

# Percutaneous Fixation Of Scaphoid Non-union. A systematic Review

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## Abstract:

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The primary risk factor for nonunion of the scaphoid is displacement/instability, but delayed or missed diagnosis, inadequate treatment, fracture location, and blood supply are also risk factors. Untreated nonunion leads to degenerative wrist arthritis, the so-called ‘scaphoid nonunion advanced collapse’ wrist. Treatment options vary from percutaneous fixation to open reduction and internal fixation with vascularized or nonvascularized bone grafting to salvage procedures involving excision and/or arthrodesis of carpal. Percutaneous fixation of fractures of the scaphoid is well documented in the acute setting by both dorsal and volar methods. What is not commonly discussed is the use of this method for delayed unions and nonunions of the scaphoid. These techniques can avoid the morbidity of an open approach and division of the carpal ligaments. Seven studies were collected from February to July 2018 on percutaneous fixation of scaphoid nonunion from PubMed, Medscape, and Google Scholar and also from materials available in the Internet covering the years between 2000 and 2017. They were included in the review, as they were deemed eligible by fulfilling the inclusion criteria. All these studies were carried out on humans and discussed the results of percutaneous fixation of scaphoid nonunion and were based on sufficient number of patients and reliable results. Healing was achieved in most cases of scaphoid nonunion treated by this method, provided that there was a good selection of cases appropriate for treatment by percutaneous fixation. Percutaneous fixation in appropriate patients provides satisfactory results with high union and minimal complication rates in scaphoid nonunions. Percutaneous screw fixation is indicated in early scaphoid nonunions without substantial cystic bone resorption, without appreciable collapse of the scaphoid architecture, and without clear avascular necrosis of the proximal pole. Moreover, the scaphoid should be with an intact external cartilaginous shell and normal scapholunate angle without a humpback deformity.

**Keywords:** minimally invasive, nonunion, percutaneous fixation, scaphoid, without bone graft

## Introduction

Among all wrist injuries, the incidence of fractures of the scaphoid is second only to that of fractures of the distal radius. Scaphoid fractures constitute 60–70% of all carpal bone fractures and 11% of all hand fractures<sup>[1]</sup>.

The scaphoid has several unique characteristics that affect its healing potential. Approximately 80% of the bone is covered with articular cartilage, and the scaphoid has a tenuous blood supply. The main blood supply to the scaphoid is from the radial artery. The dorsal scaphoid branches from the radial artery enter the nonarticular portion of the scaphoid at the dorsal ridge at the level of the waist and supply the proximal 70–80% of the scaphoid. The volar scaphoid branches from either the radial artery or the superficial palmar branch enter at the distal tubercle and supply the distal 20–30% of the scaphoid. Thus, the vascularity of the proximal pole depends entirely on intraosseous blood flow. This tenuous blood supply to the proximal pole of the scaphoid helps to explain the increased frequency of delayed union, nonunion, and avascular necrosis (AVN) of scaphoid fractures<sup>[2]</sup>.

Scaphoid NU is actually a not well-defined concept, but most authors agree that a NU exists if there is no evidence of scaphoid healing, at least 3 months after the initial fracture. Approximately 3–4% of

nondisplaced scaphoid fractures result in nonunion. Within the group of fractures with significant displacement, the incidence of nonunion is 46–55%<sup>[3,4]</sup>.

Percutaneous screw fixation has been advocated for minimally displaced acute scaphoid fractures and was recently reported for displaced scaphoid fractures. A few reports have described the percutaneous approach for treating scaphoid delayed unions and nonunions<sup>[5,6]</sup>.

Studies have shown that delayed or nonunion scaphoid fractures should be treated with internal fixation. A number of authors have suggested that selected scaphoid nonunions may heal with rigid fixation alone<sup>[7]</sup>. However, open approaches, either dorsal or palmar, have certain problems including soft tissue stripping, damage to ligaments, especially the radioscapheocapitate and radiolunate ligaments, leading to instability and injury to the already damaged blood supply, leading to AVN, infection, reflex sympathetic dystrophy, painful scar formation, and stiffness<sup>[8]</sup>. For these reasons, there has been a trend toward percutaneous fixation of such fractures<sup>[9]</sup>.

We undertook a systematic review for results of percutaneous fixation of the scaphoid in case of nonunion.

## Aim of the study:

The aim of this study was to introduce a systematic review to estimate the results of percutaneous fixation of the scaphoid in case of nonunion.

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## Materials and methods

### Search strategy

We collected papers on percutaneous fixation of scaphoid nonunion from PubMed, Medscape, and Google Scholar and also from materials available in the Internet covering the years between 2000 and 2017. We used the search terms scaphoid/percutaneous fixation/nonunion/nonunion/nonunited/without bone graft. The search was performed in electronic databases from February to July 2018.

### Study selection

All studies were independently assessed for inclusion. They were included if they fulfilled the following criteria.

#### Inclusion criteria of published studies:

- (1) Published in the English language.
- (2) Published in peer-reviewed journals.
- (3) Focused on percutaneous fixation of scaphoid nonunion.

### Data extraction

If the studies did not fulfill the above criteria, they were excluded, such as reports without

peer-review, not within the national research programme, letters, comments, editorials, news, and studies not focused on percutaneous fixation of scaphoid nonunion.

### Quality assessment

The quality of all studies was assessed. Important factors included study design, attainment of ethical approval, evidence of a power calculation, specific eligibility criteria, appropriate controls, adequate information and specified assessment measures. It was expected that confounding factors would be reported and controlled for and appropriate data analysis made in addition to an explanation of missing data.

### Data synthesis

A structured systematic review was performed.

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## Results

In total, 10 potentially relevant publications were identified; three articles were excluded, as they did not meet our inclusion criteria. A total of seven studies were included in the review, as they were deemed eligible by fulfilling the inclusion criteria. All these studies were carried out on humans and examined all the results of percutaneous fixation of scaphoid nonunion. They were reviewed from Medline databases (PubMed, Medscape). A structured systematic review was performed.

Studies here are considered to discuss the results of percutaneous fixation of scaphoid fracture nonunion and to be based on a sufficient number of patients and reliable results, as shown in the following tables:

**Table (1):** Baseline characteristics of included studies

References	Number of patients	Male : female	Patient age years mean (range)	Zone of nonunion or delayed union	Duration of fracture	Method of fixation	Duration of follow-up
Slade <i>et al.</i> [5]	15	14 : 1	20 (17–28)	Waist 10 proximal pole 5	Average 9 months (range: 4–15 months)	Arthroscopically assisted dorsal percutaneous screw fixation	35 weeks
Saint-Cyr [8]	8	6 : 2	27 (17–39)	Waist	Average 6 months	Dorsal percutaneous screw fixation	averaged 13 weeks
Mahmoud and Koptan	27	26 : 1	28.3 (20–40)	Waist	Mean 18.2 months (6–36 months)	Volar percutaneous screw fixation	24.6 months (12–39)
Capo <i>et al.</i> [3]	12	11 : 1	24 (14–47)	Waist	Average 8.7 months (range: 2–14 months)	Percutaneous screw fixation Volar 8 Dorsal 4	35 months (range: 12–96) postoperatively
Taskin Altay	33	31 : 2	16 (25–33)	Proximal pole 15 Waist 18	Mean 7.6 months (range: 2–36 months)	Dorsal percutaneous screw fixation	(mean: 16; range: 7–48 months after the operation)
Galal Hegazy	21	17 : 4	23 (16–45)	Waist	Average 6.8 months (range: 4–8.3 months)	Volar percutaneous screw fixation	mean 25 months (range: 18–35)
Gürger <i>et al.</i>	12	10 : 2	27 (19–41)	Waist 8 Proximal pole 4	mean 7.5 months (range: 4–12 months)	Volar percutaneous screw fixation	Mean 18 weeks (range: 8–36)

(1) Baseline characteristics of the included studies (Table 1).

(2) Results of the included studies (Table 2).

**Table (2): Results of the included studies**

<b>Study</b>	<b>Results</b>	<b>Notes</b>
1-Slade et al	All were united successfully	average time to union was 14 weeks (range 6 -34 weeks)
2- Michel Saint-Cyr	All were united successfully	Average time to union was 11 weeks (range, 6 to 28 weeks) for both groups combined. Time to union was 13 weeks (range, 6 to 28 weeks) for the nonunion group and 7 weeks (range, 6 to 8 weeks) for the delayed union group
3- M. Mahmoud, W. Koptan	all fractures united	mean time to union was 11.6 weeks
4-John T. Capo, Ben Shamian and Marco Rizzo	-11 united successfully -One patient with sickle cell anemia required revision fixation	-Average time to union was 4 months (range 3–6 months) in the eleven patients - One patient with sickle cell united 3 months after revision
5- Taskin Altay	All were united successfully without any additional procedures.	Pain, range of motion, grip strength and return to regular employment were evaluated and all patients had good or excellent results
6-Galal Hegazy	All were united successfully without any additional procedures.	average time to union was 4 months (range 3–6 months) post-screw fixation
7- M Gürger, M Yilmaz, E Yilmaz and S Altun	-11 united successfully -One patient still non-united	-mean time to union was 15.5 weeks (range 8–30) -patient with nonunion underwent grafting with nonvascularized bone graft and union was achieved at 10 weeks.

## Discussion

Studies have shown that delayed or nonunion scaphoid fractures should be treated by internal fixation. However, open approaches, either dorsal or palmar, have certain problems including soft tissue stripping, damage to ligaments, especially the radioscapheocapitate and radiolunate ligaments, leading to instability and injury to the already damaged blood supply, leading to AVN, infection,

reflex sympathetic dystrophy, painful scar formation, and stiffness [10,11]. For these reasons, there has been a trend towards percutaneous fixation of such fractures [8–10].

Most of the literature with regard to percutaneous fixation of scaphoid fractures is performed by the palmar approach. However, Jeon and colleagues reported a comparison of palmar and dorsal percutaneous fixation and found no difference in terms of union time

and clinical outcome, and they concluded that the dorsal approach was better, allowing more precise placement of the screw [12].

One of the major concerns for this approach may be the lack of grafting. However, the need for grafting for such nonunions is not certain [13], and some additional procedures are utilized to promote healing [14,15]. Reaming of the scaphoid in preparation for the screw creates an opportunity to establish bleeding of the bony surfaces [5]. This mechanism probably occurs for all cases united without grafting.

Slade *et al.* [5] proposed a progressive classification for scaphoid nonunions. This classification is a useful guide to determine the applicability of minimally invasive procedures for scaphoid nonunions [16]. Minimally invasive surgery is indicated in early scaphoid nonunions without substantial cystic bone resorption, without appreciable collapse of the scaphoid architecture, and without clear AVN of the proximal pole. Additional inclusion criteria for percutaneous treatment of these nonunions should be an intact external cartilaginous shell and intact and normal scapholunate angle without a humpback deformity [16]. The integrity of the cartilage shell can be evaluated by arthroscopy or by a magnetic resonance imaging study [17]. Many publications report the use of percutaneous techniques in the

treatment of delayed unions and nonunions of the scaphoid [5] (Tables 1 and 2).

## Conclusion

Percutaneous fixation in appropriate patients provides satisfactory results with high union and minimal complication rates in scaphoid nonunions. The percutaneous technique avoids devascularization of the scaphoid, division of the carpal ligaments, and provides a much more aesthetic scar. Percutaneous screw fixation is indicated in early scaphoid nonunions without substantial cystic bone resorption, without appreciable collapse of the scaphoid architecture, and without clear AVN of the proximal pole. Moreover, the scaphoid should be with an intact external cartilaginous shell and normal scapholunate angle without a humpback deformity.

## Conflicts of interest

There are no conflicts of interest.

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