How to Cite:
Ahmed, W., Kashyap, N., Kumar, R., & Kumar, I. (2022). A hospital based assessment of the functional outcome of scaphoid nonunion treated with herbert screw and bone grafting. *International Journal of Health Sciences*, *6*(S5), 1590–1596. https://doi.org/10.53730/ijhs.v6nS5.8918

A hospital based assessment of the functional outcome of scaphoid nonunion treated with herbert screw and bone grafting

Dr. Wasim Ahmed
Associate professor, Department of Orthopaedics, Indira Gandhi institute of medical sciences, Patna, Bihar, India

Dr. Nishant Kashyap
Assistant Professor, Department of Orthopaedics, Indira Gandhi institute of medical sciences, Patna, Bihar, India

Dr. Rahul Kumar
Senior Resident, Department of Orthopaedics, Indira Gandhi institute of medical sciences, Patna, Bihar, India

Dr. Indrajeet Kumar
Assistant professor, Department of Orthopaedics, Indira Gandhi institute of medical sciences, Patna, Bihar, India
Corresponding author email: Indrajeet98ortho@rediffmail.com

***Abstract*---**Aim: The aim of this study to evaluate the functional outcome of scaphoid nonunion treated with bone grafting and Herbert screw fixation. Methodology: This study was done Department of Orthopaedics, Indira Gandhi institute of medical sciences, Patna, Bihar, India for 3 year, 18 cases were referrals from peripheral centers with a possible diagnosis of scaphoid nonunion after failed conservative treatment. The injuries were classified according to Herbert's Classification. Clinical examination included the assessment of tenderness, active and passive range of movement in wrist, and grip strengths were also measured. AP, Lateral and oblique view radiographs of wrist were taken preoperatively, the same technique also being used at follow-up examinations. MRI was taken for assessing the fracture morphology and classification of the fracture properly. The diagnosis of radiological union required clear evidence of bony trabeculaetransversing the graft from proximal to the distal pole in standard scaphoid views. Patients were asked to attend for routine review at 3 weeks, 6 weeks, 9 weeks and 3 months and any additional visits being scheduled as required. Standard wrist radiographs were taken at each visit and a detailed clinical assessment was recorded. Results: Out of 18 patients, 16 (88.9%) were males and 2 (11.1%) were

females. 55.6% of the patients had 20-30 years of age followed by 30-40 years of age group (33.3%) and > 20 years of age (11.1%). Out of 18 patients, 8 patients had road traffic accidents, 9 had fall on outstretched hand and 1 fracture caused by assault. The right wrist was affected in 15 cases and left in 3 patients. The mean time from injury to surgical fixation was 11 $\pm$ 5 months. The occupations of the patients in terms of weight loading of the wrist were heavy loading in 66.7% patients, light loading in 11.1% patients and clerical work in 22.2% patients. Our study resulted in 66.7% excellent, 22.1% good and 11.1% fair functional outcomes. Conclusion: Our study concluded that the management of scaphoid non unions with the Herbert screw and bone grafting can provide enough stability to allow fracture healing without much external splintage. The healing of the nonunion is better than that in other surgeries like k wire fixation or bone graft surgeries alone.

***Keywords*---**Scaphoid, Herbert screw, Splint age, fixation.

Introduction

The scaphoid bone is one of eight small bones—called carpal bones—in the wrist. These bones allow complex, yet delicate, movements of the hand and wrist. The carpal bones fit between the bone of the forearm and hand. The scaphoid sits below the thumb and is shaped like a kidney bean. Injuries to the wrist can cause a scaphoid fracture, a possible source of hand and wrist pain. Scaphoid fractures are the most common fractures of the carpal bones. The traditional management of a scaphoid fracture, especially for non-displaced fractures, is with cast immobilization.

Scaphoid is most commonly fractured carpal bone that accounts for 60% of total such fractures [1]. Most case series report around a 10% nonunion rate; however, the majority of scaphoid fractures heal without surgery. Any fracture that does not heal more than six months after injury is considered as nonunion [2]. The anatomical properties such as tenuous blood supply, joint fluid dilution and inability to form the callus as well as biomechanical properties including the high shear stress and tendency to displace the fractured fragments are the main reasons for scaphoid nonunion. Delayed diagnosis, inadequate treatment, carpal instability, tendency of excessive disintegration and fragmentation at fracture site, delayed onset of treatment and presence of accompanying avascular necrosis are the extrinsic causes for nonunion [3, 4]. Older age and smoking habit are the systemic factors that may cause delayed union of scaphoid [5, 6].

The main treatment modalities include scaphoid cast immobilization, percutaneous k wire fixation, bone grafting techniques with immobilization and Herbert screw fixation with or without bone grafting [7]. These fractures frequently result in nonunion either due to treatment problems or due to failure in identifying the fractures in initial radiographs. X-rays of the scaphoid are very difficult to interpret, and even if the fracture appears to be united after initial treatment, radiographic follow-up later shows the development of established

nonunion in many cases. Many studies suggest that the real incidence of non-union after conservative treatment of scaphoid is of the order of fifty percentage [8, 9].

Barton and Warren-Smith mentioned that open reduction, Herbert screw fixation and bone grafting give better functional results as compared to bone grafting alone [10]. In recent years several types of vascularized bone grafting have been reported to enhance the rate of scaphoid union with more than 90% success rate [11, 12]. Even though they have superior union rate, it require a long time for immobilization of wrist joint after surgery to incorporate the graft, have problems of getting appropriate graft size, fixation as well as incorporation into the scaphoid because of its curved boat-shaped morphology, and more importantly vascularized bone graft plays a possible role in established avascular necrosis of proximal pole of scaphoid which would otherwise be united quite well by bone grafting and Herbert screw fixation only [13]. So there should be definitive indications to treat the scaphoid nonunion with vascularized bone grafting. The aim of this study to evaluate the functional outcome of scaphoid nonunion treated with bone grafting and Herbert screw fixation.

Materials and Methods

This study was done Department of Orthopaedics, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for 3 year, 18 cases were referrals from peripheral centers with a diagnosis of scaphoid nonunion after failed conservative treatment.

Methodology

18 patients were assessed with fresh radiographs and MRI wrist was taken in all cases. The injuries were classified according to Herbert's Classification.
Clinical examination included the assessment of tenderness, active and passive range of movement in wrist, and grip strengths were also measured. AP, Lateral and oblique view radiographs of wrist were taken preoperatively, the same technique also being used at follow-up examinations. MRI was taken for assessing the fracture morphology and classification of the fracture properly. The diagnosis of radiological union required clear evidence of bony trabeculaetransversing the graft from proximal to the distal pole in standard scaphoid views. Reconstruction of nonunion (type D) was advised for all symptomatic cases and all consenting patients irrespective of the age group and was included in the study. Patients with associated neurovascular injuries, other carpal bone fracture of same limb, those with previous surgery of fractured area and those with musculoskeletal diseases are also excluded from the study. Surgery was not performed for patients with advanced radiocarpal osteoarthritis or in asymptomatic patients.

Procedure

A standard volar approach was used for internal fixation in all cases. The state of the articular cartilage and synovium, the presence of any fibrous adhesions or inter- position at the fracture site was assessed intra-operatively. The condition of the fracture surfaces and degrees of fracture mobility were carefully assessed and

the fracture site was observed for bleeding after freshening. For type D1 non unions, the synovial adhesions and fibrous tissues were meticulously removed without destabilizing the fracture, and cancellous graft was used to fill any defects after curetting out all the avascular tissue and cysts. All types D2 cases; the pseudarthroses was removed from fracture surfaces and were then reconstructed using a corticocancellous bone graft. The Herbert screw was then inserted freehand, using the drill guide wire. Most bone grafts were taken from the contra-lateral iliac crest or from the distal radius depending upon the amount of graft needed and size of the nonunion gap. A firm padded removable splint were used to support the wrist for the first two weeks and after the suture removal, patients are advised to start mobilizing exercises of the wrist. During the initial eight weeks after surgery, patients were advised to avoid excessive loading of their wrist and to avoid contact sports. Light removable splints were prescribed only when the patient was unlikely or unwilling to comply with this advice.

Patients were asked to attend for routine review at 3 weeks, 6 weeks, 9 weeks and 3 months and any additional visits being scheduled as required. Standard wrist radiographs were taken at each visit and a detailed clinical assessment was recorded. Radiographically fractures were recorded as united only if cross-trabeculation was present and the fracture line was no longer visible on any of the standard views. But our study duration is inadequate comment on radiological outcome analysis and hence it was not included in the main study results.

Results

There were 18 cases of scaphoid nonunion treated with Herbert screw fixation and cancellous bone grafting. Out of 18 patients, 16 (88.9%) were males and 2 (11.1%) were females. 55.6% of the patients had 20-30 years of age followed by 30-40 years of age group (33.3%) and > 20 years of age (11.1%). Out of 18 patients, 8 patients had road traffic accidents, 9 had fall on outstretched hand and 1 fracture caused by assault. The right wrist was affected in 15 cases and left in 3 patients. The mean time from injury to surgical fixation was 11 $\pm$ 5 months. The occupations of the patients in terms of weight loading of the wrist were heavy loading in 66.7% patients, light loading in 11.1% patients and clerical work in 22.2% patients. All the patients were regularly followed up and were evaluated for clinical and radiological outcomes.

Table 1: Demographic details and injury details

Variables		Number	%
Age	<20	2	11.1
	20-30	10	55.6
	30-40	6	33.3
Gender	Male	16	88.9
	Female	2	11.1
Injury cause	Road traffic accidents	8	44.4
	Fall	9	50.0
	Assault	1	5.5
Wrist side	Right	15	83.3

	Left	3	16.7
Occupation (In terms of weight loading)	Heavy loading	12	66.7
	Light loading	2	11.1
	Clerical work	4	22.2

Our study resulted in 66.7% excellent, 22.2% good and 11.1% fair functional outcomes. Wrist function was assessed by range of movement and grip strength which was greatly improved after Herbert screw fixation of the scaphoid. The movement which was mostly difficult improve was wrist dorsiflexion after reconstruction. The rigid internal fixation of the scaphoid resulted in significant decrease in pain. Most of our patients had moderate to severe pain preoperatively, but 86% cases had no pain at the latest review. Based on our study results we like to propose that the successful internal fixation of scaphoid with Herbert screw and bone grafting can improve the wrist function considerably. The most common complication of surgery was the postoperative pain and discomfort at the donor site in case of the bone graft taken from iliac crest, although this resolved with time. 1 superficial wound infection resolved completely with antibiotic therapy only. None of the wrists had protrusion of the screw or developed nonunion.

Table 2: Functional outcome of the study

Functional outcome	Number	%
Excellent	12	66.7
Good	4	22.2
Fair	2	11.1
Poor	Nil	Nil

Discussion

The treatment of scaphoid nonunion remains a big challenge to every orthopaedic surgeon particularly when it is associated with the vascular impairment of proximal fragment [2]. Dobyns and Linscheid [14] mentioned the criteria for identification of radiological union. Based on this criteria nonunion was anticipated when distance between the fracture fragments was greater than the inter-carpal bony distance, sclerosis on the fractured ends was more pronounced than the subchondral sclerosis of other carpal bones and degenerative changes as well as increase in fracture gap was more prominent in stress radiographs of wrist joint [14]. When consolidation of nonunion is not achieved, functional outcomes are not satisfying with development of joint stiffness, persistent pain, radio-carpal and inter-carpal arthritis [15].

The morbidity associated with prolonged use of plaster immobilization is also very concerning especially in young individuals. Even though union can be achieved in majority of cases [16], long periods of immobilization may be needed. If conservative management fails, then the Matti-Russe procedure may be effective in 85% of cases [17, 18]. But this procedure also will not reduce the period of immobilization. In a study Dias, Brenkel and Finlay [19] reviewed 82 patients treated conservatively after almost two years: and concluded that ten patients had

definite nonunion and another 20 cases had a visible fracture line. But conservative management of fracture scaphoid with cast is still a common treatment modality, but it results in unacceptably high rate of nonunion and associated poor functional outcomes. Hence for displaced scaphoid fracture and for non-unions, open reduction and internal fixation will be the ideal modality of management [20].

Our study resulted in 66.7% excellent, 22.1% good and 11.1% fair functional outcomes. According to Merrell G.A. et al [21] who done a systematic meta-analysis of the literature on the treatment of scaphoid nonunion which included 36 articles, for the unstable nonunion, screw fixation with grafting produces 94% union rate compared to K-wires and wedge grafting (77% union). They also suggested that there is no evidence supporting the postoperative immobilization after solid screw fixation. Yi-Chao Huang, Yih Liu et al [22] retrospectively reviewed 49 patients treated with Herbert's screw fixation and bone graft and got a union rate of 93.9% with 59% excellent results and 35% good results. Based on these studies we can conclude that results of vascularized bone grafting are not superior as compared to non-vascularized bone grafting. It may not be necessary to treat all scaphoid nonunion without avascular necrosis of proximal fragment by vascularized bone grafting that otherwise has been united by this technique.

Conclusion

Our study concluded that the management of scaphoid non unions with the Herbert screw and bone grafting can provide enough stability to allow fracture healing without much external splintage. The healing of the nonunion is better than that in other surgeries like k wire fixation or bone graft surgeries alone. Combination of thorough curettage of unhealthy bone, impaction of cancellous bone chip graft, cortical-containing bone grafting if required, and internal rigid fixation with Herbert's screw provides a good option for treatment of scaphoid nonunion especially in the absence of avascular necrosis of proximal fragment.

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