Acute Scaphoid Fractures

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Scaphoid fractures often occur as a result of a fall on the outstretched arm or a forced dorsiflexion injury of the wrist.1,2 The traumatic incident may be minimal and the injury may be mistakenly dismissed as a sprain, especially if a fracture is non-displaced and radiographs are read as negative. However, the penalty for missing these important injuries is high. The blood supply to the scaphoid is tenuous and, if disrupted by the fracture, healing may be compromised. Avascular necrosis occurs in an estimated 13% to 50% of scaphoid fractures, and the incidence is even higher in fractures involving the proximal one fifth of the scaphoid.2–5

The scaphoid receives its blood supply primarily from the artery to the dorsal ridge of the scaphoid, a branch of the radial artery. The branches of this vessel enter the nonarticular portion of the scaphoid through foramina at the dorsal ridge at the level of the waist of the scaphoid.4,6 Subsequently, these vessels divide and run proximally and palmarly to supply the proximal pole of the scaphoid.4,6 Other branches provide 20% to 30% of the blood flow and arise from the distal palmar area of the scaphoid, originating either directly from the radial artery or the superficial palmar branch.1,2 Thus, the vascularity of the proximal pole depends entirely on intraosseous blood flow. Because of the limited blood supply, fractures have a prolonged healing period, with an acute proximal pole fracture averaging 3 to 6 months. Nonunion may occur (in 5% to 10% of all cases, with an even higher incidence in displaced fractures), and numerous series document progression of nonunion to collapse and arthritis.1,2 Because treating the established nonunion can be challenging, especially in the setting of progression to degenerative arthritis, diagnosing and appropriately treating the acute fracture and the possible sequelae of nonunion is essential.

DIAGNOSIS OF ACUTE SCAPHOID FRACTURES

Because early radiographs are normal for many patients, diagnosing a scaphoid fracture can sometimes be difficult. Most patients will experience tenderness to palpation over the anatomic snuff box or the distal scaphoid tubercle, pain with longitudinal compression of the thumb, and limited range of motion and pain at the end arc of motion, especially with flexion and radial deviation.7–9 Reduced grip strength may be noted.7–9 However, not all patients will experience pain over the scaphoid, even with a well-defined fracture seen on radiograph.7 Overall, sensitivity is high for clinical examination, but specificity approaches only 74% to 80%.8,9

Plain-film radiographs are usually obtained first in the acute setting when a scaphoid fracture is suspected. The lateral radiograph is particularly useful, and a proper study should show a colinear capitate and radius, with the pisiform located between the distal pole of the scaphoid and the body of the capitate. This study allows the carpal alignment and distal radioulnar joint alignment to be evaluated. Classically, patients who had clinical findings of scaphoid fracture but negative initial radiographs were treated with 2 weeks of cast immobilization followed by repeat examination and radiographic studies, with the belief that the delay allows for bony resorption adjacent to the fracture site, making the fracture visible.7,10

Although this approach remains an accepted option for treatment, it may result in unnecessary...
immobilization, with adverse effects on return to work and requirement for repeat radiographs, clinical examinations, and splint or cast changes.11-13 Most patients who have a suspected scaphoid fracture have not actually injured the scaphoid, and casting for no fracture just to present a conservative treatment modality results in overtreatment at the expense of office visits, radiographs, and lost work.

Other options may include use of alternative imaging techniques. Bone scan is sensitive but not specific for diagnosing scaphoid fracture.14 Bone scintigraphy has shown 100% sensitivity and 98% specificity for a scaphoid fracture compared with approximately 65% to 70% sensitivity for plain-film radiographs.15-20 MRI is superior to repeat radiographs for detecting occult scaphoid fracture21 and is considered by many the gold standard for detecting scaphoid fracture, with sensitivity of 95% to 100% and specificity approaching 100%.22-24 Furthermore, the value of an MRI includes the ability to identify and diagnose other causes of wrist pain if a scaphoid fracture is not present. If a scaphoid fracture is identified, vascularity of the proximal pole can be determined preoperatively with MRI. Acute fractures may show normal or decreased T1 and increased T2 intensity. Nonunion and impaired vascularity is often seen with low T1 and T2 marrow signal intensity, which may correlate with poor healing.25,26

The importance of missed diagnosis is highlighted by the risk for nonunion in up to 12% of patients if an occult scaphoid fracture is not identified and immobilized. Therefore, many authorities recommend a highly conservative strategy to immobilize patients who have a history suggestive of scaphoid fracture but negative plain films. However, this treatment using splinting and casting can lead to loss of work and economic implications.11,12,14 Cost of time off from work and serial casting and office visits easily exceeds the cost of an MRI or CT scan for definitive diagnosis.12

In a randomized control trial of 28 patients who had suspected scaphoid fracture, Brooks and colleagues13 investigated the cost-effectiveness of MRI for diagnosing suspected scaphoid fractures. Patients were randomized to undergo MRI scan or conservative treatment with immobilization and serial clinical and radiographic evaluation. Those who underwent MRI had a shorter duration of immobilization and decreased use of health care resources but increased cost to treat compared with patients randomized to the non-MRI group, who were immobilized and evaluated with serial clinical and radiographic examination. Cost per day of unnecessary immobilization between the groups was $44.37. However, these costs do not consider absenteeism from work and leisure activities.13 Pillai and Jain11 reported a rate of more than 80% of unnecessary immobilization when all clinically suspected scaphoid fractures with negative radiographs were immobilized in the traditional treatment algorithm. In this series, 6.7% of 90 initially radiographic-negative wrists were found to have a scaphoid fracture, whereas 10 additional patients had other injuries of the wrist not involving the scaphoid.11 The findings suggest that the cost of needless immobilization, with further clinical and radiographic studies, would have exceeded early alternative investigations, such as MRI or bone scan, which were frequently required anyway.11

Thorpe and colleagues27 reported a series of 59 patients who had clinical symptoms suggesting scaphoid fracture but negative radiographs. All underwent MRI, bone scintigraphy, and clinical follow-up, with clinical follow-up deemed the gold standard for diagnosis. Clinically, 4 scaphoid fractures, 10 other fractures, and 3 significant ligamentous injuries were identified. Although all scaphoid fractures were identified with both MRI and bone scan, MRI was noted to have better interobserver agreement and fewer false-positives. Likewise, other causes of wrist pain, including ligamentous injury or carpal instability, could be identified with MRI, whereas these findings could not be diagnosed with bone scan. These investigators further noted that costs were similar.27

In a study comparing sensitivity and specificity of MRI and bone scintigraphy in diagnosing occult scaphoid fractures, 43 patients who had wrist trauma and normal radiographs underwent MRI and bone scan an average of 19 days after injury. Of these, 6 patients (14%) ultimately were diagnosed with a scaphoid waist fracture. Patients were followed up for more than 1 year after injury. MRI was noted to be more sensitive in detecting occult scaphoid fracture, with fewer false-positives than bone scan.28 Dorsay and colleagues12 investigated the cost-effectiveness of early MRI for detecting occult scaphoid fractures. They noted that 75% of patients who had clinical evidence of scaphoid fracture would be immobilized unnecessarily if they underwent standard treatment with repeat radiographs after immobilization. The cost differential between standard follow-up and MRI was small.12

In practice, although MRI can detect a fracture within 4 to 6 hours, this specialized study cannot always be obtained in the emergency department. However, obtaining an MRI at 36 to 48 hours is a reasonable goal. Occasionally, MRI may show
a false-positive result, but false-negative examinations are rare. Thus, an early MRI can reliably exclude patients who do not have a scaphoid fracture and in whom immobilization may safely be discontinued. Although CT scans can also identify fractures and are useful for defining incomplete or nonunions and for preoperative planning with respect to intrascaphoid angles and scaphoid collapse, they are not as accurate as MRI for identifying acute occult scaphoid fractures and may not reveal alternative diagnoses, such as ligamentous injury.

Technetium bone scan is sensitive, but false-positives may occur in patients who have arthrosis or prior or concurrent injury. Likewise, bone scans require a delay in performing the test and often do not adequately elucidate alternative diagnoses. MRI is at least as sensitive and more specific, involves less radiation exposure, and may allow alternative problems to be diagnosed.  

The authors’ algorithm in a patient who has wrist trauma is to obtain anteroposterior, lateral, and oblique radiographic views of the wrist. If a scaphoid fracture is identified on the radiographs, then a CT scan can be obtained for surgical planning if necessary. If the radiographs are negative or equivocal, then a limited MRI of the wrist is then obtained to determine the presence or absence of a scaphoid fracture. If needed, a CT scan can also be obtained after the MRI to help plan for surgical treatment.

**CLASSIFICATION**

Classification of scaphoid fractures has been well described in the literature. Three common classifications used for scaphoid fracture are the Mayo classification, Russe classification, and Herbert classification (Fig. 1).

![Herbert classification of scaphoid fractures.](From Herbert TJ. The fractured scaphoid. St. Louis (MO): Quality Medical Publishing; 1990; with permission.)
Some series have shown limited prognostic value and poor inter- and intraobserver reliability of scaphoid fracture classification schemes, Nevertheless, the Mayo, Russe, and Herbert classifications are commonly used in clinical practice and many authorities feel they may be helpful in determining treatment options and providing prognostic information. The first two classifications are based on anatomic planes of the scaphoid. However, the Herbert classification defines stable and unstable fractures and therefore may be particularly helpful in determining treatment options. The type A Herbert classification fracture is a stable acute fracture and type B is an unstable acute fracture. Stable fractures include fractures of the tubercle (A1) and an incomplete fracture of the waist (A2). These fractures can potentially be treated nonoperatively. The other types of fractures in the Herbert classification usually require surgical treatment. Type B fractures (acute unstable fractures) include subtypes B1 (oblique fractures of the distal third), B2 (displaced or mobile fractures of the waist), B3 (proximal pole fractures), B4 (fracture dislocations), and B5 (comminuted fractures). Type C fractures show delayed union after more than 6 weeks of plaster immobilization, whereas type D fractures are established nonunions, either fibrous (D1) or sclerotic (D2).

TREATMENT OF ACUTE SCAPHOID FRACTURES

Differences of opinion exist on indications for operative therapy in the setting of acute scaphoid fractures. Nonoperative therapy often requires prolonged immobilization of at least 12 weeks, and much longer for more proximal fractures. Although few studies exist in the literature documenting consequences of long-term cast immobilization, clearly this treatment can result in significant stiffness that may require a protracted rehabilitation period, and some series suggest a poorer outcome after prolonged immobilization. In addition, union rates are higher with operative management, approaching 95% or higher in most series of all types of scaphoid fractures. Multiple studies of percutaneous fixation of scaphoid fractures have documented satisfactory outcomes and minimal complications. Comparative studies of surgery versus casting for acute fractures have documented better range of motion at the wrist, earlier healing (7 weeks until union versus 12 weeks with casting), and earlier return to work with surgical management. Furthermore, minimal differences were seen in these groups with respect to outcomes and satisfaction at final follow-up and, importantly, no increased complication rate related to surgical treatment was observed. Therefore, percutaneous treatment of acute scaphoid fracture seems to have a low morbidity level and, in the hands of an experienced surgeon, will not result in a higher complication rate than nonsurgical treatment. Furthermore, up to one third of proximal pole fractures may result in a nonunion even with appropriate immobilization. Several studies showed good results with early surgical intervention, and a careful dorsal approach does not seem to injure the blood supply.

AUTHORS’ PREFERRED APPROACH TO ACUTE SCAPHOID FRACTURES

In considering overall treatment options, perhaps all proximal pole and displaced scaphoid fractures are best treated with surgery (Figs. 2 and 3). Percutaneous screw fixation is preferred. The scaphoid is reduced and preliminarily pinned dorsally to volarly, and then a screw introduced volarly, unless the fracture is of the proximal pole, in which case the opposite approach is taken.

SCAPHOID NONUNIONS

Despite optimal therapy, nonunion or malunion may ensue. Patient and nonunion characteristics must be considered when treating the established scaphoid nonunion. Because the bony attachments of the dorsal intercarpal ligament and dorsal scapholunate ligament are maintained in the

Fig. 2. This acute scaphoid fracture was identified in a 29-year-old man who fell from a ladder injuring his nondominant hand.
setting of a fracture of the proximal one third of the scaphoid, these fractures rarely show instability patterns, such as dorsal intercalated segmental instability. Nonunion of a scaphoid fracture, however, can result in carpal malalignment and progressive radiocarpal arthritis, but the real effect of a malunion is less clearly defined. In a series of 160 scaphoid nonunions treated with internal fixation and bone grafting in which 90% healed, failure to achieve union was related to a proximal fracture location, avascularity of the proximal pole, instability of the fracture, and delay to surgery. Residual flexion deformity of the scaphoid did not affect the outcome, and therefore malunion was not believed to contribute to a poor result. This study, however, showed that the length of immobilization negatively affects the functional outcome.

SUMMARY

Operative fixation is the authors’ preferred treatment for acute fractures in which the fracture is clearly visible on plain film radiographs. We believe that a clearly visible fracture line is evidence of a displaced fracture that should be treated operatively. Several authors have shown low morbidity and satisfactory outcomes after operative fixation. Surgical time and morbidity are minimal and complications are infrequent. In addition, acute treatment may result in decreased risk for nonunion.

When a patient presents with clinical symptoms suggesting scaphoid fracture, initial radiographs are obtained. A scaphoid fracture readily identified on plain films represents displacement, and acute operative treatment is recommended, with the authors preferring percutaneous placement of a cannulated screw. If no fracture is seen and clinical findings suggest scaphoid fracture, an MRI should be obtained. If the MRI shows a fracture, nonoperative treatment may be undertaken with a short-arm thumb spica cast, with the wrist in neutral position immobilizing the thumb to the interphalangeal joint, unless the fracture is at the proximal pole. This cast is maintained for 6 weeks and then a CT scan is obtained. If the CT still suggests an healed fracture, cast immobilization is maintained for another 6 weeks, except when a fracture of the proximal pole is identified on MRI. In these cases, percutaneous operative fixation should be undertaken to lessen the chance of nonunion. After operative fixation, the patient is placed in a volarly based thumb spica splint. If the patient is unlikely to comply with postoperative activity restrictions, then a short-arm thumb spica cast is placed. If the patient is reliable, a removable splint may be provided. Activity is restricted to lifting no more than 2 lb, no repetitive use, and using the hand only for activities of daily living and personal hygiene. At 6 weeks, a CT scan is obtained to evaluate for evidence of union. If evidence of healing is present, such as disappearance of the fracture line, spot welding between fragments, or callous formation, then immobilization is discontinued and the patient allowed a gradual return to activities. The literature suggests that partial union is often present but usually progresses to full union without the need for additional immobilization. If no evidence of healing is noted, immobilization is continued and another CT scan obtained 4 to 6 weeks later.

REFERENCES


