Management of acute scaphoid fractures in athletes

Summary

This paper reviews the epidemiology, diagnosis and both conservative and operative treatment options of acute fractures of the scaphoid, with special regard to the sportsmen. Focus is placed on rapid and accurate diagnosis by the current most sensitive and specific methods. Low-invasive fixation of nondisplaced fractures and costs versus benefits of this approach are presented. An algorithm for diagnosis and treatment of the clinically suspected fracture of the scaphoid is proposed and summarizes our present attitude regarding these lesions.

Questions one should be able to answer after having read this paper:
• Which methods of diagnosis should be preferred?
• Which fracture classification should be used and how should the fracture be described?
• Which type of cast in case of conservative treatment?
• What is meant by «low invasive»?
• Which scaphoid fractures are amenable to low invasive fixation?
• Which nondisplaced fractures of the scaphoid are to be fixed?
• What is the expected outcome after low invasive fixation?
• What are the costs and benefits of low invasive fixation?

Key words: Scaphoid, fracture, low-invasive, osteosynthesis, athletes

Incidence and natural history of scaphoid fractures

As in the general population, the scaphoid is the carpal bone most commonly injured in athletes, accounting for at least 70% of all carpal fractures. It is most often encountered in 15 to 30 year-old males and its common occurrence in young athletes makes a high incidence of suspicion essential. As an example, approximately 1% of all college football players in the United States sustain a incidence of suspicion essential. As an example, approximately twice as much as when the treatment is initiated earlier [22]. In unstable fractures, the union rate for those treated in a cast is only 50 to 60%, whatever the delay in treatment.

When casted within 3 weeks of injury, union rates of 90 to 100% were reported for undisplaced fractures [5]. Stable fractures treated between 6 weeks and 6 months of injury have shown a 90% union rate but the time to union was 20 to 24 weeks, that is approximately twice as much as when the treatment is initiated earlier [22]. In unstable fractures, the union rate for those treated in a cast is only 50 to 60%, whatever the delay in treatment.

Diagnosis

In case of a scaphoid fracture suspected clinically, radiographic confirmation is mandatory. This diagnosis can be difficult, as in acute fractures, the initial plain radiographs are frequently normal. These should include four views: the front and profile views of the wrist and two scaphoid views. In the first, the wrist is dorsiflexed and maximally deviated ulnarily with the forearm in pronation to show the scaphoid in extension («navicular view»). The second is an oblique view with the forearm supinated 45° and the wrist in slight dorsiflexion and ulnar deviation.

Traditional management for clinically suspected, but radiographically negative, acute scaphoid fractures, is to cast the wrist and repeat the same views in 10 to 14 days. In most athletic injuries however, a definitive diagnosis is requested earlier. Further investigational studies such as bone scintigraphy (BS), computer tomograms (CT) and magnetic resonance imaging (MRI) are available to the clinician. Other techniques like X-ray-enlargement [15] or tomograms are obsolete.

Four considerations should direct the choice among these imaging techniques: sensitivity, specificity, usefulness, and costs. Bone scintigraphy and MRI are both very sensitive [5,12,36] and able to provide a positive diagnosis in most instances. The peak sensitivity for BS is from 3 to 10 days after injury [25].
However, it has been shown that MRI is at least as sensitive and is
certainly more specific than scintigraphy [34]. MRI not only is
the most reliable imaging technique to establish the diagnosis of
scaphoid fracture, it is also able to provide useful information
regarding its location, displacement or post-traumatic deformity
as well as vascularity of the proximal pole (Fig. 1). On the contrary,
a positive scintigraphy is nonspecific regarding the exact location
and type of fracture. Furthermore, false positive are sometimes
observed (scapholunate lesions given as proximal pole fractures).

![Figure 1: MRI of an occult scaphoid fracture (negative conventional radiographs).](image)

Although false negative may occur with computed tomography,
it has been frequently used in establishing the diagnosis for it gives
the best definition of bone cortex and fracture pattern, especially
in case of fracture displacement such as in the well-described
humpback deformity (volar angulation of the distal fragment). CT
scans provide no information about the blood supply of the prox-
imal pole and are far less informative than MRI in this regard. Both
techniques require careful positioning in order to get scans along
the longitudinal axis of the scaphoid (45° to both the frontal and
sagittal planes), which best allow proper assessment of angulation
and displacement. It is possible to use short protocol MRI (or CT)
and to significantly reduce the time and consequently the costs of
these procedures. Applying such a short protocol makes MRI as
cost-effective as bone scintigraphy for direct costs and may also
contribute to reduce indirect costs by saving time to diagnosis and
treatment [14, 35].

Taken together, these points uphold my actual strategy in case of
a clinically suspected fracture with initial negative radiographs: a
short protocol MRI along the scaphoid axis should be favoured, as
it rapidly provides the most sensitive, specific and useful informa-
tion to treat the fracture appropriately. If the fracture is already
visible on plain radiographs, and the presence and extent of dis-
placement and/or comminution are questionable, one may choose
between a CT scan or an MRI. If the vascularity of the proximal
fragment is the main concern to decide which treatment is most
adequate, MRI again should be the first choice.

**Classification**

There are four main ways to classify scaphoid fractures: by loca-
tion, fracture orientation, fracture stability and time from injury.
All are important in assessing the fracture, its prognosis and how
it should be managed.

Fractures of the distal third or tuberosity usually heal without
complication within 4 to 6 weeks by conservative means. Middle
third fractures are the most common and can be treated orthopaedi-
cally when nondisplaced. Fractures of the proximal pole are at high
risk of compromised blood supply and consequently, of nonunion.

The classification by Russe (Fig. 2) sorts the scaphoid fractures
into transverse, horizontal and vertical oblique, the latter being
considered less stable. Fracture orientation may also be relevant in
making the decision to fix it operatively or not (see below).

![Figure 2: The Russe classification: (a) transverse, (b) horizontal oblique, (c) vertical oblique.](image)

Herbert’s classification (Fig. 3) focuses mainly on instability
patterns and delay from injury. I found it more comprehensive by
adding the A3 pattern to the type A, acute stable fractures. It is a
complete but undislocated waist fracture, and probably the com-
monest among scaphoid fractures. All type A fractures may be
treated successfully by cast. All type B fractures are unstable or
potentially unstable and require an operative approach to insure
reduction and union. They include: (1) more than 1 mm displaced
fractures, (2) vertical oblique fractures, (3) angulated or com-
minuted fractures, (4) transcaphoperilunate injuries (5) proximal
pole fractures. Type C fractures are delayed union. Type D fractures
are established nonunions, either fibrous or true pseudarthrosis.

![Figure 3: Modified Herbert’s classification. A1 to A3: stable fractures, B1 to B5: unstable acute fractures, C: delayed union, D: established nonunions (fibrous and pseudarthrosis).](image)

When classifying a scaphoid fracture, one should define it along
the four lines described above: where is it located (tuberosity, waist or proximal pole)? How is the fracture oriented with respect to
the longitudinal axis of the scaphoid? Is the fracture stable (not
a B1 to B5 fracture)? Is it really an acute fracture? In addition, if
the fracture involves the proximal pole, its vascularity should be
assessed by an MRI.
Management of acute scaphoid fractures in athletes

**Treatment of acute scaphoid fractures**

Treatment of acute scaphoid fractures in the athlete is conditioned by various factors, some being dependent on the features of the fracture itself, others being more specific of the athletic conditions, including the desires of the athlete and his entourage. In professional sportsmen, economic considerations become more and more important, whereas the family circle is often very much involved in high-performing amateurs or semi-professionals. In counseling and eventually in making his choice of treatment, it is my opinion that the physician should not forget long-term issues regarding his patient and especially his post-competitive future. Getting the whole picture is essential in making the right choice.

Treatment options are basically as follows: (1) traditional casting and no sports until fracture healing has occurred; (2) cast treatment followed by a playing cast during sport activity during the late period, when applicable; (3) open reduction and internal fixation (ORIF) with return to sports as symptoms permit; (4) low-invasive internal fixation (LIIF), early mobilization and return to sports as symptoms permit.

**Conservative treatment**

Conservative treatment of scaphoid fractures is usually indicated for nondisplaced waist fractures. Although the average time to union of scaphoid fractures treated nonoperatively is 9 to 12 weeks, a significant number takes longer, up to 6 months of immobilization [31]. Traditional cast treatment of nondisplaced mid-third fractures results in nonunion in 5% to 13% of cases, depending on the series [16, 24]. Half the cases of delayed union and nonunion show clinical and radiological signs of malunion, most often by volar angulation of the distal pole of the scaphoid, leading to the so-called “humpback” deformity. Due to the loss of the link-effect of the scaphoid between the first and the second carpal rows, the luno-triquetal block rotates progressively toward dorsal and the classical dorsal intercalated segmental instability (DISI) pattern ensues. This leads to abnormal intracarpal motion [20] and to secondary arthritis, beginning at the radial styloid, in the vast majority of cases (97% at 5 years). The gradual panarthrits and wrist deformation described as Scaphoid Nonunion Advanced Collapse or SNAC wrist results in the mid- to long-term (10 to 20 years).

Conservative treatment is also associated with osteopenia and the relative joint stiffness following long-lasting immobilization. The need to wear a cast for at least 8 to 12 weeks is not always well accepted in the general population and is often felt as a reduction in the quality of life, possibly leading to compliance problems. The wrist is not as painful without a cast, it might be even more difficult to convince the athlete of the necessity to have it casted.

The type of cast has been, and is still to some extent, a matter of controversy [9]. Should it be a long (brachio-antebrachial) or a short (antebrachial) cast? This issue has been particularly well discussed in the paper by Barton [2]. There is no definitive evidence that a long-arm cast is able to improve significantly the outcome of conservative treatment by reducing the nonunion rate. As for the thumb, which is traditionally included in the so-called “scaphoid cast”, as far as the thumb is maintained in a position of function – and not adducted as often observed – its inclusion cannot harm; there is no evidence that it helps however. My own feeling is that the wrist must be immobilized by a well moulded cast and that it should be changed and wound properly for the time required. Under these conditions, clinical and radiological union have the best chances to occur. Whatever the type of cast, problems happen when it is not well adapted, not worn continuously or not long enough.

If conservative treatment by cast is chosen, fractures of the distal third (tuberosity) will usually heal by a below elbow cast in 4 to 6 weeks. The most common fractures of the mid-third or waist will require 8 to 12 weeks to get bone union. In the general nonathletic population with a scaphoid waist fracture, the mean time off work is 144 days [24].

An alternative to traditional casting and no sport until fracture has healed is cast treatment plus use of a playing cast for sports participation. This method involves placing the wrist in a thumb spica cast when not practicing, then applying a protective playing cast for participation [30]. US rules permit use of a rigid cast by football players as long as it is covered by a protective foam. Reister et al. reported a 92% healing rate, with an average healing time of 6 months, with this technique [27]. Another study comparing scaphoid fractures treated by cast only or by cast plus a playing cast for sports showed that a high percentage of fractures in the latter group failed to unite without surgical intervention [26]. In the light of these studies, use of a playing cast appears as a bad compromise and compares favourably neither with the rigid but proven-by-practice method of true casting, nor with minimally invasive or conventional open fixation techniques as described below.

**Operative treatment**

**Unstable fractures**

Most authors agree that open reduction and internal fixation is indicated and is the treatment of choice for fractures that are displaced and/or unstable [11, 17, 29]. According to the aforementioned classification by Herbert, these are:

- Fractures with displacement of more than 1 mm (B1)
- Vertical oblique or angulated fractures (B2, B3)
- Fractures associated with luxation of the wrist (B4)
- Fractures of the proximal pole (B5)

Displacement may be translational or rotational. In this case, it is usually best visible on the articular surface of the scaphoid facing the capitate. When angulation is suspected (shortening of the scaphoid on the front view and axis disruption on the lateral view), CT scan or MRI are mandatory to fully appreciate the degree of anterior comminution which is usually present. Proximal pole fractures are regarded by most as unstable or potentially unstable fractures. As a matter of fact, they gather two problems: one is their precarious blood supply which commonly leads to delayed union or nonunion; the second is that they mimic or are equivalent biomechanically to a scapholunate injury, leading to an instability within the wrist.

For all these conditions, open reduction and internal fixation are advocated. Without going into technical details, some points deserve to be mentioned. For mid-third fractures, a volar approach is used and anatomic reposition of the fragments is obtained. Internal fixation can be achieved by different means, including Herbert-Whipple, Acutrak and AO cannulated screws. They are usually inserted from distal to the proximal pole. Accurate placement of the screws should be sought and constitutes a guarantee for healing [23]. If comminution is present, definitive management must include a volar wedge graft in order to recover the length and shape of the original bone. A free, cortico-spongyous graft from the iliac crest is the gold standard for this purpose. Proximal pole fragments, especially the very small ones, are best exposed and fixed by a dorsal approach. The size of the screw should be adapted to that of the fragment.

Following surgery, the patient is treated with immobilization of the wrist for a varying period of time, depending on the stability obtained at the time of fixation, the degree of compliance which is expected and the healing progress as shown by radiographs.

**Stable fractures**

As an alternative to traditional casting, low-invasive internal fixation (LIIF) of acute nondisplaced mid-third scaphoid fractures can be proposed to the athlete. From a general point of view, the underlying rationale is threefold: (a) from a medical standpoint, it is to improve the union rate; (b) from an economical view, to reduce the related (particularly indirect) costs; (c) from the patient standpoint, to improve the quality of life, by allowing immediate motion of the wrist.
This method of treatment appears well suited to athletes. In fact, they were among the first to benefit from this approach [28]. The first and largest series using a minimally invasive technique for fixation of scaphoid fractures was published in 1991 [37]. In this series, displaced as well as undisplaced fractures were treated. Since then, several series [3, 4, 10, 13, 19, 33] with more restricted criteria for patient selection have been published (Table 1). Although it is not always easy to assess bone union of the scaphoid [7], the overall union rate using these methods was close to 100%. The more selective were the inclusion criteria (that is exclusion of unstable fractures), the best the results. In addition to this obvious advantage of LIIF over conservative treatment, it was shown in a prospective randomized study that early mobilization was possible without adverse effect on fracture healing [1]. This sets the basis for a more systematic use of LIIF in athletes. Rettig recently reported on a short series of 10 athletes treated by LIIF for acute mid-third fractures with a 3 years follow-up [30]. The union rate was 100%, with return to sport average of 4.4 weeks.

Since 1999, we have prospectively operated and followed 35 patients, including athletes, with our own protocol and technique, using a 3.0 mm self-taping cannulated AO compression screw (Fig. 4). Our goals with this study were to assess technical feasibility and difficulties, patient acceptance, short to mid-term results, as well as to better define indications for this low-invasive fixation technique.

The screw is inserted through a 1 cm transverse volar incision over the scapho-trapezial joint. It is not necessary to open the joint, but the tuberosity of the scaphoid must be recognized and carefully prepared. The procedure is performed on an outpatient basis. Postoperatively, a short arm splint is applied for three to five days. Mobilization of the wrist is then allowed (Fig. 5). Impact loading, torque and extreme wrist positions are forbidden. Force exercises and load are not allowed for a minimum of six weeks postoperatively or until radiological union of the scaphoid can be established.

Table 1: Reports of cases treated by minimally invasive internal fixation.

<table>
<thead>
<tr>
<th>Year</th>
<th>Journal</th>
<th>Nb. of patients</th>
<th>Screw</th>
<th>Fracture</th>
<th>Union (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wozasek and Moser 1991</td>
<td>JBJS</td>
<td>198</td>
<td>Cannulated 2.9</td>
<td>All</td>
<td>89</td>
</tr>
<tr>
<td>Ledoux et al. 1995</td>
<td>Acta Orthop. B.</td>
<td>23</td>
<td>Herbert</td>
<td>Undisplaced</td>
<td>100</td>
</tr>
<tr>
<td>Inoue and Shinoya 1997</td>
<td>JBJS</td>
<td>40</td>
<td>Herbert</td>
<td>Undisplaced</td>
<td>100</td>
</tr>
<tr>
<td>Brauer et al. 1997</td>
<td>Unfallchirurg</td>
<td>24</td>
<td>Herbert</td>
<td>All</td>
<td>100</td>
</tr>
<tr>
<td>Haddad and Goddard 1998</td>
<td>JBJS</td>
<td>15</td>
<td>Acutrak</td>
<td>Undisplaced</td>
<td>100</td>
</tr>
<tr>
<td>De Cheveigne 1998</td>
<td>Abstract GEM</td>
<td>57</td>
<td>Osteo (nC)</td>
<td>Undisplaced</td>
<td>100</td>
</tr>
<tr>
<td>Taras et al. 1999</td>
<td>Hand Clinics</td>
<td>5</td>
<td>Herbert</td>
<td>?</td>
<td>100</td>
</tr>
<tr>
<td>Adolfsson et al. 2001</td>
<td>JHS(B)</td>
<td>25</td>
<td>Acutrak (C)</td>
<td>Undisplaced</td>
<td>96</td>
</tr>
<tr>
<td>Bond et al. 2001</td>
<td>JBJS</td>
<td>11</td>
<td>Acutrak (C)</td>
<td>Undisplaced</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>398</td>
<td></td>
<td></td>
<td>98.3</td>
</tr>
</tbody>
</table>

C: cannulated
nC: non cannulated

Figure 4: Low-invasive internal fixation (LIIF) technique using the 3 mm cannulated AO screw. Top row: insertion of the guide-wire. Bottom row: screw in place.

Figure 5: Wrist motion two weeks post low-invasive internal fixation of an acute mid-third scaphoid fracture (right side).

All patients except one were males. Mean age was 28 years. Except three slightly displaced fractures, all were of the A2 or A3 types. Seven patients had associated lesions on the same or contralateral side. The average operation time was 47 minutes. Union was achieved in all cases after a mean of 6.5 weeks. Three non-compliant patients required additional splinting to heal. Mean time off-work was 43.5 days (including patients with associated injuries). We had no implant-related complication. Horizontal oblique fractures were found to be a potential problem, as they may translate anteroposteriorly during screw insertion. In addition, as the fracture line is not perpendicular to the screw axis, poor compression may result. The same is true with relatively proximal fractures of the mid-third, which are less stable and may prove difficult to maintain and fix. In such a case, a dorsal approach should be preferred.

A cost-effectiveness study comparing direct and indirect costs of conservative versus low-invasive fixation in a general population was run in parallel. Our data (unpublished, manuscript in preparation) show that direct costs are about twice as high in the operative group compared to the conservative group. Conversely, indirect costs tend to be lower in the operative group, due to the improved union rate and markedly decreased time off-work.

In summary, we found that low-invasive internal fixation of scaphoid fractures was well accepted by the patients as it strikingly reduces the need for immobilization and improves quality of life. It is technically demanding and requires an appropriate instrumentation as well as surgical training. Caution is mandatory.
Management of acute scaphoid fractures in athletes

in case of horizontal oblique and proximal mid-third fractures. Thanks to the high union rate, low complication rate and the limited time off-work, it appears as a cost-effective method to treat acute nondisplaced fractures of the scaphoid.

Conclusions

Acute scaphoid fractures in the athlete present some peculiarities in management. However, treatment options are basically the same as in the general population presenting a scaphoid fracture, that is young active males. Figure 6 synthesizes our current guidelines for diagnosis and treatment of acute fractures of the scaphoid.

Most displaced and proximal pole fractures require open reduction and internal fixation by either a volar or a dorsal approach to achieve anatomic reduction (with an iliac crest graft when necessary) and allow for timely healing. Low-invasive fixation may be applicable in some cases with little displacement and no comminution.

Acute, nondisplaced, transverse mid-third fractures (the most common type seen both in athletes and the general population) are ideal indications for low-invasive internal fixation with a compression screw. Specific knowledge of the surgical anatomy as well as appropriate training to get the necessary skills are prerequisites for the high union rate and low complication rate that can be expected from this method.

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