likely be dealt with by applying gradual distraction to the wrist with an external fixator, through a one, or more commonly, two-stage operation [33–37]. The second operation after the application of the external fixator is usually performed 7–10 days after gradual application of distraction. As far as the other two factors are concerned though, our options are limited. However, these are the factors that will determine the surgical methods applied and which by order of preference are the following:

1. Open reduction, ligamentous reconstruction or substitution, and internal fixation.
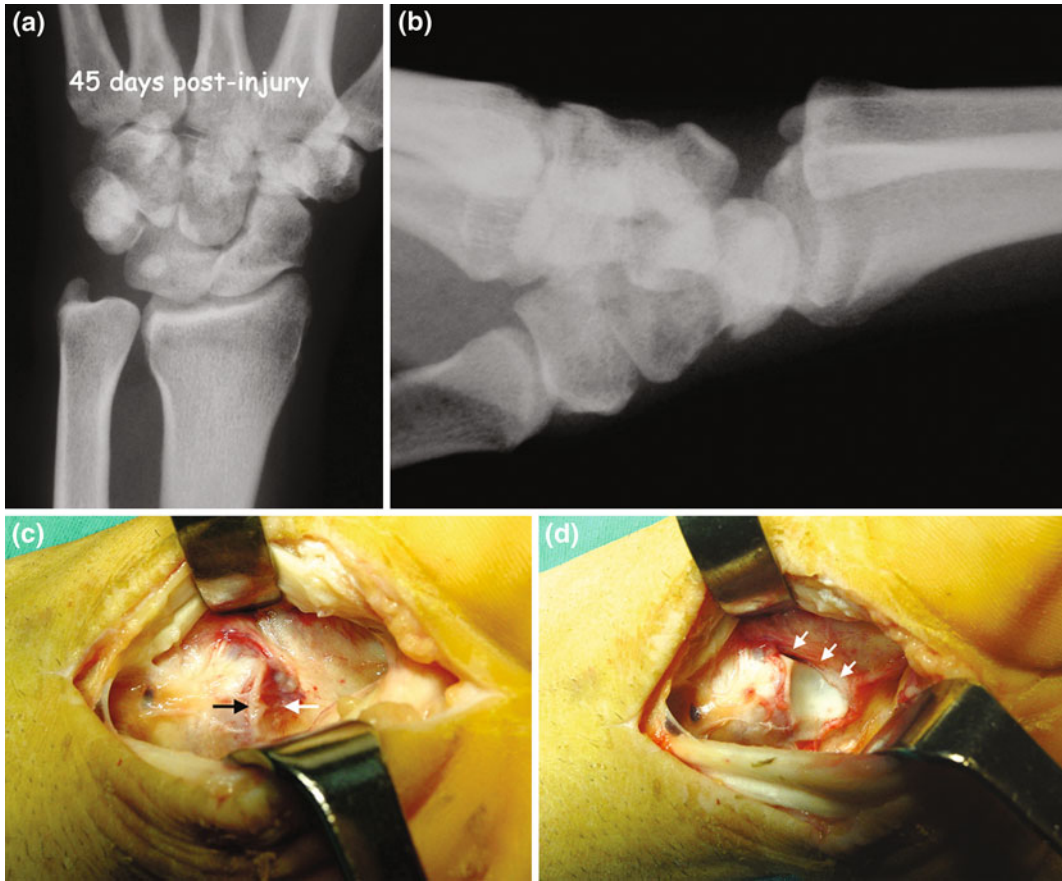
Fig. 7.4 Male, 27-years old, dorsal perilunate dislocation with a 6 weeks old injury, which escaped diagnosis (**a**, **b**); palmar access exposed scar tissue (*white arrow*) at the distal articular surface of the lunate (*black arrow*) (**c**); following the removal of the scar tissue the articular cartilage appeared to be in good condition (*white arrows* show the midcarpal rent) (**d**); dorsal access revealed the scar tissue proximal of the capitate (*asterisk*), which presented with a chondral defect (*arrow*) (**e**); after dislocation reduction, ligamentous reconstruction was performed using bone anchors (**f**); fixation was limited at the proximal carpal row and external fixation was applied (**g**, **h**); 3 months later, omission to place a transfixing pin, bridging the two rows, led to dorsal subluxation of the capitate head (**i**, **j**). With permission from [44]

2. Partial wrist fusion (scapholunocapitate or lunocapitate or four-corner fusion with scaphoid excision [11, 16] or scaphocapitate with lunate excision [16, 27]).
3. Proximal row carpectomy and
4. Wrist fusion.

Which method will be chosen among the last three (2, 3 or 4), will depend upon the condition of the joint cartilage of the head of the capitate, the distal lunate, and the radial fossae (Table 7.1).

Consequently, how a neglected injury will be treated, does not depend as much upon the time limits set by the literature, but upon surgeon's experience and the anatomical conditions encountered. In any case, successful delayed open reduction produces better functional results than any salvage operation [2, 7, 13, 17, 32, 38] and functional and radiological results are better in delayed than in chronic injuries [5, 39].
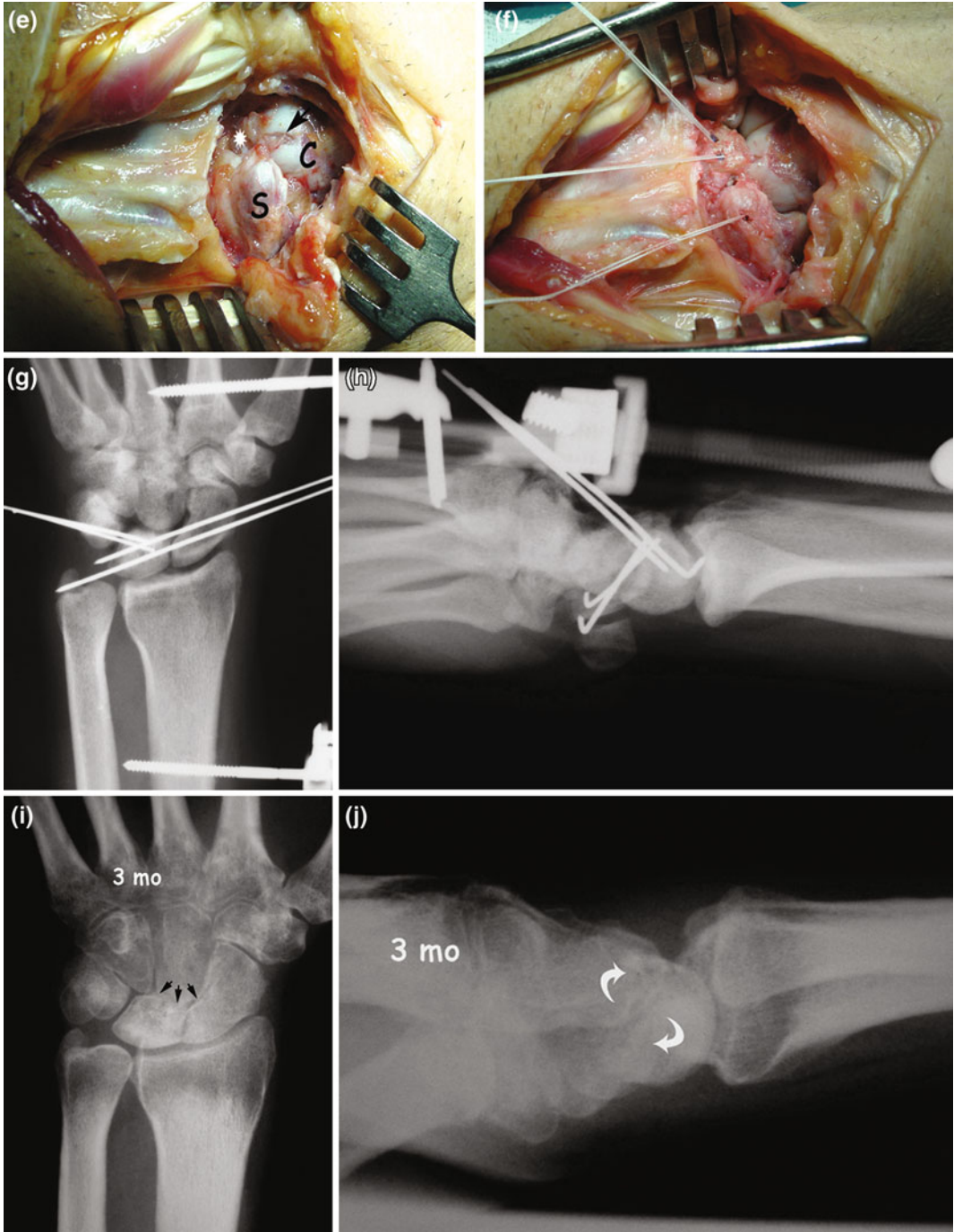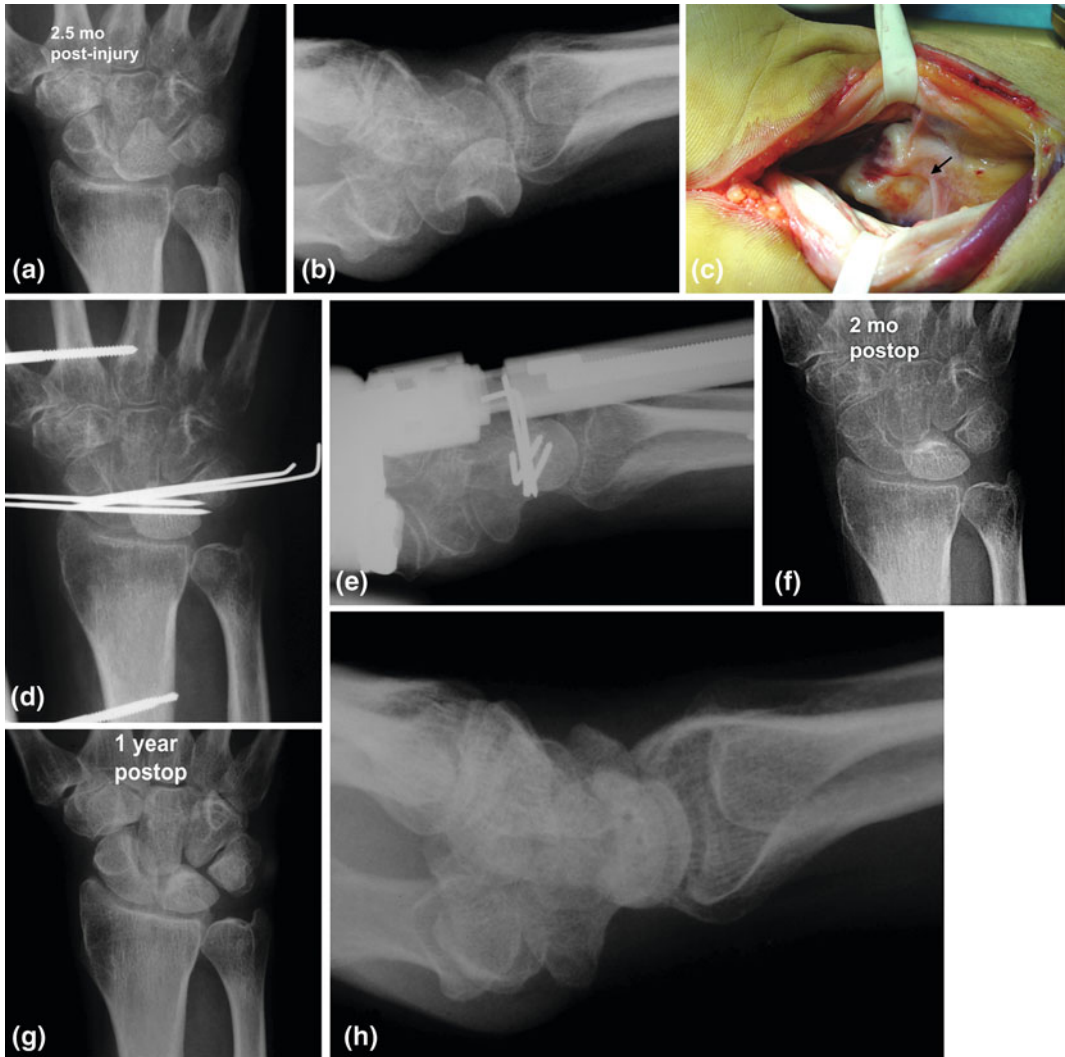
Fig. 7.4 (continued)

Fig. 7.5 Male, 58-years old, a 2.5 months old lunate dislocation (**a**, **b**); arrow shows the only vascular supply to the volarly dislocated lunate (**c**); postop X-rays (**d**, **e**); 2 months later, transient ischemia of the lunate was apparent (**f**); final X-rays 1 year postop (**g**, **h**)

It is properly supported [11, 39] that the decision on the type of operation, should be taken intraoperatively, according to the condition of the articular cartilage of the midcarpal and radiocarpal joints.

Kailu et al. [39] proposed to use the International Cartilage Repair Society grading system (ICRS) to grade the severity of the cartilage damage as follows: *ICRS 0 (normal):* Macroscopically normal cartilage without notable defects; *ICRS 1 (nearly normal):* The cartilage has superficial lesions (fibrillation, softening, fissures); *ICRS 2 (abnormal):* Defects that extend deeper but involve <50 % of the cartilage thickness; *ICRS 3(severely abnormal)*: Lesions that extend through >50 % of the cartilage thickness but not through the subchondral bone plate; and *ICRS 4 (severely abnormal):* Cartilage defects that extend into the subchondral bone. The authors suggested that in delayed or chronic cases with low-grade cartilage damage (ICRS I and ICRS II), open reduction and

internal fixation should be attempted, while in high-grade damage (ICRS III and ICRS IV), a salvage procedure should be considered.

The basic principles for reduction of neglected perilunate dislocations are identical with those for acute injuries. We believe that, up to 2 or 3 months post-injury, an open reduction and internal fixation should be attempted with the following essential steps:

1. Combined (dorsal and palmar) approach, as this diminishes the amount of force necessary for the reduction.
2. Removing of the scar tissue occupying the space opposite the lunate fossa (dorsally) and the distal articular surface of the lunate (palmarly).
3. Assessment of the articular cartilage i.e., distal lunate, head of the capitate.
4. Distraction of the joint, with an external fixator or other distraction device like lamina spreader (Fig. 7.3a–d)
5. Reduction of the dislocation, by using the most atraumatic technique possible and by maintaining the soft tissues of the proximal lunate intact. Using sharp or blunt instruments to help the reduction of the lunocapitate joint, as has been suggested [5, 16, 37], threatens the integrity of the friable lunate.
6. Fixation of the lunate with K wires with the adjacent bones. While transfixing pins (bridging rows or radius) are not necessary in acute injuries, they are essential in delayed cases in order to avoid recurrence of subluxation (Fig. 7.4a–j).
7. Retaining external fixator in slight distraction postoperatively to preserve the carpal height (Fig. 7.5a–h).

Capsular or ligamentous flaps (Blatt or DIC ligament flaps) may be needed to supplement the deficient SL interosseous ligament [15]. Reinforcement with tendon grafts of the SL ligament in neglected perilunate dislocations is most likely referred to in literature as a theoretical possibility, since only Howard and Dell [12] applied it in practice, emphasizing the technical difficulties of this method. Probably, the contraction of the capsuloligamentous structures and the scar tissue developed in cases older than 2–3 months, contribute to adequate stability and wrist stiffness, so that capsulodesis or tendon grafts are not necessary measures, a view also supported by Massoud and Naam [16] and Dhillon et al. [5]. If it's feasible, we insert one or two bone anchors to the proximal scaphoid or lunate to augment the remnants (if any) of the SL ligament with the proximal DIC ligament and the dorsal capsule.

In cases of neglected trans-scaphoid fracture-dislocations, where comminution, bone resorption or ischemic changes of the scaphoid may be encountered, simple bone grafts or vascularized bone grafts may be needed.

In the case of open reduction, as well as the case of partial fusion, chronic contracture of the capsuloligamentous structures, renders difficult the accurate alignment of the joint between the lunate and the capitate. If the lunocapitate joint is fixed with a K-wire (during open reduction) or fused (in partial fusion) with dorsal angulation, then dorsal impingement of the capitate to the dorsal radial rim will produce a painful restriction of dorsiflexion of the wrist.

Kailu et al. [39] supported that loss of the articular cartilage at the midcarpal joint, leads to the decrease of carpal height ratio postoperatively, which has adverse effects on wrist function. They are considered important to protect the articular cartilage postoperatively, especially in chronic cases in which the joint capsule is contracted and the articular cartilage is inevitably under compression after reduction. This was accomplished by using an external fixator in a neutralizing mode, to block the axial load on the cartilage of the proximal carpal row and to maintain normal carpal alignment during the initial stages of ligament healing. Concerning the distraction, Bathala and Murray [8] highlighted that when attempting to reduce a chronically dislocated carpus, the surgeon must take into account that shortening of the median nerve and the radial and ulnar arteries will have occurred.

For injuries dated more than 3 months, usually our options are confined to a salvage procedure (proximal row carpectomy, partial or total wrist fusion), depending on the condition of

the articular cartilage of the head of the capitate, distal lunate, and of radial fossae.

Massoud and Naam [16] retrospectively reviewed 19 patients for chronic perilunate injuries with a mean delay of 29 weeks (range, 13–35), who were treated with open reduction and internal fixation. They divided the patients into two groups based on the type of injury: 13 patients with greater arc and 6 patients with lesser arc injuries and they attempted to compare the functional outcome. They found no significant differences between the two groups concerning pain (VAS), active ROM and grip strength. Statistically, significant difference was found concerning the Mayo wrist scoring system according to which, good to excellent result was achieved in 69 % of patients with greater arc injuries compared with 33 % of patients with lesser arc injuries. They concluded that patients with lesser arc injuries have a less successful outcome. In addition, they commented that the reduction of greater arc was technically easier than that of lesser arc injuries.

Rettig and Raskin [40] treated with proximal row carpectomy 12 patients with stage III and IV perilunate dislocations, which had remained undiagnosed for a period of 8 weeks until 6 months. In seven of the patients, they discovered small cartilaginous defects at the head of the capitate. After a follow-up of 40 months on average, the patients demonstrated significant pain relief, functional range of motion, and satisfactory grip strength (arc of flexion–extension 80o and grip strength 80 % of the contralateral wrist). Three heavy manual workers were unable to return to their former occupation, while one patient developed asymptomatic radiocapitate arthritis.

For patients of this category, who frequently present cartilage defects at the head of the capitate and who are usually treated with proximal row carpectomy, the interposition of the dorsal capsule is possibly effective [41, 42].

Wrist arthrodesis is indicated in cases of generalized arthritis of the wrist, while in cases of neglected perilunate dislocations, the suggestion made by Richards and Roth [43] to perform a fusion of the distal carpal row to the radius, preceded by proximal row carpectomy, is interesting. Advantages of this method are: the simultaneous decompression of the carpal tunnel, the removal of sclerotic, and avascular bone that may delay union, the fact that arthrodesis is performed on less articular surfaces and thus reduces the risk of nonunion, that wrist malalignment (ulnar displacement and radial subluxation) is easier fixed and that the risk of ulnocarpal impaction is reduced.

For patients who appear many years after the injury (frequently for another reason) with symptoms of carpal tunnel syndrome or with flexor-tendon rupture, we usually tackle the problem alone (carpal tunnel release, tendon reconstruction), since these patients may not be candidates for surgical correction of the bony deformity [6, 9]. Although the few reports of isolated carpal bone excision agree on its lack of success, in cases where the lunate has been dislocated for years and the wrist has been adapted to its absence, excision of the lunate (because of tendon or median nerve problems) probably makes no difference (Fig. 7.1a–k).

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