Scaphoid fracture

Review of diagnostic tests and treatment

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abstract

OBJECTIVE To help make diagnosis and treatment of scaphoid fracture more precise by review of published evidence.

QUALITY OF EVIDENCE MEDLINE was searched using the terms "scaphoid," "carpal navicular," "fracture," "computed tomography," "bone scan," and "scintigraphy." Most papers were case-series observational reports. Papers were cited if the case series was large or if there was a high degree of agreement among several observers. The main recommendation for change in treatment of scaphoid fracture is based on two randomized clinical trials involving more than 1000 patients with proven scaphoid fracture.

MAIN MESSAGE Fracture of the scaphoid requires a specific mechanism of injury. "Snuffbox" tenderness is not specific for scaphoid fracture and is not the most useful physical finding; other physical findings provide more specific evidence for or against scaphoid fracture. Physical examination remains the basis of initial treatment and should be thorough and meticulous. X-ray films must be of high quality and should be examined carefully for bone and soft tissue signs of fracture. A Colles'-type short arm cast is adequate for treating common undisplaced scaphoid waist fractures; the thumb need not be immobilized. For suspected scaphoid fractures, without radiologic evidence of fracture, treating symptoms is likely sufficient.

CONCLUSION Evidence found in the literature can be used to improve diagnostic accuracy for scaphoid fractures, to optimize treatment for these injuries, and to reduce unnecessary immobilization and disability for patients.

résumé

OBJECTIF Aider à préciser le diagnostic et le traitement des fractures du scaphoïde en examinant les données probantes publiées.

QUALITÉ DES DONNÉES Une recension dans MEDLINE utilisant les termes en anglais pour «scaphoïde», «scaphoïde carpien (carpal navicular)», «fracture», «tomographie par ordinateur», «scintigraphie osseuse» et «scintigraphie». La majorité des articles portaient sur des rapports d'observation sur des séries de cas. Les ouvrages ont été cités si les séries de cas portaient sur des nombres importants ou s'il y avait un fort consensus entre plusieurs observateurs. La principale recommandation de changement dans le traitement des fractures du scaphoïde se fonde sur deux essais cliniques aléatoires portant sur plus de 1000 patients souffrant effectivement de fractures du scaphoïde.

PRINCIPAL MESSAGE Une fracture du scaphoïde est causée par un mode de blessure spécifique. Le test de la sensibilité de la tabatière anatomique n'est pas spécifique pour une fracture du scaphoïde et ne représente pas l'observation physique la plus utile; d'autres observations physiques procurent des preuves plus précises confirmant ou excluant une telle fracture. L'examen physique demeure la base sur laquelle fonder le traitement initial, et devrait se révéler méticuleux et approfondi. Les films radiologiques doivent être de grande qualité et devraient être examinés attentivement pour déceler des signes de fracture dans les os et les tissus mous. Un plâtre court au bras pour fractures de Colles est adéquat pour traiter les fracture courantes sans déplacement du col du scaphoïde; l'immobilisation du pouce n'est pas nécessaire. Si on soupçonne une fracture du scaphoïde sans avoir de preuve radiologique de fracture, le traitement des symptômes suffit probablement.

CONCLUSION Les données probantes tirées des ouvrages scientifiques peuvent servir à améliorer la précision du diagnostic des fractures du scaphoïde, optimiser le traitement de telles blessures et réduire l'immobilisation inutile et l'invalidité chez les patients.

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Cet article a fait l'objet d'une évaluation externe.
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The scaphoid is one of eight carpal bones. Scaphoid fractures comprise almost 90% of carpal bone fractures[1] and are most common in men (~85%) between 15 and 30 years old.[2,3]

Diagnosis and treatment of scaphoid fracture has been fraught with uncertainty and fear. Despite numerous reports in the literature, the issue has seen little practical change in more than 50 years. Generations of medical students have learned that tenderness in the anatomical snuffbox is the cardinal sign of scaphoid fracture. These students have also learned that inadequate treatment of suspected scaphoid fracture can result in disabling complications for patients and painful lawsuits for physicians. For these reasons, patients are routinely immobilized in casts, often on the basis of snuffbox tenderness alone.

This paper reviews the literature on diagnosis and treatment of scaphoid fracture. As with any diagnostic process in medicine, features in the history, examination, and radiographs together aid clinicians in making diagnostic and treatment decisions. These features will be reviewed with the goal of helping physicians to diagnose and treat scaphoid fracture with greater precision and confidence.

Quality of evidence

MEDLINE was searched (1960 to 1998) using the terms "scaphoid," "carpal navicular," "fracture," "computed tomography," "bone scan," and "scintigraphy." Commonly referenced or seemingly important articles predating 1960 were also obtained. Articles were cited if they involved a large case series, if they were frequently cited in the literature, or if, among several papers, there was a high degree of interobserver agreement. Exceptions to this are noted when discussed.

Most of the studies cited were retrospective case-series reviews of charts and x-ray films. Anatomical studies included detailed dissections of 297 scaphoids postmortem. The main postmortem study of mechanism of scaphoid fracture involved 31 forearms in a mathematically precise model to recreate hypothetical injury conditions. The main bone-scan study involved 187 patients followed for 32 months. For use of CT in diagnosing scaphoid fracture, there were no sizeable studies reported in the literature. The recommendation for change in treatment of scaphoid fractures is based on two randomized clinical trials involving more than 1000 patients with diagnosed scaphoid fractures.

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Types of scaphoid fractures

Table 1[1,2] and **Figure 1** show types of scaphoid fractures. Scaphoid fractures are uncommon in children; most occur at the distal third.[4-6] Low incidence is thought to be due to the degree of ossification of the scaphoid in children as well as the lesser forces involved in their falls.[4,7]

Anatomic studies of 297 scaphoid bones showed that, in 33% of the specimens, the proximal scaphoid has one or no nutrient vessels.[8,9] Therefore, in about one third of patients, fracture at or proximal to the waist will leave the proximal fragment at risk for avascular necrosis.

Table 1. **Classification of scaphoid fractures in adults**

SITE AND TYPE OF FRACTURE	%
Distal third*	10
Middle third	70
• Transverse	• 42
• Horizontal oblique	• 24.5
• Vertical oblique	• 3.5
Proximal third	20

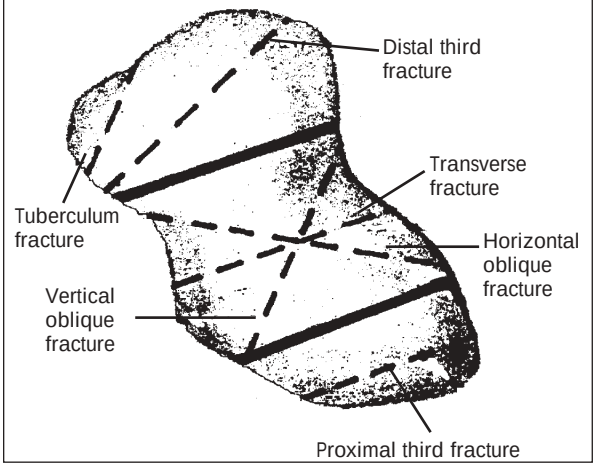
Data from Leslie and Dickson[1] and Gumucio et al.[2]
**Includes tuberculum fractures.*

History and mechanism of injury

Common middle-third scaphoid fractures have been experimentally shown to result from extreme dorsiflexion (>95°) of the wrist with compressive force to the radial side of the palm.[10] This most commonly occurs during a fall on an outstretched hand. Researchers suggest that falls backward, with a hand directed anteriorly, are most likely to force such extreme dorsiflexion.[7]

A few scaphoid fractures result from forced dorsiflexion by other means, such as the force of the palm against a steering wheel in a motor vehicle accident. A direct blow to the scaphoid can also result in fracture; in the past, "crank-handle kickback" was a frequent cause of scaphoid fracture. The great forces involved in crank-handle kickback produced a high incidence of displaced, oblique, or unstable fractures.[1] Current incidence of such scaphoid fractures is unknown, but is probably much lower.

Figure 1. **Types of scaphoid fractures**



Fractures of the scaphoid tubercle result from a similar mechanism and occur predominantly in a younger age group.[7] Anatomists do not agree on the name(s) of the ligamentous structures involved[6,11] (perhaps radial collateral ligaments), but tubercle fractures are generally considered avulsion fractures.[7]

Knowing the mechanism of fracture can heighten physicians' suspicions for scaphoid fracture. In cases where the mechanism of injury is not consistent with those described, differential diagnoses can be appropriately weighted.

Physical examination

An injured wrist containing fractured bone will have a bloody effusion that is visible or palpable.[6,12,13] If the injury is very recent (<4 h), the effusion might not have developed to a detectable level. Similarly, if the injury is several days old (>4 days), the effusion might have resolved.

The classic sign of scaphoid fracture is, of course, tenderness in the anatomical snuffbox. This finding alone is not sufficient to diagnose fracture of the scaphoid or occult fracture of the scaphoid. Snuffbox tenderness is a highly sensitive test for scaphoid fracture, but its specificity is low.[14-16]

Most wrist injuries resulting in joint effusion will produce snuffbox tenderness. A traumatized wrist with an effusion might be diffusely tender, and careful examination for points of maximum tenderness is essential. Tenderness in the snuffbox alone can be found with fracture of the trapezium or radial styloid, as well as with de Quervain's disease or osteoarthritis of the first carpometacarpal joint.[14]

A finding of tenderness at the scaphoid tubercle strongly supports a diagnosis of scaphoid fracture.[15,16] Palpating the scaphoid tubercle applies almost direct pressure on the scaphoid bone itself, whereas snuffbox palpation is less direct. Scaphoid tubercle tenderness is highly sensitive for scaphoid fracture and more specific than snuffbox tenderness. The absence of scaphoid tubercle tenderness makes a diagnosis of scaphoid fracture unlikely. The absence of snuffbox and scaphoid tubercle tenderness virtually excludes a diagnosis of scaphoid fracture.

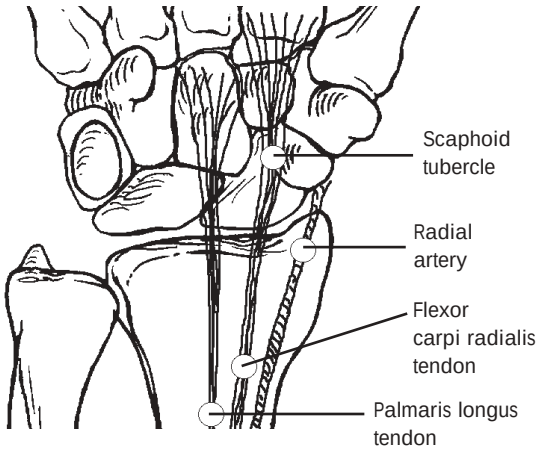
The scaphoid tubercle is located precisely at the intersection of the distal wrist crease and the tendon of flexor carpi radialis. With radial deviation of the wrist, scaphoid orientation is altered such that it produces a prominent bump on the radial side of the volar wrist (**Figure 2**).

Chen[14] has described the Scaphoid Compression Test, which is intended to discriminate scaphoid fracture from other causes of snuffbox tenderness. In his series of 52 traumatized wrists with snuffbox tenderness, he reports very high sensitivity and specificity of this test for scaphoid fracture. Others[17,18] have not found such high specificity. The test is, at least, sensitive for fracture on the radial side of the wrist and thus provides an aid to diagnosis.

The Scaphoid Compression Test is performed by grasping the thumb of the affected limb in one hand while stabilizing the forearm in the other hand. Compressive force is applied as shown in **Figure 3**[14]. Wrist pain indicates a positive result.

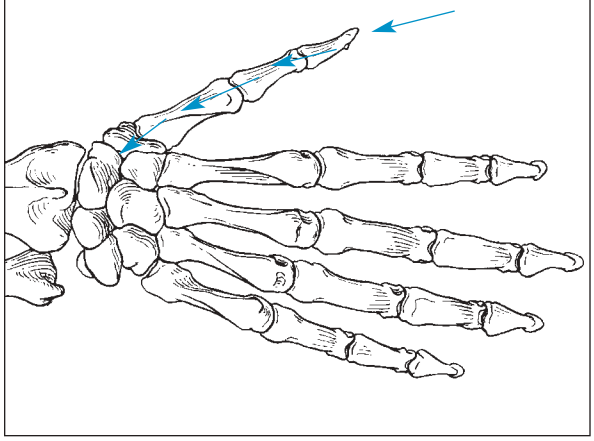
Several authors describe tests for scaphoid fracture involving forced deviation of the wrist. These tests have poor specificity for scaphoid fracture,[18,19]

Figure 2. **Landmarks for locating the scaphoid tubercle**



and I think such maneuvers with a traumatized wrist might be unwise. Findings on physical examination remain the main determinant of initial treatment. The value of careful examination cannot be overstated.

Figure 3. **Scaphoid Compression Test rationale**



Radiographic examination

Standard x-ray examinations for suspected scaphoid fracture, at most facilities, include four views of the wrist:

- posteroanterior (PA) with ulnar deviation;
- lateral;
- semipronated oblique; and
- "scaphoid view" with the wrist pronated in ulnar deviation and the x-ray beam 25° off vertical, directed cephalad.

The critical point about x-ray views is to obtain at least one clear view of the scaphoid showing the trabecular pattern.[1] If this view is not initially obtained, physicians should request additional views. If clinical suspicion is high and the four standard views do not reveal a fracture, one author[20] has demonstrated that an additional view, taken obliquely between PA and semipronated views, might show a fracture. In equivocal cases, x-ray films of the uninjured scaphoid might also be helpful.[21] A magnifying glass is very helpful, perhaps essential, for examining the scaphoid cortex and trabecular pattern for disruption.[22]

Leslie and Dickson[1] reported that, in a series of 222 scaphoid fractures, 98% were visible on x-ray film at first examination. The remaining 2% became visible after 2 weeks. Other authors[23,24] have reported less optimistic figures—as low as 84% visible on first examination.

Wrist x-ray films should also be evaluated for soft tissue signs of fracture. In particular, displacement of the scaphoid fat stripe (SFS), a radiolucent stripe adjacent to the radial side of the scaphoid as visualized on the PA film, should be sought. Fractures of the radial carpal bones or the radial styloid cause edema and hemarthrosis (effusion) that further displace the SFS radially.[13,25,26] Radial convexity or obliteration of the SFS is considered diagnostic of fracture. From several series of scaphoid fractures, authors have reported sensitivities for this test in the range of 95%.[13,25] Conversely, approximately 95% of nontraumatized wrists had normal SFSs. When other clinical signs suggest scaphoid fracture, a distorted or obliterated SFS provides strong supporting evidence. This sign is said to be useful for up to 2 weeks after injury.[25] A magnifying glass is very helpful in searching for the SFS.

Radiographically visible soft tissue swelling on the dorsum of the wrist is also indicative of carpal bone fracture.[27]

Other imaging methods

Colour flow Doppler ultrasound, which measures displacement of the radial artery, is based on the same principle as the SFS sign.[28] In addition to high cost, this test has the disadvantage of requiring standardized operator interpretation and familiarity with the test.

Computed tomography can detect scaphoid fracture with high specificity,[29,30] but sensitivity is poor. It is economically impractical for initial assessment.

Radioisotope bone scanning is reported to be highly sensitive as early as 24 hours after scaphoid fracture.[31,32] It is, however, criticized for a high rate of false positives (poor specificity), especially in very young or elderly people.[24,33,34]

Magnetic resonance imaging (MRI) holds hope of being the most reliable method for detecting fresh scaphoid fractures when standard x-ray films are not diagnostic. At this time, MRIs are rarely available, and costs of MRI are prohibitive.

Treatment

Common scaphoid fractures. Standard orthopedic textbooks describe immobilizing a fractured scaphoid in a forearm cast extending to the proximal palmar crease (to allow full function at metacarpophalangeal joints) and including the proximal phalanx of the thumb.[35,36] Positions of the hand, wrist, or thumb are not thought critical; therefore, the best position for function is ideal.[37,38] Patients should be able to hold a glass of wine between thumb and index finger.[39]

Bohler et al[38] demonstrated, in a prospective randomized study of more than 700 scaphoid fractures, that inclusion of the thumb had no effect on outcome (time to union and incidence of nonunion). Clay et al,[40] in a prospective study of 392 scaphoid fractures,

similarly found no difference in outcome with treatment in a scaphoid cast or a Colles' cast. Leaving the thumb free clearly allows patients greater hand function. No studies in the literature contest the hypothesis that thumb inclusion is unnecessary. It appears that a Colles' cast is sufficient for treatment of most scaphoid fractures.

Immobilization in the cast should continue until there are clinical and radiographic signs of bony union. These signs are absence of tenderness, appearance on x-ray films of bony trabeculae crossing the fracture line, a sclerotic band at the fracture site, or cortical continuity.[1,2] For most scaphoid fractures (waist and distal third), 6 to 8 weeks' immobilization is sufficient.[1] The time varies directly with patients' age.

Scaphoid tubercle fractures, which are nonarticular and have a rich blood supply, are reported to heal well regardless of treatment.[1,2] Symptomatic treatment with a removable wrap or splint is sufficient.

Leslie and Dickson,[1] in their series of 222 scaphoid fractures, assessed time to bony union by the criteria discussed above. Their findings are summarized in **Table 2[1]**.

High-risk scaphoid fractures. Special considerations arise for proximal pole fractures, displaced fractures (≥ 1 mm[41,42]), fractures that become displaced during treatment, and oblique fractures.[1,2] These fractures are unstable or subject to vascular compromise, or both, and are at risk for the complications we fear.

It has been demonstrated that, with supination and pronation, substantial movement at the scaphoid still occurs in a short arm cast.[43] For high-risk scaphoid fractures (proximal, oblique), a long arm cast should be applied[43,44] with the elbow at 90°. Fractures that are displaced ≥ 1 mm are considered unstable and should be referred to an orthopedic surgeon.[41,42]

When a cast is applied, it is important that it fit well for the duration of treatment. Casts should be checked biweekly and replaced if loose.[2] When a cast is loose and is removed, x-ray films are indicated for all but distal pole fractures.[2] Films should be examined for displacement, signs of bony union or nonunion, and avascular necrosis. Displacement while in the cast is a poor prognostic sign for nonunion.[1]

After 12 weeks of immobilization, if signs of bony union have not developed, signs of nonunion (failure of trabeculation across the fracture, sclerosis of fracture margins) or avascular necrosis (increased opacification of the proximal fragment) should appear.[2]

Table 2. **Time to union by type of scaphoid fracture**

TYPE OF FRACTURE	CLINICAL UNION (DAYS)	RADIOLOGIC UNION (DAYS)	TIME IN CAST (DAYS)
Tuberosity	33	39	30
Distal third	50	44	47
Middle third			
• Transverse	84	67	64
• Horizontal oblique	55	57	49
• Vertical oblique	75	72	65
Proximal third	79	93	64

Data from Leslie and Dickson.[1]

Should these signs appear, referral to an orthopedic surgeon is indicated.

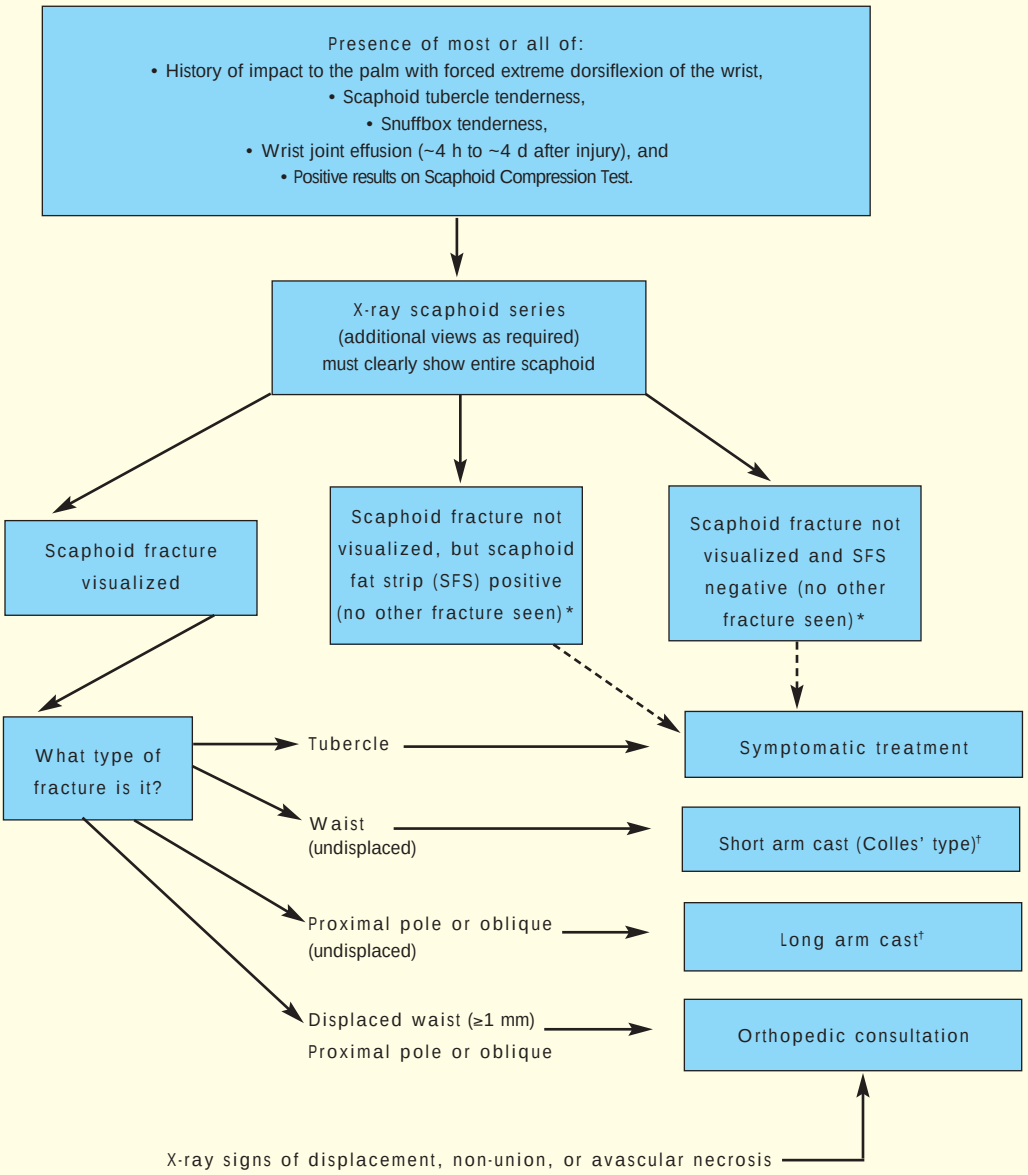
A common diagnostic and treatment dilemma is a scaphoid that seems fractured on physical examination but appears normal on x-ray films. If a diagnostic decision cannot be made after using all the techniques previously described, traditional practice is to cast the wrist (a Colles' cast will suffice). At 2 weeks from date of injury (not 7 or 10 days), the cast is removed, the wrist re-examined, and x-ray films taken again if clinical signs of fracture persist.[1,2,39] Bone resorption along the margins of fracture fragments will, theoretically, make a fracture visible at that time.

Several authors have reported that scaphoid fractures not visible on initial x-ray films are "incomplete" or otherwise minor and will heal regardless of treatment.[1,4,12] Leslie and Dickson[1] state that the 2% of fractures that became radiographically visible during treatment were all incomplete fractures on the compression (concave) side of the scaphoid. Others[12,45,46] have reached similar conclusions and have suggested that symptomatic treatment is most appropriate in these cases.

The prevalent concern about missing these fractures, with resulting dire complications, is probably exaggerated. These "occult" scaphoid fractures are definitely not associated with the long-term dire consequences we fear. There are no reports in the literature of such fractures progressing to displacement, nonunion, avascular necrosis, or radiocarpal arthritis.

At the 2-week after-injury reassessment, the wrist should again be carefully examined for signs of scaphoid fracture. If clinical signs of fracture are present, repeat wrist and scaphoid x-ray examinations. If

Figure 4. **Diagnosis and treatment of scaphoid fracture**



**Traditional practice dictates that these be placed in a scaphoid cast for 2 weeks, then reassessed. The literature strongly suggests that symptomatic treatment will suffice.*

†Cast for 6 to 12 weeks until clinical and radiographic signs of healing appear. Check biweekly; change cast if loose. If cast is changed, have x-ray examination. If film shows signs of displacement, non-union, or avascular necrosis, refer to an orthopedic surgeon.

a fracture is then visible, treatment can proceed with confidence and as appropriate for that fracture.

At the 2-week reassessment, in a notable number of cases, clinical signs persist but x-ray films continue to appear normal. It is common practice to order a bone scan at this point. This test is highly sensitive, but specificity is poor; CT scan is more specific but sensitivity is lower. The usefulness and cost-effectiveness of either bone scans or CT scans 2 weeks after injury is questionable. To what extent should one investigate an injury that might have little clinical significance? Pending further clarification of these injuries, the most appropriate management might be to continue casting injured wrists and, at 2-week intervals, reexamine and x-ray again until signs of scaphoid fracture have resolved.

A dilemma remains with wrists that show clinical signs of scaphoid fracture but have normal x-ray films. It would be useful to clarify the exact nature and natural courses of these injuries. This might best be achieved by a prospective study using MRI imaging. Such a study would help physicians to treat these wrists appropriately and with confidence, and fear of adverse outcomes for such patients could be further reduced. Also, MRI scanning might eliminate the question of what to do at the 2-week reassessment.

Conclusion

Diagnosis of scaphoid fracture is made by presence of specific features in the history, physical examination, and radiographs. These are:

- history of appropriate mechanism of injury (impact to the radial side of the palm with extreme dorsiflexion of the wrist);
- physical examination revealing substantial (likely maximum) tenderness in the snuffbox and at the scaphoid tubercle. A wrist-joint effusion will be apparent if a patient is examined between several hours and 4 days from time of injury, and results of the Scaphoid Compression Test will be positive.
- When standard wrist radiographs (three) and a scaphoid view are obtained, with at least one view showing the entire scaphoid bone clearly, meticulous examination of the scaphoid cortex with a magnifying glass might reveal discontinuity. If a fracture is visualized, assess whether it is displaced. When the SFS is sought and radial convexity or obliteration of the SFS is noted, a fracture is indicated.

Figure 4 presents a schematic of diagnosis and treatment of scaphoid fracture. Refinement of physical and x-ray examination techniques will improve physicians' precision and confidence in diagnosing and treating scaphoid fractures.

Key points

- Clinical examination for scaphoid fracture is more accurate using the Scaphoid Tubercle Tenderness Test than the "snuffbox" test.
- X-ray films of the scaphoid should be of high quality and examined carefully for bone and soft tissue signs of fracture.
- A Colles'-type short arm cast is adequate for common, undisplaced scaphoid fractures; thumb immobilization is unnecessary.
- When the scaphoid is tender, but shows no radiologic signs of fracture, patients should be reassessed every two weeks until clinically healed. Bone scans and computed tomography do not assist management.
- Fractures of the proximal pole or of ≥1 mm displacement are high risk and should be referred.

Points de repère

- L'examen clinique des fractures du scaphoïde est plus précis à l'aide du test de sensibilité du tubercule du scaphoïde qu'au moyen du test de la tabatière anatomique.
- Les films radiologiques du scaphoïde devraient être de grande qualité et examinés attentivement pour déceler des indices de fracture dans les os et les tissus mous.
- Un plâtre court au bras pour fractures de Colles est approprié dans les cas habituels de fractures du scaphoïde sans déplacement; l'immobilisation du pouce n'est pas nécessaire.
- Lorsque le scaphoïde est sensible mais les signes radiologiques de fracture sont absents, les patients devraient être réévalués aux deux semaines jusqu'à la guérison clinique. Les scintigraphies osseuses et la tomographie par ordinateur n'aident pas dans la prise en charge.
- Les fractures du pôle proximal ou les déplacements de 1 mm et plus présentent des risques élevés et devraient faire l'objet d'un aiguillage vers des services spécialisés.

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