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Arthroscopic and Minimally Invasive Management of Scaphoid Non-Union: A Case Series

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Abstract

Introduction:The scaphoid has a poor blood supply. Consequently, the healing process will be disrupted if the fracture occurs, leading to complications, such as delayed union, nonunion, malunion, avascular necrosis, and even wrist arthrosis. Principles of scaphoid nonunion management are correction of scaphoid malalignment, debridement of necrotic bone and scar tissue, exposure of healthy, well-vascularized scaphoid bone, bone grafting, and stabilization. Arthroscopic-assisted bone grafting for scaphoid nonunion has a reliable clinical outcome with a union rate of around 80% to 100%. Therefore, in our case series, we describe an arthroscopic and total minimally invasive management for scaphoid nonunion based on the case in our institution. ***Method:***This study included a total of 6 patients with nonunion scaphoid fractures who underwent arthroscopic and minimally invasive surgery at Fatmawati Hospital and Soeharso Orthopaedic Hospital. Several measurements were used to evaluate patients' functional capability, including grip strength, wrist extension, wrist flexion, ulnar deviation, radial deviation, pronation, and supination preoperatively and postoperatively. The outcome were VAS, quick DASH, and PRWE. ***Result:*** In our study, the union rate was 100%. The VAS pain score was also improved significantly (p=0.023) from preoperative (5.78) to postoperative (0.4). The significant improvement was also shown for Quick DASH (p=0.005) and PRWE (p=0.031). The grip strength in our study was improved after surgery (52 to 77) and had comparable strength to the contralateral unaffected hand (77 to 80). ***Summary:*** We found that arthroscopic and minimally invasive surgery in nonunion scaphoid fracture shows a quite promising method to achieve union to the fracture and positively affect the recovery of grip strength and range of motion of the wrist.

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Introduction

A scaphoid or navicular bone is one of the small bones of the carpal. It lies obliquely across the two rows of carpal bone and in the line of loading between the thumb and forearm.[1] Scaphoid fracture is quite common which almost 75% of all carpal fractures.[2] Because of its position, the combination of forced carpal movement and compression exerts stress on the bone, and it tends to fracture. This can occur as in a fall on the dorsiflexed hand.[2,3]

The classification for scaphoid fracture is based on the location and the severity. The scaphoid fractures can occur in three anatomical locations, distal tubercle, waist, and proximal pole. Fracture in the distal tubercle and waist may predispose to nonunion and malunion regarding its unstable characteristics. If the fracture occurs closer to the forearm in the proximal pole, the healing process can be more difficult because these areas do not have a good blood supply. Other than that, based on the severity, scaphoid fractures divides into non-displaced fracture and displaced fracture.[2,3]

The scaphoid has a poor blood supply. The blood supply of the scaphoid arises from the dorsal distal pole, which means that the proximal pole has a poor blood supply. Consequently, if the fracture occurs, the healing process will be disrupted and it leads to complication, such as delayed union, nonunion, malunion, avascular necrosis, and even wrist arthrosis.[2–4]

Nonunion after the scaphoid fractures are mostly asymptomatic in older patients with low demands. However, in the younger and more vigorous patients, it may be obvious that the fracture is not unite. The patients will be seen as symptomatic osteoarthritis. Sometimes a patient is seen with a sprain, but X-rays show an old, ununited fracture with sclerosed edges.[2,3]

According to Nagle et al.[5], principles of scaphoid nonunion management are correction of scaphoid malalignment, debridement of necrotic bone and scar tissue,

exposure of healthy, well-vascularized scaphoid bone, bone grafting, and stabilization.[5] In 2003, Slade et al. described the arthroscopy technique for scaphoid nonunion. After that, many studies found that arthroscopic-assisted bone grafting for scaphoid nonunion has a reliable clinical outcome with a union rate around 80% to 100%.[6] In the previous study, the arthroscopy and minimally invasive surgery have many advantages, such as comprehensive wrist assessment with magnification, evaluation for minimal trauma to the ligament structure and circulation of the scaphoid. A vascularized bone grafting may increase the union rate. Though, non-vascularized bone graft has a similar outcome in the union rate.[7] The corticocancellous iliac crest graft could be the treatment of choice for osteosynthesis.[2,8,9] Therefore, in our case series, we describe an arthroscopic and minimally invasive management for scaphoid nonunion based on the cases in our institution.

Materials and methods

Patient selection

This study included a total of 6 patients with nonunion scaphoid fractures who underwent arthroscopic and minimally invasive surgery at Fatmawati General Hospital and Soeharso Orthopaedic Hospital, from March 2019 to December 2021. Informed consent was taken from the patients and the approval ethics of the committee. Several measurements were used to evaluate patients' functional capability, which includes grip strength, wrist extension, wrist flexion, ulnar deviation, radial deviation, pronation, and supination preoperatively and postoperatively. The patients were followed up until 20 ± 10.3 months.

The outcomes were VAS, quick DASH, and PRWE. The statistical analysis with Student's t tests was used to evaluate the preoperative, postoperative, and side-to-side differences. The p-value of ≤0,05 were considered statistically significant. We also used a two-tailed test in all cases.

Operative procedure

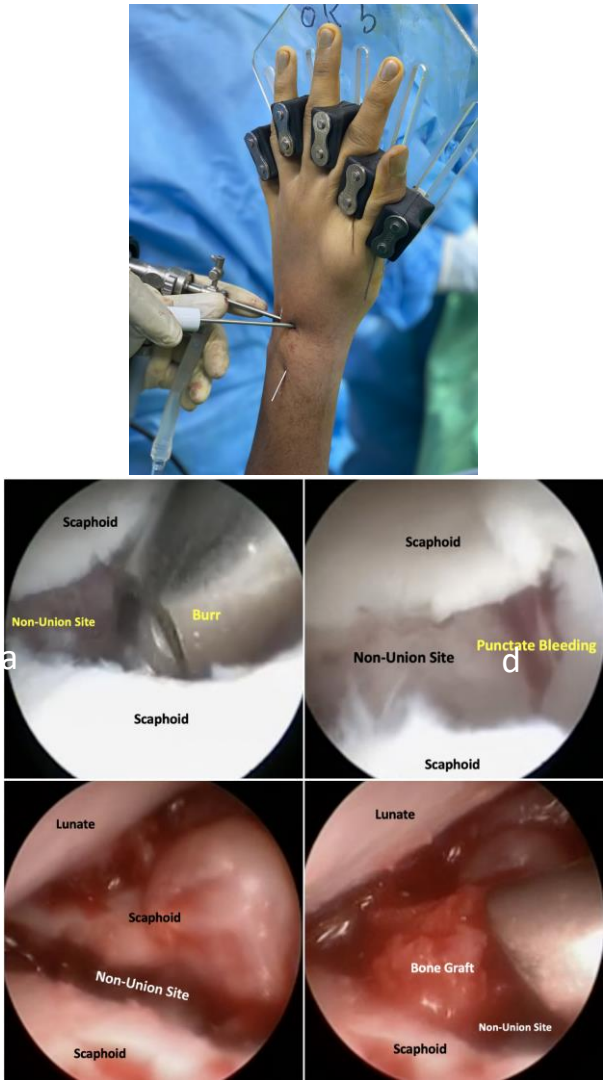

Figure 1. Arthroscopy and minimally invasive surgery in nonunion scaphoid fractures. (a) Temporarily K-Wire to fix the lunate, (b) debridement of nonunion site, (c) Puncate bleeding, (d) refreshed nonunion site, (e) Bone graft placement

The patients were under general anesthesia in a supine position with the operated arm supported on a hand table. The arthroscopy was applied through finger traps to

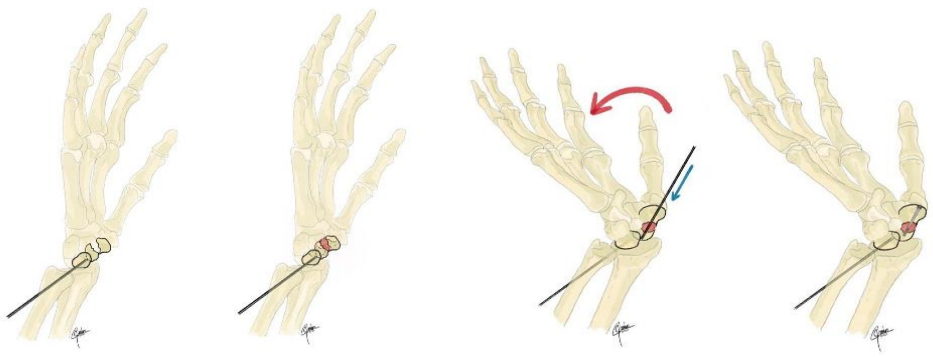

Figure 2: Step by step illustration of the fragment reduction, bone grafting, and fixation.

the index, middle, and ring fingers with a vertical traction force of 12-15 pounds. The nonunion is evaluated through the midcarpal radial ulnar (MCU) portal, and the midcarpal radial (MCR) portal was used for the working portal. The nonunion site is debrided from the overlying fibrous tissue with a 2-mm shaver and 2.9-mm burr until punctate bleeding is seen. The radiocarpal joint was also evaluated for concomitant ligament or cartilage damage. Using the Linscheid maneuver to correct the DISI deformity, the wrist was on palmar flexion to reduce the dorsal tilt of the proximal pole of the scaphoid. A temporarily 1.6-mm K-wire was inserted from the dorsal site of the distal radius to the lunate to maintain the correction of the lunate. The fluoroscopy guidance was used to locate the distal pole of the scaphoid. A 1.4-mm K-wire was inserted from the distal pole as a joystick to reduce the distal fragment, and intraarticular reduction was made using the probe. After the reduction was satisfactory, an additional 1.0-mm K-wire was inserted from the distal pole with a center-center axis configuration. Bone grafting was prepared from the distal radius and was harvested as much as possible with the volume between 1.5 to 2.5 ml using a bone marrow biopsy trochar. Then, the small pieces of bone graft are transported to the nonunion site through a cannula. The fracture was fixed using a 2.0-2.4 headless compression screw (Acumed, Oregon, USA) under the fluoroscopy (figure 2). After the procedure, a short arm splint was applied for 2 weeks and patients followed the rehabilitation protocol.

Results

This study included a total of 6 patients with nonunion scaphoid fractures who underwent arthroscopic and minimally invasive surgery. The patient's characteristics are shown in Table 1. This study included 5 males and 1 female with a mean age of 30.67 (18-40) years old. Five patients had fractures at the waist, and one patient had fractures at proximal.

Table 1. Patients' characteristics

Age (years)	30.67 (18/40)
Duration (months)	12.5 (6-24)
Male/Female	5/1
Location of the fracture	
Proximal	1
Waist	5
Distal	0

We also evaluated the radiographic features, such as scapholunate angle and scaphoid length, at preoperative and postoperative (Table 2).

Table 2. Radiographic features

Radiographic features	Preoperative (SD)	Postoperative (SD)
Scapholunate angle (SA)	70.1±7.2	58.4±3.4
Scaphoid length (SL)	26.7±2.5	26.8±3.1

In this study, clinical outcomes, such as grip strength and range of motion, were evaluated preoperative and postoperative. The postoperative evaluation was obtained at the last follow-up to the patient. We also assessed the contralateral hand. The results are shown in Table 3. Clinical examination in 6-months postoperatively shown in Figure 4.

Table 3. Grip strength and range of motion

Radiographic features	Preoperative (SD)	Postoperative (SD)	Contralateral hand (SD)
Grip strength	52 (5.4)	77 (4.2)	80 (2.3)
Wrist extension	54 (3.5)	72 (4.3)	83 (3.4)
Wrist flexion	62 (4.4)	74 (3.3)	82 (3.7)
Ulnar deviation	38 (3.8)	39 (3.3)	40 (4.3)
Radial deviation	19 (2.3)	19 (3.1)	21 (4.6)
Pronation	96 (4.3)	97 (3.8)	100 (3.7)
Supination	89 (4.3)	90 (3.7)	95 (4.2)

Figure 3. Clinical examination in 6-months follow-up

The outcomes of this study are VAS pain score, Quick DASH, and PRWE. We evaluated these outcomes at the preoperative and postoperative (Table 4). The union was obtained in all patients (100%).

Table 4. The outcome of the stud

Outcomes	Preoperative (SD)	Postoperative (SD)	p-Value
VAS Pain Score	5.78 (2.12)	0.4 (0.11)	0.023
Quick DASH	22.7 (8.3)	1.3 (1.1)	0.005
PRWE	54 (4.3)	22 (3.3)	0.031

Discussion

A scaphoid fracture is quite common, which almost 75% of all carpal fractures.[2] In our study, we included 6 patients with the range of age was 18 to 40, which were young adults. We did not have the patients with the fracture at the distal tubercle.

Scaphoid nonunion in Indonesia is not frequently seen because the patients usually did not seek medical treatment for the condition for the first time until the condition becomes symptomatic. According to Geissler and Slade classification, one case presented with class 3, three cases presented with class 4, two cases with class 5. Although screw fixation alone is recommended in class 3[10], we performed bone grafting in the patient presented with it because intraoperatively, we found some bone gap after debridement was performed.

The scaphoid has a poor blood supply. Consequently, if the fracture occurs, the healing process will be disrupted, and it leads to complications, such as delayed union, nonunion, malunion, avascular necrosis, and even wrist arthrosis.[2–4] Therefore, the management of scaphoid nonunion are maintaining blood supply, debridement and refreshing of the nonunion site, realignment, bone grafting, and internal fixation.[9,12] However, the surgical approach with open surgery for better exposure may lead to further complications. Moreover, many studies reported minimally invasive surgery techniques for bone grafting and fixation within a nonunion site. These procedures have a union rate of up to 100%.[9,13,14]

In the previous study, arthroscopy and minimally invasive surgery have many advantages, such as comprehensive wrist assessment with magnification, evaluation for minimal trauma to the ligament structure and circulation of the scaphoid.[2,8,9] The comparison of union rate after arthroscopy approach and open procedures showed comparable and promising rates in several studies with the union rates of 90-100% compared to open procedure. In the minimally invasive surgery approach, the probing to test the stability of the nonunion site is a good method to distinguish delayed union from established nonunion because it will differ the surgical treatment. Besides, the assessment and evaluation of scapholunate and lunotriquetral ligament could be made through arthroscopy.[9,14,15]

A systematic review conducted by Ferguson et al. found that the union rate in the vascularized bone graft was higher than non-vascularized bone graft. Although, the results were similar between the two groups. The mean was 84% in vascularized bone graft and 80% in non-vascularized bone graft. However, the vascularized bone graft has several disadvantages, such as greater exposure which increases the risk of vascular injury. Besides, the procedure requires a skilled orthopedic surgeon because the technique is more complicated.[7]

In our study, all patients (100%) have the union at final follow-up, which was similar to the previous study. As mentioned before, the union rate after the arthroscopic treatment of scaphoid nonunion in previous studies was 90-100%.[9,14] The VAS pain score was also improved significantly (p=0.023) from preoperative (5.78) to postoperative (0.4). The significant improvement was also shown for Quick DASH (p=0.005) and PRWE (p=0.031). This might not be in line with the study by Oh et al. (2018), which reported no significant differences in clinical and radiographic outcomes at the two years follow-up.[16] This study had very small subjects and may have introduced selection bias at the enrollment of the patients. Therefore, future studies should include a larger group of patients.

The grip strength and range of motion were also evaluated. The grip strength in our study was improved after surgery (52 to 77) and had comparable strength to the contralateral unaffected hand (77 to 80). Similar results were shown to the range of motion preoperative and postoperative. The results also showed improvement and had a comparable result to contralateral unaffected hand. It was similar to the previous study that reported a recovery of grip strength from 79 to 104%.[17,18]

However, according to Ho et al.[19], there are some contraindications for arthroscopic bone grafting:

1. Long-standing scaphoid nonunion with significant carpal collapse cannot be adequately corrected after arthroscopic fibrosis release and closed reduction. Although according to Delgado et al.[20] it's possible to reduce the humpback deformity like performed in our patients, we found it's difficult if there's abundant arthrofibrosis and after debridement, it could leave a substantial gap between the bone fragment, but we believe experience, patience, and the use of a smaller arthroscope, most fibrotic joints can be loosened up, and the gap can be filled with an improvement of the technique

2. Severe SNAC wrist changes likely preclude good outcomes from the scaphoid union after bone grafting.

Avascular necrosis is not an absolute contraindication, though the chance of persistent nonunion is higher than in cases with good intraoperative bone bleeding.

Conclusion

Based on our six patients, we found that arthroscopic and minimally invasive surgery in nonunion scaphoid fracture shows a quite promising method to achieve union to the fracture and have a positive effect on the recovery of grip strength and range of motion of the wrist.

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