

Scaphoid Fracture: Functional Outcome Following Fixation with Herbert Screw

Parajuli NP, Shrestha D, Dhoju D, Shrestha R, Sharma V

Department of Orthopaedics and Traumatology
Kathmandu University School of Medical Sciences
Dhulikhel Hospital, Kathmandu University Hospital
Dhulikhel, Nepal

Corresponding Author

Nirajan Parajuli
Department of Orthopaedics and Traumatology
Kathmandu University School of Medical Sciences
Dhulikhel Hospital, Kathmandu University Hospital
Dhulikhel, Nepal
E-mail: parajulinirajan@gmail.com

Citation

Parajuli NP, Shrestha D, Dhoju D, Shrestha R, Sharma V. Scaphoid Fracture: Functional Outcome Following Fixation with Herbert Screw. *Kathmandu Univ med J* 2011;36(4):267-73.

ABSTRACT

Background

Most scaphoid fractures though heal uneventfully with cast treatment, immobilization with cast is associated with complication like wrist stiffness. Open reduction and fixation with Herbert Screw though technically demanding procedure can yield excellent results and prevents complication like nonunions and loss of wrist function.

Objectives

To assess clinical outcome and radiological union of scaphoid fracture after operative management following Herbert screw fixation in patient attending Dhulikhel Hospital.

Methods

All scaphoid fracture, treated from Feb 2007 till Feb 2011, were retrospectively studied in Dhulikhel Hospital, Kathmandu University Hospital. Fifteen patients with scaphoid fractures were treated with Herbert screw. Fourteen were males and one was female. Serial radiographs were taken to assess radiographic union and functional outcome was assessed using Modified Mayo wrist score.

Results

Out of 15 patients, 13 scaphoid had waist fractures and two had proximal pole fractures. All scaphoid were treated with open reduction and Herbert screw fixation either by volar approach or by dorsal approach. All fractures maintained good alignment post operatively. Nine (60%) patients had excellent results with normal wrist range of motion, five (33.3%) patients had good results and one (6.7%) patient had poor outcome. In 14 (93.3%) patients good radiological union was seen at final follow up at six months time.

Conclusion

Fixation with Herbert screw for scaphoid fracture is an effective and convenient way of treatment with satisfactory functional outcome and less complication.

KEY WORDS

scaphoid fracture, Herbert screw, functional outcome

INTRODUCTION

Scaphoid fracture mainly occurs in young adults and constitute 2%- 7% of all fractures, and is the most commonly fractured carpal bone which accounts for approximately 82- 89% of all carpal fracture.^{1,2} Left untreated or poorly reduced, a scaphoid fracture may develop a malunion or nonunion. Even with proper treatment around 10 to 35% of these fractures go into nonunion.^{3,4} This leads to altered carpal biomechanics with resultant pain, diminished motion of wrist, grip strength, and carpal arthritis. The management option for patients with acute nondisplaced

scaphoid fracture or with delayed union have expanded from open surgical technique to percutaneous fixation technique that reliably expedite fracture healing and return to work/ sport relative to traditional cast treatment.

Predicting successful scaphoid healing after a fracture can be difficult because reported union rates range between 10% and 50% with traditional cast treatment.^{5,6} The most influential factors for nonunion includes displaced fractures, fractures with ligamentous injuries and proximal pole fractures. Long term studies confirm a 10% to 12%

failure rate with plaster immobilization of presumed stable fracture.^{5,6} Although the failure rate of stable fracture is not high, one must balance the odds of fracture union against three to six months cast immobilization; especially in young patient population who are active and least tolerant to prolonged immobilization.

The benefit of percutaneous Herbert screw fixation lie in the fact that; fracture reduction and fixation can be accomplished without further injury to the scaphoid blood supply and stabilizing ligament of the wrist.^{7,8} Difficulty with precise placement of screw, need of jig, and expertise limited the application of using percutaneous technique in our setup. Encouraging results have been reported after open reduction and internal fixation of scaphoid fractures using the Herbert screw for fractures which are stable, unstable and for those with delayed union.⁹⁻¹⁵

Our study was intended to review the clinical, radiological and functional outcome of open reduction and Herbert screw fixation for scaphoid fractures.

METHODS

Between February 2007 and February 2011, 17 cases of scaphoid fracture were treated with Herbert screw in our centre which included cases of acute scaphoid fracture, patients with delayed union or fractures which showed no signs of healing after 12 weeks wearing plaster cast and fracture presenting late; four weeks to three months after injury. We excluded patients with tuberosity fracture, trans-scaphoid perilunate dislocation; hump back deformity of scaphoid, Dorsal intercalated segmental instability deformity (DISI), osteonecrosis of proximal scaphoid fragment, previous wrist injury or any other associated fracture around the wrist and established scaphoid nonunion.

Out of 17 patients, 15 met our inclusion criteria and were included in our retrospective study. Fourteen were males and one female with average age of 26.06 years (range 18-45 years). Eleven patients had an injured right wrist and four had left wrist injury. The mean duration of presentation after injury was 14.5 days (range 1- 65 days). The minimum follow up was six months (range 6 – 24months). Seven (47%) patients were operated with in first week after injury, three (20%) patients with in two weeks and three (20%) were operated in between two to four weeks. Two (13.3%) patients had delayed union of scaphoid waist fracture after 12 weeks of cast treatment who were operated after 12 weeks (Table.1).

Scaphoid radiographs included, postero anterior view, lateral view, semipronation oblique and antero posterior view with wrist in ulnar deviation. Injuries were graded according to Herbert and Fisher Classification (Table 2). We operated on six (40%) type B2 fractures, four (26.7%) type A2 fractures, three (20%) type B3 fractures and two (13.3%) type C fracture.

Volar approach was used to all waist fracture and dorsal approach to all proximal pole fracture. One proximal pole fracture was approached from volar side because of poor dorsal skin quality and fracture being in between proximal and middle third junction. Surgery was performed under general or regional anesthesia. Preliminary reduction was achieved with K-wire fixation and once satisfactory reduction achieved, Herbert screw fixation was done and confirmed using image intensifier. In all cases scaphoid cast was applied post operatively with a window at surgical wound site. Two weeks post operatively; sutures were removed and cast continued for another four weeks. At six weeks, cast was removed and replaced with removable wrist immobilizer brace for another four weeks along with physiotherapy. Hand grip strengthening exercise with active assisted range of motion exercise of wrist was started. All patients were evaluated at four weeks interval until fracture united. At each follow up, patients were subjected to clinical as well as radiological examination with scaphoid profile. Union was considered to have occurred when there was no tenderness at the anatomical snuff box or at scaphoid tubercle and there was evidence of trabeculae crossing fracture on at least three views.

On final follow up clinical assessment were performed based on Modified Mayo Wrist Score (MMWS) (Table 3). Grip strength was measured asking the patient to squeeze the examiners index finger, and the strength was compared on contralateral side. To avoid subjective bias two surgeons assessed grip strength separately and the average of two findings was taken as a final outcome. Grip strength was graded according to MRC grading. Range of motion was measured using goniometer.

Data were analyzed using Statistical Package for Social Sciences (SPSS version 15, Chicago, Illinois).

RESULTS

Out of 15 scaphoid fractures; 14 fractures united successfully. Radiological union was confirmed in 14 patients at the end of 10 weeks (range 8- 16 weeks) post operatively. In those patients with delayed union with cast treatment, fracture union was seen at eight weeks post operatively. (Fig 2) In one patient with proximal pole fracture radiological union was achieved after sixteen weeks. In one patient radiological union was not seen till final follow up (6 months). In other cases; wrist flexion averaged 61° (range 35 to 75°) and wrist extension averaged 60° (range 40 to 70°). According to Modified Mayo wrist score (MMWS); the mean pain score was 21.3 (range 10 to 25), mean range of motion score was 23.3 (range 15 to 25), mean grip strength score was 24.6 (range 0 to 25) and activity score was 23.3 (range 15 to 25). Grip strength at final follow up averaged 4 (range 3 to 4.5). The mean MMWS score was 92 (range 45 to 100). Accordingly nine (60%) patients had excellent results, five (33.3%) patients had good results and one (6.7%) patient had poor result

Table 1. Demographic profiles of patients and details of approach, MMWS and complication.

SN	Age	Sex	Side	Herbert type	Time to surgery (Days)	Approach	Time to union (weeks)	MMWS (Points)	Remarks
1	23	Male	Left	B2	30	Volar	8	100	
2	18	Male	Right	B3	1	Dorsal	16	80	
3	25	Male	Right	A2	1	Volar	6	100	
4	26	Male	Left	B2	1	Volar	10	90	
5	30	Male	Right	B2	21	Volar	14	95	
6	22	Male	Left	C	65	Volar	8	85	cast failure
7	28	Female	Right	B2	30	Volar	12	85	
8	23	Male	Left	A2	25	Volar	8	95	
9	45	Male	Right	B3	2	Volar	NA	45	Nonunion +screw loosening and proximal pole sclerosis
10	24	Male	Right	C	60	Volar	10	100	cast failure
11	18	Male	Right	A2	2	Volar	8	95	
12	22	Male	Right	B2	15	Volar	10	95	
13	26	Male	Right	B3	14	Dorsal	12	85	
14	35	Male	Right	A2	2	Volar	8	100	
15	26	Male	Right	B2	10	Volar	10	95	

Table 2 Classification of scaphoid fractures (Herbert and Fisher 1984).¹¹

Type A	Acute Stable fractures
A1	Fractures of the tubercle
A2	Undisplaced "crack" fractures of the waist
Type B	Acute unstable fracture
B1	Oblique fracture of the distal third
B2	Displaced or complete fractures of the waist
B3	Proximal pole fracture
B4	Fracture-dislocations of carpus (Trans scaphoid perilunate dislocations)
B5	Comminuted fractures
Type C	Delayed Union; Unhealed six weeks after injury
Type D	Established non-union six months after injury
D1	Fibrous Non-union
D2	Sclerotic Non-union (Pseudarthrosis)

with total MMWS of 45. Figure 1 shows an acute mobile fracture in 24 years gentleman, who was treated with open reduction and Herbert screw fixation. Fourteen months post operative radiographs showed complete union with excellent results.

There were no perioperative complications. None of the patient had malunion. One patient showed signs of nonunion, proximal fragment sclerosis and screw loosening in a proximal third scaphoid fracture (Fig 3). This patient lost follow up after three months and again followed with us at six months post operatively. This patient was planned for vascularised muscle pedicle graft but he denied further treatment. None of the patients showed signs of post traumatic osteoarthritis of the scaphoid or wrist at final follow up (range 6-24 months). Four patients

Table 3. Modified Mayo wrist Score.

Category	Points
Pain (25 points)	
None	25
Mild occasional	20
Moderate (with normal use, not at rest)	10
Severe, Constant	0
Range of Motion (25 points): Flexion+ Extension (Degrees)	
> 140	25
100 - 140	20
70 - 99	15
40 - 69	10
< 40	0
Grip strength (25 points)	
Normal	25
Diminished but > 50% of normal	15
Less than 50% of normal	0
Activity (25 points)	
Same activities	25
Restricted activities caused by injured wrist	15
Change of work or sports caused by injured wrist	0

had scar tethering and sensitivity which subsided with physiotherapy and scar massage. One patient required local steroid injection for scar tenderness.

DISCUSSION

Fractures of scaphoid are common, and many times are difficult to diagnose and treat. Fracture scaphoid can cause prolonged morbidity and absences from work in young



Figure 1. Acute mobile fracture. Fourteen months post fixation with sound union and excellent function.

adults in which they are most common.¹⁵ In our series only two (13.3%) patients were above 30 years, rest 13 (86.7%) patients were below 30 years. This finding suggests that scaphoid fracture is common in young adults.

Even the primary treatment demands expertise and familiarity with different treatment options. If those requirements are met a good prognosis can be expected. Open reduction and internal fixation of acute fracture of the scaphoid using a compression lag screw was recommended by McLaughlin and Maudsley and Chen to allow early mobilization of wrist.^{16,17} Herbert and Fischer first described the technique in 1984, since then the Herbert screw has become widely accepted as a mode of treatment.¹⁸ Rettig ME et al evaluated 14 patients with acute displaced scaphoid waist fractures treated by open reduction and internal fixation with Herbert screw and K wires using either volar approach or dorsal approach. Out of 14; eight were treated with Herbert screw fixation. Thirteen (93%) out of 14 got united within 11.5 weeks (range 8 – 20 weeks) with good function.¹⁰ Nondisplaced (<1 mm displacement), stable fractures of distal and middle 1/3rd of scaphoid can be treated conservatively. Saeden B et al in a prospective

study compared Herbert screw fixation versus short arm cast for acute scaphoid fracture in 61 patients with 62 fractures and found that the operative group returned to work in a shorter period of time. Hence there has been a trend towards surgical fixation of these fractures.^{9,19-21} In a study done by Davis EN et al, in cost/utility analysis of open reduction and internal fixation versus cast immobilization for acute nondisplaced mid waist scaphoid fracture; they concluded that compared with casting, open reduction and internal fixation is cost saving from the societal perspective. When considering only direct costs, open reduction and internal fixation is cost effective relative to other widely accepted interventions.^{9,21} In our study we have operated four cases of A2 type fractures which healed uneventfully with good clinical results compared to two patients who was treated initially with cast treatment eventually was operated and showed good results. Herbert screw can be inserted through both palmar and dorsal approach. Palmar approach is useful in waist as well as distal pole fractures and preserves the important dorsal blood supply; however it disrupts the volar carpal ligaments and gives poor exposure of proximal pole. Dorsal

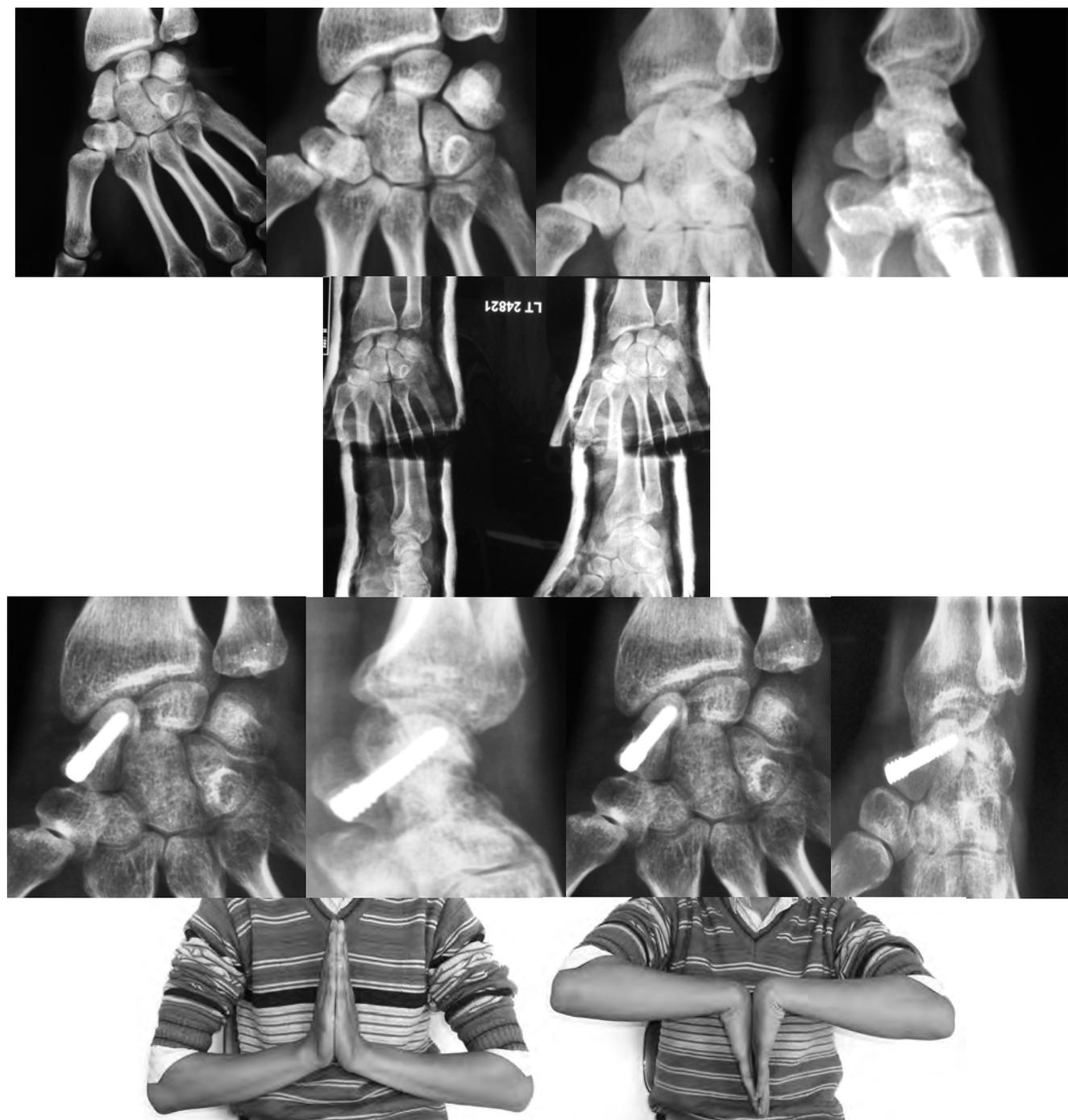


Figure 2. Acute undisplaced fracture. Twelve weeks post cast application with signs of delayed union and tenderness at snuff box. Eight weeks post fixation with sound union and excellent function at 6 months.

approach provides exposure of the proximal pole but can disrupt the tenuous blood supply.^{11,22} In our study we have used volar approaches in 13 cases and dorsal approach in two cases. We did not encounter any complications or difficulties peroperatively using those approaches. Filan and Herbert achieved 88% union rate with displaced or mobile fracture of scaphoid waist that had early surgical intervention with screw fixation.¹² Various authors have recommended Herbert screw fixation of scaphoid fracture by percutaneous technique. Naranje S et al reported 100% union rate with Percutaneous Herbert screw fixation in 32 patients involving both fresh and late scaphoid fracture

presentations with dorsal approach.²⁰ Similarly Shin AY et al found that the fracture union occurred at an average of 7.1 week compared to 11.6 weeks with cast treatment using volar percutaneous fixation for stable scaphoid fracture.²³ Reported union rates and complication rates with the percutaneous technique ranged from 94% to 100% and 0% to 30%, respectively. Which seem to be comparable with those of the open technique.²⁴ In our series we achieved 93% union rate, minimal complication and an early return of wrist function with open reduction and internal fixation with Herbert screw irrespective of type of fracture.

Open technique, however, is not without risk and significant



Figure 3. Proximal third fracture. Six months post fixation showing Nonunion with screw loosening and sclerosis of proximal fragment with poor functional outcome.

complications have been reported.^{12,13,14} It requires significant soft tissue dissection and violation of the extrinsic volar and dorsal ligaments.^{2,10} The most common complication seen in various studies were; problem with scar (Hypertrophied scar), screw protrusion, osteoarthritic changes in scaphotrapezial joint after volar approach and post operative instability.¹² Another common complication following Herbert screw fixation is nonunion. Review of literature, however, shows that the most common reason for failure in Herbert screw procedure is improper screw placement. Several authors have stressed that, important consideration during Herbert screw fixation is that the screw should be placed within the center of the scaphoid. A high successful union rate of approximately 95% can be achieved after adequate screw fixation; however malpositioning can result in nonunion of scaphoid fractures.^{11,20,25} Nonunion may occur in 5% to 10% of all cases, with an even higher incidence in displaced fracture and proximal pole fracture. The reason behind such high incidence is attributed to the tenuous blood supply of the scaphoid. The blood supply of the scaphoid is primarily from the radial artery via the artery to the dorsal ridge of the scaphoid, whose branches

enter the scaphoid via foramina at the dorsal ridge and run proximally and palmarly to supply the proximal pole. The proximal pole therefore, is dependent entirely on intraosseous blood flow. Avascular necrosis is said to occur in 13% to 50% of cases of fracture of the scaphoid, and the incidence of avascular necrosis is even higher with in those with involvement of the proximal one fifth of the scaphoid.^{11,26} These findings by various authors explains the nonunion and avascularity of proximal fragment in one of our case (Fig 3). In other patients only minor complications were seen.

There is several limitation of our study; this is a retrospective study so we are limited to existing data. This study is not a comparative study between other methods of treatment, so a similar study with a nonoperative control group or a comparative study with another operative technique would be ideal. A long term follow up is necessary to find out its long term functional outcome and complication (avascular necrosis of proximal fragment, osteoarthritis and carpal instability).

CONCLUSION

Open reduction and internal fixation is an option to reliably diminish the incidence of nonunion and malunion with residual carpal instability that occur with cast immobilization in scaphoid fracture. In the background of lack of resources and lack of experience in surgeons limited

the use of percutaneous technique in our set up, we recommend use of Herbert screw for fixation of scaphoid fracture whether displaced or undisplaced for better radiological and functional outcome.

REFERENCES

- Haisman JM, Rhode RS, Weiland AJ. American Academy of Orthopedic Surgeons. Acute fracture of the scaphoid. *J Bone Joint Surg. Am* 2006;88:2750-8.
- Tysver T, Jawa A. Fractures in brief. Scaphoid Fractures. *Clin Orthop. Relat. Res* 2010;468: 2553-5.
- Schuind F, Haentjens P, Van Innis F, Vander Maren C, Garcia-Elias M, Sennwald G. Prognostic factors in treatment of carpal scaphoid nonunions. *J Hand surg Am* 1999;24:761-76.
- Kilic A, Sokucu S, Parmaksizoglu AS, Gul M, Kabukcuoglu YS. Comparative evaluation of radiographic and functional outcomes in the surgical treatment of scaphoid nonunions. *Acta Orthop Traumatol Turc* 2011; 45(6):399-405.
- Duppe H, Johnell O, Lundborg G et al. Long term results of the fracture of the scaphoid, a followup study of more than thirty years. *J Bone Joint Surg Am* 1994;76:249-52.
- Raudasoja L, Rawlins M, Kallio P, Vasenius J. Conservative treatment of scaphoid fractures; a followup study. *Ann Clin Gynaecol* 1999;88:289-93.
- Menapace KA, Larabec L, Arnolzky SP et al. anatomic placement of the Herbert Whipple screw in scaphoid Fractures; a cadaveric study. *Am. J Hand Surg* 2001;26:883-92.
- Krimmer H. Scaphoid fracture repair using the Herbert screw system. *Atlas Hand Clin* 2003;8:57- 66.
- Davis EN, Chung KC, Kotsis SV, Lau FH, Vijan S. A cost/utility Analysis of open reduction and internal fixation versus cast immobilization for acute nondisplaced mid waist scaphoid fracture. *Plast. Reconstr. Surg* 2006;117:1223.
- Rettig ME, Kozin SH, Cooney WP. Open reduction and internal fixation of acute displaced scaphoid waist fractures. *J Hand Surg* 2001;26A:271-6.
- Kawamura K, Chung KC. Treatment of scaphoid fractures and nonunions. *J. Hand Surg* 2008;33A:988-97.
- Filan SL, Herbert TJ. Herbert screw fixation of scaphoid fractures. *J. Bone Joint Sur* 1996;78-B:519-29.
- Barton NJ. Herbert screw for fracture of scaphoid. *J. Bone Joint Surg* 1996;78-B:517-8.
- Slade JF, Magit DP, Geissler WB. Scaphoid fractures in Athletes. *Atlas Hand Clin* 2006;11:27-44.
- Krasin E, Goldwirth M, Gold A, Goodwin DR. Review of the current methods in Diagnosis and Treatment of scaphoid fractures. *Post grad. Med J* 2001;77:235-7.
- Mclaughin HL. Fracture of the carpal navicular (scaphoid) bone: some observation based on treatment by open reduction and internal fixation. *J. Bone Joint Surg [Am]* 1954;36-A:765-74.
- Maudsley RH, Chen SC. Screw fixation in the management of the fractured carpal scaphoid. *J. Bone Joint Surg [Br]* 1972;54-B:432-41.
- Herbert TJ. Use of Herbert Bone screw in surgery of the wrist. *Clin orthop* 1986;(202):79- 92.
- Mcqueen MM, Gelbke MK, Walkfield A, et al. Percutaneous screw fixation versus conservative treatment for the fractures of the waist of Scaphoid, prospective randomized study. *J. Bone Joint Surg [Br]* 2008;90(1):66-71.
- Naranje S, Kotwal PP, Shamsery P, Gupta V, Nag HL. Percutaneous fixation of selected scaphoid fractures by dorsal approach. *International orthopedics* 2010;34:997-1003.
- Saeden B, Tornkvist H, Ponzer S, Hoglund M. Fracture of the carpal scaphoid; a prospective randomized 12 year follow up comparing operative and conservative treatment. *J. Bone Joint Surg* 2001;83B(2):230-4.
- Chung KC. simplified approach for unstable scaphoid fracture fixation using the Acutrak screw. *Plast Reconstr Surg* 2002;110:1697-1703.
- Shin AY, Hofmeister LCDR EP, MC,USN. Volar percutaneous fixation of stable scaphoid fractures. *Atlas Hand Clin* 2003;8:19-28.
- Bushnell BD, McWilliams AD, Messer TM. Complication in dorsal percutaneous cannulated screw fixation of nondisplaced scaphoid waist fracture. *J Hand Surg* 2007;32A:827-33.
- Bedi A, Jebson PJ, Hayden RJ, Jacobson JA, Martus JE. Internal fixation of Acute nondisplaced scaphoid waist fractures via a limited Dorsal approach; An assessment of Radiographic and functional outcomes. *J. Hand Surg* 2007;32A:326e1-e9.
- Steinmann SP, Adams JE. Scaphoid fractures and nonunions; diagnosis and treatment. *J Orthop Sci* 2006;11:424-31.