

Postoperative Immobilization of Scaphoid Fractures: A Comprehensive Review of the Literature

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Abstract

The optimal protocol for postoperative immobilization following operative treatment of scaphoid fractures remains controversial. Reports of successful management with brief postoperative immobilization suggest that earlier restoration of function may be achieved by limiting the duration of immobilization. However, the risk of nonunion and its associated complications suggest that a more conservative approach with extended immobilization could optimize fracture healing. This paper presents a thorough review of the relevant literature and summarizes the myriad postoperative immobilization protocols and their reported outcomes. Postoperative immobilization protocols and reported outcomes for displaced, comminuted, and proximal pole fractures are discussed separately. The literature is reviewed following different operative techniques, including open reduction internal fixation and percutaneous screw fixation. Vigilant postoperative care of scaphoid fractures managed surgically is warranted to monitor for signs of nonunion while attempting to regain motion and strength to the injured wrist.

Keywords: scaphoid fracture, carpal fracture, postoperative immobilization, union, nonunion

Introduction

The scaphoid is the largest bone in the proximal carpal row, and approximately 75% of its surface is covered with cartilage.¹ The blood supply to the scaphoid is largely retrograde, with the proximal 70% to 80% of the bone receiving its blood supply from a branch of the radial artery entering the scaphoid on the dorsal ridge at the level of the waist.² Scaphoid fractures, therefore, have reduced capacity for periosteal healing and timely union secondary to a predominantly cartilaginous lining and largely retrograde blood supply.³ Fractures of the scaphoid occur with an estimated incidence of approximately 30 per 100,000 with a unimodal young male predominance and a median incidence in the third decade of life.⁴ Risk factors for nonunion include proximal pole fractures, displaced fractures, and delayed medical care. A scaphoid nonunion can result in wrist pain, decreased grip strength, and functional limitations. The risk of nonunion in displaced fractures may be as high as 50%.⁵ Up to 75% of patients with untreated or unsuccessfully treated scaphoid fractures show degenerative radioscaphoid changes within 4 years of injury. Furthermore, nonunion of the scaphoid is associated with increased risk of posttraumatic avascular osteonecrosis.⁶

The optimal treatment of displaced and proximal pole scaphoid fractures is typically surgical, and certain nondisplaced waist fractures may also benefit from operative intervention. Optimal management remains a topic of ongoing investigation due to a paucity of high-quality prospective randomized control trials investigating the modality and duration of immobilization following operative treatment of scaphoid fractures.⁷ This paper reviews the current literature on postoperative immobilization of scaphoid fractures and proposes best practices for its application.

Non-Displaced Scaphoid Fractures

Nondisplaced or minimally displaced scaphoid fractures may be managed conservatively with immobilization, with up to 96% of acute nondisplaced scaphoid fractures achiev-

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ing union.⁸ However, new evidence suggests that early percutaneous screw fixation (PCSF) of these fractures may lead to a decreased time to union, more rapid functional improvements, and lower rates of complications.⁹⁻¹⁴ For patients who undergo PCSF, optimal postoperative immobilization is controversial.⁹ For example, while Herbert and Fisher¹⁵ and Filan and Herbert¹⁶ suggest that postoperative immobilization is unnecessary, Adolfsson et al compared conservative management to PCSF using an Acutrak standard screw in 53 patients with nondisplaced acute scaphoid waist fractures. Those treated non-operatively wore a below-elbow plaster cast for 10 to 16 weeks, while the operative group was immobilized in a thumb-to-elbow plaster splint for 3 weeks postoperatively. The operative group was then transitioned to a removable plastic splint for 3 additional weeks while participating in sports or strenuous activity. Twenty of the 23 patients managed operatively with subsequent immobilization showed radiographic signs of union by 10 weeks, with union ultimately achieved in 96% of patients who underwent PCSF.⁹

Alnaeem et al¹⁰ performed a systematic review to compare cast immobilization with percutaneous or miniopen screw fixation for management of nondisplaced scaphoid fractures. They found operative management was associated with a faster return to work and time to union without a significant difference in union or complication rates. Postoperative immobilization protocols for the 171 patients in the surgically managed group varied from 3 to 21 days of immobilization with a mean of 8 days; in 5 of the 6 studies included, immobilization lasted for less than 11 days after surgery. The average time to radiographic union for patients in the surgical group was 44 days, with a total of 24 complications (14%) in this group including 4 non-union and 2 bone necrosis.

Arora et al¹¹ randomized patients to PCSF with immediate active range of motion or conservative treatment with below-elbow cast immobilization only until radiographic signs of union were observed. Patients treated with PCSF began active finger motion before discharge but wore a palmar splint until suture removal and wound healing. They began physiotherapy after splint removal but were restricted from full load bearing and manual work or sport activities until radiological signs of union were observed. Fracture union was observed at a mean of 43 days (range: 31-52 days), and all but 1 of the 21 patients treated with operative management achieved union.

Bond et al¹² performed a prospective randomized study comparing cast immobilization with PCSF of nondisplaced fractures. Patients managed with PCSF were placed in a short-arm thumb-spica plaster splint that was maintained for 7 to 10 days. Patients were then placed in a removable custom-fabricated Orthoplast short-arm thumb-spica splint, which was worn full time except during bathing and during early active range-of-motion and strength-maintenance pro-

grams. This splint was not discontinued until fracture union was observed. Fracture union was achieved at an average of 7 weeks, and there were no cases of nonunion among the 11 patients randomized to this treatment.

Dias et al¹⁴ performed a randomized control trial comparing open reduction internal fixation (ORIF) with nonoperative management for patients with acute, minimally displaced scaphoid waist fractures. Of the 44 patients managed with ORIF, 95% were treated with a bulky bandage alone for 2 weeks and were allowed active movement of the wrist and hand, while the remaining 5% were placed in a plaster volar splint for 6 weeks due to concern about the security of fixation. By the end of the study, all 44 patients in the surgical fixation group achieved union.

Iacobellis et al¹⁷ reported on 44 patients with acute scaphoid fractures and included long-term follow-up data on 36 of those patients. Five of the 36 patients had fractures at the distal third (Herbert Type B1) and the remaining 31 had fractures at the waist (Herbert Type B2). All patients were treated with PCSF and were immobilized in a short thumb-spica cast for 2 weeks. All fractures achieved union, and all patients returned to normal daily activities within 4 weeks.

Marzouki et al¹⁸ studied PCSF of nondisplaced or minimally displaced acute fractures at the scaphoid waist. After the procedure, patients underwent 3 weeks of splint immobilization before resuming normal activities. Intense activities and sports were restricted for 3 months. The average time to union was 13 weeks, and 20 of 21 patients achieved union by study end.

McQueen et al¹⁹ performed a prospective randomized control trial comparing PCSF to cast immobilization for patients with nondisplaced or minimally displaced fractures at the scaphoid waist. Patients received no postoperative immobilization and were encouraged to mobilize to their limits of comfort. Mean time to union in the operative group was measured at 9.2 weeks, with a range of 8 to 18 weeks. All but 1 of the 30 patients treated with PCSF achieved union during the study interval.

Postoperative immobilization protocols following screw fixation for minimally displaced scaphoid fractures commonly involve minimal immobilization (Table 1). However, these operations are generally performed with the aim of earlier return to high level activities. The limited literature available shows comparable results between more aggressive early range of motion and more conservative prolonged postoperative immobilization, therefore further research investigating the optimal immobilization protocol will be useful for guiding future management and for identifying the characteristics, if any, that are associated with favorable outcomes from early range of motion following surgical management.

Given the surprisingly successful results of minimal immobilization with early active motion, there appears to

Table 1. Postoperative Immobilization for Minimally and Nondisplaced Scaphoid Fractures.

Study	Number of patients (N)	Fixation technique	Immobilization technique/duration	Time to union (mean)	Rate of union (%)
Adolfsson et al ⁹	23	PCSF	Thumb-to-elbow plaster splint for 3 w. followed by 3 w. with removable plastic splint during strenuous activity for 3 w.	10 w. (N = 20), 16 w. (N = 2)	96
Alnaeem et al ¹⁰	171	PSCF / MSF	Cast immobilization; mean 8 days (range: 3–21 days)	7.1 w.	97
Arora et al ¹¹	21	PCSF	Palmar splint until suture removal, but active range of motion immediately after surgery	6.1 w.	95
Bond et al ¹²	11	PCSF	Short-arm thumb spica for 7 to 10 days, then removable thumb-spica until union	7 w.	100
Dias et al ¹³	188	PCSF / ORIF	86% with minimal or no immobilization	NR	99
Dias et al ¹⁴	44	ORIF	95% of patients were treated with bulky bandage alone and active movement	NR	100
Iacobellis et al ¹⁷	44	PCSF	Short thumb-spica cast for 2 w.	8 w.	100
Marzouki et al ¹⁸	21	PCSF	Splint immobilization for 3 w.	13 w.	95
McQueen et al ¹⁹	30	PCSF	None, mobilization encouraged	9.2 w.	97

Note. w. = weeks; PCSF = percutaneous screw fixation; MSF = miniopen screw fixation; ORIF = open reduction internal fixation; NR = not reported.

be evidence to support the pursuit of a prospective randomized trial comparing minimal immobilization with cast immobilization following operative management of nondisplaced scaphoid fractures.

Displaced Scaphoid Fractures

Displaced scaphoid fractures are typically treated with operative management as these fractures have a risk of nonunion as high as 55% when treated conservatively.^{5,20} A variety of immobilization protocols for the immediate postoperative period can be found in the literature, though there are no studies that investigate postoperative immobilization as the independent variable. Postoperative immobilization protocols following operative fixation of displaced fractures include compression bandage only,¹⁵ short-term immobilization for four weeks or less,^{17,21} or long-term immobilization, often until radiographic signs of union are present.^{22–26}

Chen et al²² reported on 11 patients who sustained acute displaced scaphoid fractures and underwent closed reduction with percutaneous fixation via a cannulated compression screw. Nine fractures were at the scaphoid waist, 1 was at the distal pole, and 1 at the proximal pole. Patients were placed in a soft-arm thumb spica splint for 1 week, at which point they began an active thumb motion training program but continued to wear the splint for the remainder of the day. Trabecular bridging was confirmed radiographically for all fractures in the second postoperative month; patients were then placed in a custom-fabricated thumb spica brace which was worn at night, during work, and for recreation for an additional four weeks. All fractures healed within a

mean of 10.6 weeks (range: 10–12), confirmed via radiographic assessment.

Herbert and Fisher treated 158 patients with scaphoid fractures, of which 22 were found to have acute unstable fractures (Herbert Type B, with ORIF with a Herbert screw.¹⁵ Of the 22 Type B fractures, 2 received bone graft secondary to severe trauma resulting in significant comminution. Postoperatively, 15 of the 22 patients with Type B fractures were placed in a Colles-type plaster cast for an average of four weeks due to significant concomitant ligamentous injury; the remaining seven patients received no immobilization and immediately began active mobilizing exercises. In these patients, a firm compression bandage was applied until the sutures were removed, after which they were provided a lightweight removable Orthoplast splint. The average time for return to work for the overall study population was between five and seven weeks; data specific to the group with Type B fractures was not reported. However, union was achieved in all patients with Type B fractures.

Rettig et al²³ reported on 14 consecutive patients with acute displaced fractures of the scaphoid waist who received ORIF with Herbert compression screws (8 patients) or multiple Kirschner wires (6 patients). Postoperatively, patients were immobilized via thumb spica cast until union, which was confirmed with trispiral tomography. Union was confirmed in 13 patients (93%) after an average of 11.5 weeks (range 8–20 weeks), and nonunion occurred in 1 patient (a 70-year-old osteopenic woman).

Shih et al²⁴ treated 15 patients with acute displaced scaphoid fractures with arthroscopic reduction and percutaneous fixation via Herbert-Whipple screw. Nine patients

had scaphoid waist fractures, 4 had proximal third fractures, and two had distal third fractures. Ten patients were immobilized with plaster casts due to soft tissue injury. These patients remained in the cast for 4 to 8 weeks depending on the extent of soft tissue injury and began active joint exercises after cast removal. Union was confirmed by radiograph in all 15 patients within 12 months of surgery.

Slade et al²¹ reviewed the cases of 20 patients with displaced scaphoid fractures treated with arthroscopic-assisted percutaneous fixation via cannulated screw. Patients used a short-arm thumb spica splint for 2 to 4 weeks after surgery and active wrist motion exercises were typically initiated 10 days after surgery. Radiographs confirmed fracture healing in all patients.

Trumble et al²⁵ reported on 35 patients who suffered acute displaced fractures at the scaphoid waist and were treated with ORIF with cannulated screws: 19 patients with 3.5 millimeter AO/ASIF screw and 16 patients with Herbert-Whipple screw. Postoperatively, patients were immobilized via below-the-elbow thumb spica cast for 6 to 8 weeks, and then were placed in a removable thumb splint for 4 weeks. Average time to union (confirmed with tomography) was approximately 4 months, with 5 patients experiencing delay to union of 5 months or more.

Literature recommendations for the postoperative immobilization of displaced scaphoid fractures varies (Table 2). Some authorities recommend only splint immobilization until suture removal at 2 weeks for most patients, with the option for 4 to 8 weeks of cast immobilization in unreliable patients or unstable fractures.³

The published data show high rates of fracture union with 2 weeks of immobilization or less; furthermore, there is not clear evidence of a relationship between duration of immobilization and time to union.^{17,15,21,25} However, the data demonstrates an increased time to union is associated with increased age or increased preoperative displacement.²⁵ Therefore, for most patients, minimal postoperative immobilization may be sufficient to achieve fracture union while preventing stiffness associated with prolonged immobilization. For elderly patients, patients with extensive damage to radiocarpal ligaments, and patients with extremely displaced or severely comminuted fractures, immobilization for a longer duration may be beneficial.

Proximal Pole Scaphoid Fractures

Proximal pole fractures are inherently unstable due to the tenuous retrograde blood supply of the proximal scaphoid, small fragment size, large extension moment of the proximal row, and unbalanced linkage along the dorsoulnar scapholunate ligament; they are therefore associated with an increased likelihood of both prolonged time to union and risk of non-union.²⁷ Nonoperative management of fractures

of the proximal fifth of the scaphoid bone are associated with a relative risk of nonunion of 7.5 when compared to more distal fractures receiving the same management.²⁸ Proximal fragment fractures are associated with increased time to union due to a high likelihood of disrupted blood flow to the proximal fragment, but stabilization can produce revascularization and healing.^{3,29-31} Although the rarity of proximal pole fractures has produced limited evidence, the available literature suggests that ORIF may maximize patient outcomes, especially in cases where there is evidence of any displacement.^{32,33} Literature regarding the optimal postoperative immobilization protocol for acute proximal pole fractures managed with ORIF is especially limited (Table 3).

Brogan et al³⁴ retrospectively reported on 23 patients with fractures of the proximal pole who underwent screw fixation. Their sample included 8 patients with perilunate fracture dislocations and did not exclude polytrauma patients. Immobilization for 20 of the 23 subjects included a thumb spica splint or cast for an average of 11.2 weeks. The rate of bony union at 14 weeks was 43%, but was 70% for the subset including only nondisplaced fractures. Ultimately, 87% of patients went on to complete union.

Filan and Herbert reported on 11 acute proximal pole fractures managed with ORIF with a mini Herbert bone screw.¹⁶ Postoperatively, patients were managed with firm padded bandage for 2 weeks before transitioning to active mobilizing exercises. However, patients were restricted from full loading of the wrist and from participation in contact sports for six to eight weeks following the procedure. The reported rate of union was 85% (Herbert Type B3).

Rettig and Raskin³³ reported on 17 consecutive patients who underwent ORIF with dorsal screws for acute unstable proximal pole scaphoid fractures. Following the operation, patients were placed into a plaster thumb-spica splint until suture removal at 10 days, at which point they were transitioned to a short arm thumb-spica splint for 4 weeks. While most patients (70%) were subsequently transferred to a removable plastic splint, which was worn until union was confirmed with computerized tomography, 30% of patients were re-casted. The average time to union was 10 weeks (range: 8 to 13 weeks) although displaced fractures healed at an average of 11 weeks compared to nondisplaced fractures, which healed at an average of 9.5 weeks. Of note, 13 of the 17 patients received bone graft.

Given that proximal pole fractures are associated with prolonged healing and increased risk of nonunion and avascular necrosis, more conservative management may be beneficial. Rettig and Raskin³³ found excellent success (100% union) with 5 weeks of postoperative immobilization via cast or splint followed by removable splinting until union. Patients may benefit from prolonged immobilization until

Table 2. Postoperative Immobilization for Displaced Scaphoid Fractures.

Study	Number of patients (N)	Fixation technique	Immobilization technique / duration	Time to union (mean)	Rate of union (%)
Chen et al ²²	11	PCSF	Thumb-spica splint to union (range 4-8 w.), then removable thumb splint	10.6 w.	100
Herbert and Fisher ¹⁵	22	ORIF	Colles-type cast for 4 w. (N = 15) and no immobilization (N = 7)	NR	100
Rettig et al ²³	14	ORIF	Thumb-spica cast until union	11.5 w.	93
Shih et al ²⁴	15	AAPCSF	Thumb-spica cast for 4-8 w. if injury to radiocarpal ligaments (N = 10); Immobilization NR (N = five)	NR	100
Slade et al ²¹	20	AAPCSF	Thumb-spica splint for 2-4 w.	NR	100
Trumble et al ²⁵	35	ORIF	Thumb-spica cast for 6-8 w., then removable thumb-spica for 4 w.	17.8 w.	100

Note. w. = weeks; PCSF = percutaneous screw fixation; ORIF = open reduction and internal fixation; AAPCSF = arthroscopically assisted percutaneous screw fixation; NR = not reported.

Table 3. Postoperative Immobilization of Acute Proximal Pole Scaphoid Fractures.

Study	Number of patients (N)	Immobilization technique / duration	Time to union (mean)	Rate of union (%)
Brogan et al ³⁴	23	Thumb spica splint or cast for an average of 11.2 w.	NR	87
Filan and Herbert ¹⁶	11	Firm padded bandage for 2 w.	NR	85
Rettig and Raskin ³³	17	Plaster thumb-spica splint for 10 days, then short arm thumb-spica cast for 4 w., followed either by re-casting or removable splinting until union	10 w.	100

Note. w. = weeks; PCSF = percutaneous screw fixation; ORIF = open reduction and internal; NR = not reported.

union is confirmed after undergoing operative treatment for high-risk proximal pole fracture.

operative treatment followed by immobilization via short-arm cast.

Comminuted Scaphoid Fractures

Comminuted scaphoid fractures have been well-documented to be associated with fracture instability, longer time to union, and higher rates of non-union. Given the high rates of continued fracture instability with non-operative management, early surgical intervention including radial bone grafting often required for successful treatment and stabilization of these fractures. This is underscored by Dias, et al³⁵ who reported that 46% of their patients with comminuted fractures managed via their non-operative protocol went on to develop non-union. Postoperatively, the consensus is that immobilization should be continued in a short arm cast or a thumb-spica cast until there is evidence of fracture union.³⁶ Given that fixation of comminuted fractures is inherently suboptimal, the use of external immobilization via casting may allow for improved healing of the bone. Rettig et al²³ showed that 93% of surgically managed displaced scaphoid fractures who received postoperative immobilization with thumb spica casting showed signs of union at an average of 11.5 weeks after the procedure. Additionally, the treatment algorithms presented by Clementson et al²⁷ suggest that scaphoid waist fractures that are comminuted or displaced by ≥ 0.5 mm are best managed with

Conclusion

The scaphoid is the most commonly fractured carpal bone, and its tenuous blood supply leads to decreased healing capacity with increased risk of nonunion and subsequent wrist arthrosis or chronic wrist pain if the fracture does not heal. There is no consensus on the optimal duration or method for postoperative immobilization of scaphoid fractures. We believe immobilization should depend on the fixation (screw, k-wire and whether or not the fixation is solid), fracture location (waist or proximal pole), and patient characteristics. Proximal pole fractures are the most difficult to heal and take the longest. For waist fractures closed reduced and fixed percutaneously with a screw and good fixation, immobilization is simply for comfort; however, if a patient plans to engage in heavy activity or contact sports, a cast is required until at least 50% union is achieved. This paper presents a review of the varied postoperative immobilization protocols reported in the literature based on fracture pattern and operative technique with their associated outcomes. Future studies are necessary to determine the appropriate technique and duration of postoperative immobilization for patients with scaphoid fractures.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

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