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Original Article

Orthopaedics Section

Functional Outcome of Acute Minimally Displaced Scaphoid Waist Fractures Treated with Percutaneous Headless Compression Screw Fixation: A Prospective Cohort Study

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ABSTRACT

Introduction: Scaphoid fracture incidence has increased recently due to increased participation of people in sports and increased road traffic accidents. Availability of diagnostic tools like Computed Tomography (CT) help in easy diagnosis of scaphoid fractures, which may be missed on routine radiographs.

Aim: To evaluate the functional outcome of surgical intervention with percutaneous headless compression screw fixation for acute minimally displaced scaphoid fractures.

Materials and Methods: The present study was a prospective cohort study in which patients with acute fractures of scaphoid bone managed with percutaneous headless compression screw fixation were included between January 2020 to December 2022 and were evaluated using the Modified Mayo Wrist Score (MMWS) and Disabilities of Arm, Shoulder and Hand (DASH) score. The data obtained was entered into a Microsoft Excel sheet, and statistical analysis was performed using a Statistical Package for the Social Sciences (SPSS) software version 20.0.

Results: The study included 55 patients with a mean age of 32.9 years, out of which 43 were males and 12 were females. Road traffic accident injuries were in 19 patients, 17 were sports injuries and 19 were due to direct trauma. All patients were managed by percutaneous headless compression screw fixation. Among these, 27 patients showed excellent outcomes, 24 showed good outcomes, and four showed fair outcomes.

Conclusion: The present study shows that percutaneous fixation of minimally displaced scaphoid fractures results in early symptomatic relief and functional recovery. It also shows that percutaneous fixation using a headless compression screw has similar functional outcomes and less hospital stay and patient scarring than in open fixation methods. Functional recovery is faster with percutaneous fixation than in non operative and open fixation.

Keywords: Herbert screw, Percutaneous fixation, Sports, Trauma waist

INTRODUCTION

Fractures of the scaphoid comprise around 2-7% of all fractures, with the peak occurrence seen in men of the age group of 20-29 years [1]. Its incidence is approximately 10.6 per 100,000 person-years [2]. An 82-89% of all carpal bone fractures can be attributed to scaphoid bone fractures which make it the most common carpal bone fracture [3]. Adults most frequently experience scaphoid fractures that involve the waist (70%) and others, including fractures of the distal pole of the scaphoid which are 10-20%, fractures of the proximal pole of the scaphoid, which are 5-10%, and scaphoid tubercle fractures which are 5-7% [4]. Fractures of the scaphoid bone are frequently problematic since standard radiographic diagnosis using radiographs is challenging. Therefore, the treatment may be delayed or incorrectly diagnosed [5,6]. Fractures of the scaphoid bone are particularly prone to avascular necrosis, which occurs in 13-50% of the cases [7]. To prevent significant joint degeneration caused by treatment failure resulting in non union, considerable operational precautions must be taken. Other complications of scaphoid fracture include malunion, radiocarpal arthritis and carpal instability [5].

Orthopaedicians should be extremely cautious and precise when analysing the clinical examination and radiography results. Therefore, for a better prognosis, early diagnosis and treatment are essential. Even with appropriate care, 10-35% of these fractures fail to heal [8]. Changes in carpal biomechanics due to scaphoid non union result in discomfort, reduced wrist mobility, decreased grip strength, and carpal arthritis [9]. Percutaneous fixation techniques have replaced open surgical methods as the preferred management method for patients with undisplaced and minimally displaced acute scaphoid fractures and delayed union. These procedures consistently speed up fracture healing and enable patients to return to work or their sport sooner than the conventional cast treatment that was previously recommended to them [10]. The advantage of Herbert Screw (HCS) fixation is that the reduction of the fracture and its fixation may be completed without causing further harm to the wrist's stabilising ligaments and scaphoid blood supply. Results following open reduction and internal fixation of displaced, unstable and delayed union fractures of the scaphoid with the HCS are encouraging [11]. The optimal technique for percutaneous fixation is still being debated. There is a need for more research to compare the efficacy and safety of percutaneous fixation with other treatment options for scaphoid fractures.

Gehrmann SV et al., conducted a retrospective study on treatment of scaphoid waist fractures with headless compression screw and found that the results were similar to that of other operative screw fixation systems [12]. Gad MA et al., in their study suggested that all patients with scaphoid fractures must be offered surgical management option i.e., percutaneous screw fixation for better functional outcomes and early return to daily activities and lower complication rate [13].

This study was carried out to evaluate the functional and clinical outcome of scaphoid waist fractures managed by percutaneous headless compression screw fixation and to substantiate the current literature.

MATERIALS AND METHODS

A prospective cohort study was conducted from January 2020 to December 2022 at Shri BM Patil Medical College and Research Centre, Deemed to be University, Vijayapura, Karnataka, India. Institutional Ethical Clearance (IEC) was obtained (IEC/no.09/2020).

A total of 55 (43 males and 12 females) patients were admitted in the Department of Orthopaedics in BLDE (deemed to be university) Shri BM Patil's Medical College and Research Centre, Vijayapura with the diagnosis of scaphoid fractures, willing to participate, were included in the study. All of the patients presenting with snuff box tenderness and a history of trauma to the hand at Shri BM Patil Medical College and BLDEDU, Vijayapura, got a full general and local assessment of the hand at the orthopaedic emergency and outpatient departments. The assessment was made by history, clinical examination and radiographs.

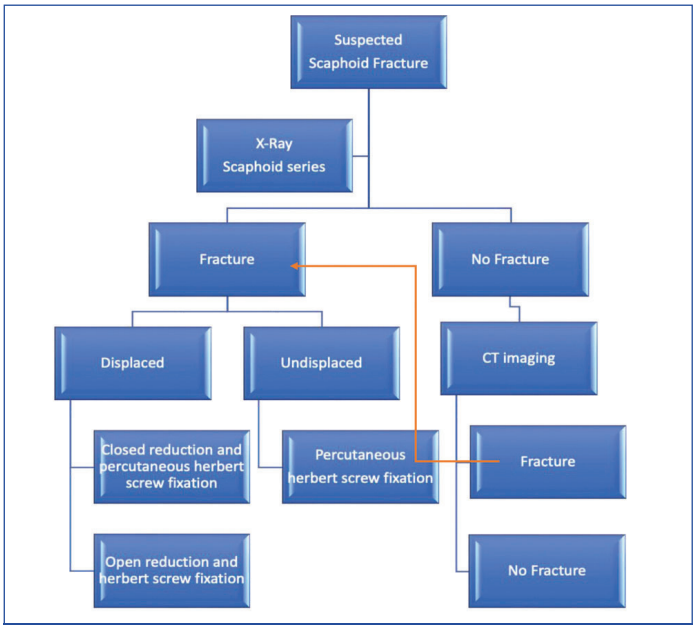
Inclusion criteria: Age more than 18 years, patients with scaphoid waist fractures, patients willing and fit for surgery were included in the study.

Exclusion criteria: Age below 18 years, patients with ipsilateral upper limb injuries, patient not fit for surgery, open fractures were excluded from the study.

Sample size: Assuming the expected population standard deviation to be 10, and employing t-distribution to estimate sample size, the study would require a sample size of: 46 to estimate a mean with 95% confidence and a precision of three.

Management protocol: Scaphoid series of X-rays were used to evaluate radiologically patients presenting with typical signs raising suspicion of fracture of scaphoid bone. Anteroposterior (AP) view, lateral view (LAT), and PA view with the wrist in ulnar (medial) deviation (Scaphoid view) were all included in the Scaphoid series (Scaphoid view).

If a fracture of the Scaphoid bone was evident on the first X-ray, the patient was categorised using the Herbert Fisher classification [14] and treated with a percutaneous HCS for internal fixation as per management protocol in [Table/Fig-1]. The patient was treated symptomatically if the first X-rays showed no fractures. But the existence of a strong suspicion that there may be one, a CT scan was advised. If the CT scan also did not reveal any fractures, the fracture was ruled out. If the CT displayed signs of a fracture, its displacement and its pattern were examined, and fractures of the scaphoid are then categorised and treated as previously indicated. All waist fractures were treated using a percutaneous volar approach [15].



[Table/Fig-1]: Management protocol.

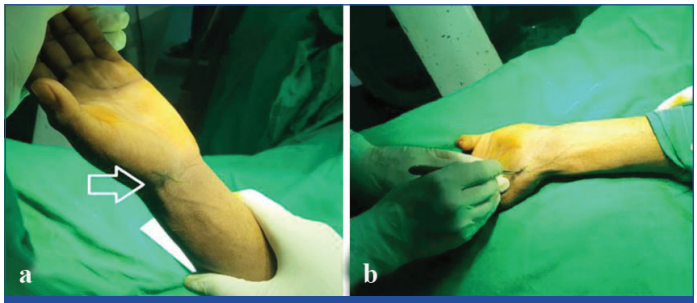
Preoperative work-up: The investigations or interventions needed for the present study are standard, routine procedures. There was no animal experimentation in this study.

Routine investigations include.

- X-ray of wrist anteroposterior, lateral and scaphoid view
- CT WRIST with 3D reconstruction (if required).
- Other specific investigations, whichever was necessary.

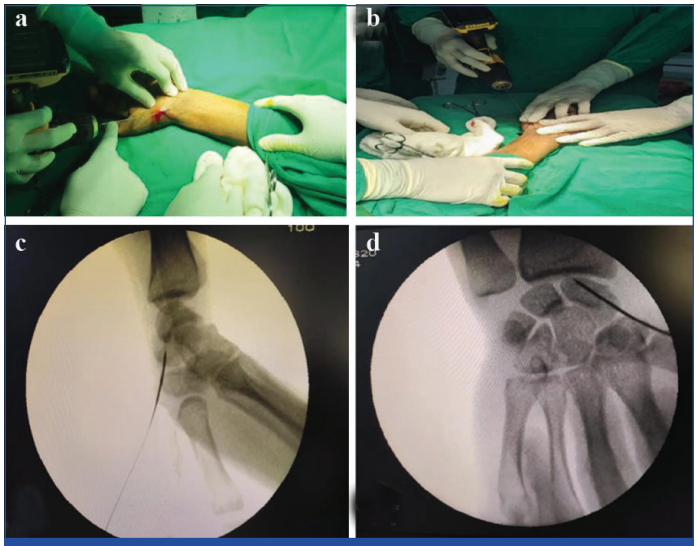
Surgical technique: The following instruments were used for the procedure, surgical knife, drill bits, drill guide, guide wires, small tissue retractors, screwdrivers etc.

Skin incision: A short stab incision was made distal to the scapho-trapezial joint after marking it [Table/Fig-2].



[Table/Fig-2]: a) Marking for skin incision; b) Skin incision.

Guide wire insertion: The insertion point of the guide wire was located over the scaphoid tubercle on its distal surface, near the end of the scapho-trapezial articulation. The guiding wire should be perpendicular to the fracture line and should not cross the proximal pole [Table/Fig-3].



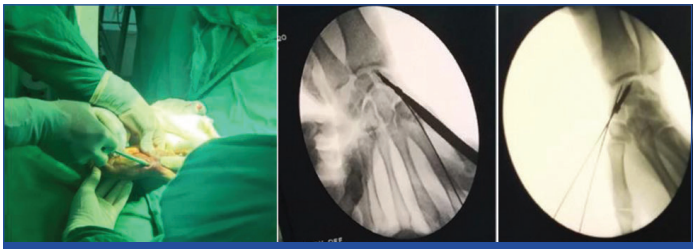
[Table/Fig-3]: (a,b) Guide wire insertion; and (c,d) Showing corresponding C-arm pictures in lateral and anteroposterior views.

Fixation: The required screw length was determined. The scaphoid was drilled using the dedicated drill bit [Table/Fig-4].

The screw was manually inserted after choosing an ideal size, with a screwdriver over the guiding wire such that the threaded portion of the screw completely crossed the fracture line. Subchondral screw position was confirmed in all views and then the guide wire was removed and final tightening was done to achieve interfragmentary compression [Table/Fig-5].

Closure: The incision was sutured. Postoperative wound picture with suture is shown in [Table/Fig-6].

[Table/Fig-4]: Drilling of scaphoid.



[Table/Fig-5]: Screw insertion and corresponding anteroposterior and lateral C-arm pictures.

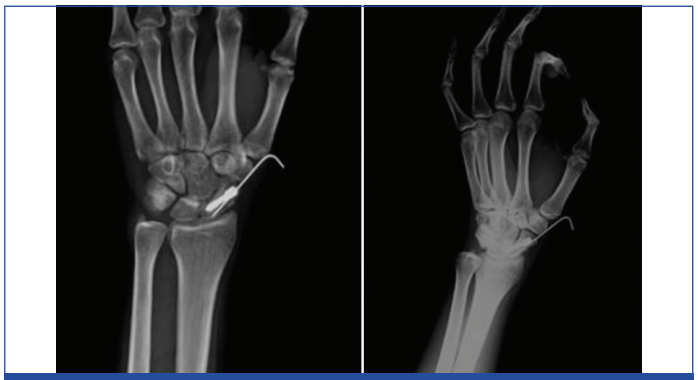
[Table/Fig-6]: Postoperative wound closure picture showing minimal incision.

Radiographic images: [Table/Fig-7] shows preoperative radiograph of hand showing AP, oblique and scaphoid view. [Table/Fig-8] shows immediate postoperative radiograph. [Table/Fig-9] shows one-month postoperative radiograph. [Table/Fig-10] shows six-months postoperative radiograph.

Postoperative care: Following surgery, intravenous antibiotics were prescribed for five days, followed by oral antibiotics for five days.

[Table/Fig-7]: Preoperative radiograph of hand showing AP, Oblique and Scaphoid view.

[Table/Fig-8]: Immediate postoperative radiograph.



[Table/Fig-9]: One-month postoperative radiograph.

[Table/Fig-10]: Six-months postoperative radiograph.

The sutures were removed on the 12th postoperative day. [Table/Fig-11a,b] shows images showing Range Of Motion (ROM) at end of six months.

Scaphoid casts with windows were applied postoperatively to all patients, which was replaced by a removable immobiliser after postoperative day 14 and was continued for four weeks. Physiotherapy for hand grip strengthening exercises and active assisted wrist ROM exercises were started two weeks postsurgery. All patients in the study were followed-up at six weeks, three months and six months postsurgery. Patients were given a clinical and radiological evaluation with a scaphoid fracture profile at each follow-up. When there was no longer any discomfort at the scaphoid tubercle or the anatomical snuff box, and there was confirmation of the bony trabeculae passing across the fracture site on two or more different views, the fracture was considered to have healed. An X-ray (radiographic) assessment of the screw position was done at all follow-ups. Upon the last follow-up, a clinical assessment was made based on the MMWS [16] and DASH [17] score. Grip strength was assessed using a standard handheld dynamometer. The ROM at the wrist was assessed using a goniometer. A p-value <0.05 was considered to be statistically significant.

[Table/Fig-11a,b]: Pictures showing ROM at end of six months.

STATISTICAL ANALYSIS

The data obtained were entered into a Microsoft Excel sheet, and statistical analysis was performed using a SPSS software version 20.0. Kruskal Wallis test was used for analysing the data.

RESULTS

The average time of final follow-up was 8.2 months. A total of 55 patients were included in the study, with a mean age of 32.9 years and a median age of 30 as seen in (distribution showing demographics) and 12 patients (21.8%) were females, and 43 patients (78.2%) were males, clearly showing a male predominance for scaphoid fractures.

Among all the patients, 24 (43.6%) patients suffered a fracture of left the scaphoid and 31 (56.4%) patients suffered a fracture of the right scaphoid bone. Among the 55 patients included in the study, 51 patients had right predominance and four patients had left-hand predominance. There was no significant relationship found between the dominant hand and the side of the scaphoid fracture.

In the present study, all scaphoid fractures were classified based on the mode of injuries into three categories-Road traffic accidents (19), sports injuries (17) and direct trauma (19).

Out of 55 patients in the study, 45 (81.8%) patients had no complaints after six months postsurgery. Six of the patients had pain at the end of six months, of which five cases showed union on radiographs and one was not united yet [Table/Fig-12]. These patients were managed conservatively with non-steroidal anti-inflammatory drugs. The patient with non union was managed by bone grafting after eight months postsurgery. Four patients had stiffness of the wrist joint at the end of six months which was managed by physiotherapy and returned to normal work by the end of nine months.

According to MMWS with a confidence interval of 95%, out of 55 patients, 27 patients had excellent outcomes, 24 patients had good outcomes [Table/Fig-13], 4 patients had fair outcomes, and none had poor outcomes. The mean MMWS was 90.91, and the median was 90 with a standard deviation of 5.781.

The mean of the preoperative data is 60.2, and the standard deviation is 2.8. The mean of the postoperative data is 11.3, and the standard deviation is 1.2. Paired t-test was used to calculate the

Parameters	n (%)
Age (years)	
<20	1 (1.8)
20-29	24 (43.6)
30-39	17 (30.9)
40-49	8 (14.6)
>50	5 (9.1)
Gender	
Male	43 (78.2)
Female	12 (21.8)
Side	
Left	24 (43.6)
Right	31 (56.4)
Mode of injury	
Road Traffic	19 (34.5)
Sports injury	17 (31)
Direct trauma	19 (34.5)
Complications	
None	45 (81.8)
Non union	1 (1.8)
Persistant pain	5 (9.1)
Stifness	4 (7.3)

[Table/Fig-12]: Showing various parameters (N=55).

[Table/Fig-13]: Outcome according to MMWS.

p-value for the hypothesis that the mean of the preoperative data was significantly different from the mean of the postoperative data. Here the p-value <0.05 indicating a significant difference between the preoperative and postoperative scores. [Table/Fig-14] shows DASH scores of pre and postoperative for direct trauma, RTA and sports injury.

Mean DASH score	Direct trauma	Road traffic accidents	Sports injury
Preoperative	61±16.23	59±12.72	63±11.73
Postoperative	13.00±5.260	11.42±5.081	10.24±4.323
p-value	<0.001	0.002	0.003

[Table/Fig-14]: Showing mean preoperative and final postoperative DASH scores.

Patients had a mean final DASH score of 11.60 and a median of 11.00 with a standard deviation of 4.965. Dash score showed a significant improvement postsurgery. The mean final DASH score in road traffic accidents is 11.42 in direct trauma is 13, and 10.24 in sports injury patients [Table/Fig-15].

	DT (n=19)		RTA (n=19)		SI (n=17)		Kruskal-Wallis Test	p-value
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation		
DASH SCORE	13.00±5.260		11.42±5.081		10.24±4.323		2.695	0.260
MMWS	88.95±5.421		91.05±6.988		92.94±3.976		4.347	0.114

[Table/Fig-15]: Showing final mean DASH score and MMWS.

Kruskal-Wallis test showed that the final DASH score and MMWS are not dependent on the mode of injury. Kruskal-Wallis test showed a significant relationship between the age of the patient and their final DASH score and MMWS. It showed better outcomes in younger populations.

DISCUSSION

Scaphoid fractures are frequent and often challenging to diagnose and manage. In young people, where scaphoid fractures are most prevalent, they can result in extended morbidity and disruptions from work [18]. In the present study, 41 (74.5%) patients belonged to the young working class of the community in the age group of 21-40 years.

Time to union: McLaughlin HL, found that Open Reduction and Internal Fixation (ORIF) with a HCS resulted in a shorter time to union (12.4 weeks vs. 17.6 weeks) than cast treatment [19]. Maudsley RH found that ORIF with a HCS resulted in a shorter time to union (12 weeks vs. 16 weeks) than percutaneous pinning [20]. Davis EN et al., found that surgical fixation resulted in a shorter time to union (10 weeks vs. 12 weeks) than casting [21]. Saeden B et al., found that HCS fixation resulted in a shorter time to union (11 weeks vs. 14 weeks) than plaster cast [22].

Functional outcome: McLaughlin HL, found that patients who underwent ORIF had a better functional outcome (mean DASH score of 92 points vs. 80 points) than patients who received cast treatment [19]. Maudsley RH found that patients who underwent ORIF had a better functional outcome (mean DASH score of 90 points vs. 80 points) than patients who underwent percutaneous pinning [20]. Davis EN et al., found that patients who underwent surgical fixation had a better functional outcome (mean DASH score of 95 points vs. 85 points) than patients who received casting [21]. Saeden B et al., found that patients who underwent HCS fixation had a better functional outcome (mean DASH score of 90 points vs. 80 points) than patients who underwent short arm plaster [22].

Complications: McLaughlin HL, found that the rate of complications was lower in the ORIF group (10%) than in the cast treatment group (20%) [19]. Maudsley RH found that the rate of complications was similar in the ORIF and percutaneous pinning groups (10%) [20]. Davis EN et al., found that the rate of complications was higher in the surgical fixation group (20%) than in the casting group (10%) [21]. Saeden B et al., found that the rate of complications was similar in the HCS fixation and short arm plaster groups (10%) [22].

Recent studies conducted by Gad M et al., and Thirunarayanan V et al., showed excellent outcomes achieved by percutaneous fixation for scaphoid waist fractures [13,23].

In this study, percutaneous volar fixation of scaphoid fractures with HCS was used and achieved a union rate of 98.1% and early wrist mobilisation and return to day-to-day activities and work were seen. Significant complications in the study were persistent pain, stiffness and non union. Other complications like hypertrophic scars, screw protrusion, arthritis of the wrist joint, and sensitive scars were not seen in this study. The average size of the screw used for scaphoid fixation was 18 mm. Screws ranging from 14 to 22 mm were used in the present study. Non union was seen in a single patient in the study. The reason might be attributed to the disruption of the precarious blood supply of the Scaphoid during trauma.

The current study provides additional evidence that percutaneous fixation with an HCS is an effective treatment for acute scaphoid fractures. Fixation with HCS results in a shorter time to union, a lower rate of complications, and a better functional outcome than cast treatment, percutaneous pinning or short arm plaster.

Limitation(s)

This was not a comparative study between other modes of management. The follow-up period consisted of only six months and thus, few long-term complications like arthritis, avascular necrosis of proximal fragment etc., could not be evaluated thoroughly.

CONCLUSION(S)

The present study showed that percutaneous fixation of minimally displaced scaphoid fractures results in excellent to good outcomes in majority of the patients leading to early relief of symptoms and early recovery of function. A review of these cases shows that percutaneous fixation using a headless compression screw had good functional outcomes, less hospital stay and patient scarring. Ideal screw size and proper positioning also play a pivotal role in good functional outcomes.

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