Full length article

The clinico-radiological outcome of open reduction and internal fixation of displaced scaphoid fractures in the adult age group

Amit Kumar*, B.P. Sharma, Saurabh

Central Institute of Orthopaedics(CIO), Vardhman Mahavir Medical College and Safdarjung Hospital, Delhi, India

ARTICLE INFO

Article history:

Received 24 June 2016

Accepted 10 January 2017

Available online 17 January 2017

Keywords:

Scaphoid

Fracture

Open reduction

Internal fixation

Herbert screw

ABSTRACT

Background: Scaphoid fracture is the most common among carpal bone fractures, frequently imperceptible on initial radiographs. Tendency of scaphoid fracture to undergo in non-union makes it an important challenging injury for all orthopaedic surgeons. Displaced scaphoid fracture has high non-union rate in conservative management asserting the need to explore operative treatment

Materials and method: A prospective study was conducted in our institution in thirty patients in 20 to 50 year age group, for displaced scaphoid fracture (<30 days duration). Patient were followed up at every 4 week interval for 6 month and then three monthly for total duration of 18 months. At each follow up clinical and functional outcome was measured by Mayo wrist score and Patient rated wrist evaluation, and radiological outcome was measured in terms of union.

Results: Mayo wrist score showed satisfactory outcome at 8 week, and good and excellent outcome at 12 week and 16 week period. Patient rated wrist score showed improvement in clinical and functional result at three month period.

Conclusions: The use of open reduction and internal fixation by Herbert screw in acute displaced scaphoid fracture has good clinical, functional, and radiological outcome, and associated with early recovery.

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1. Introduction

The scaphoid is the most common fractured carpal bone, comprising approximately 51%–62% of all carpal fractures¹ These fractures are most commonly seen in male 15–30 years of age. Scaphoid forms the link between proximal and distal rows of carpal bones and thus more vulnerable to fracture commonly through its weakest part, the waist.² Poor treatment or no treatment of this fracture can lead to its non-union, which may cause painful and severely disabled wrist. Therefore fracture of scaphoid is an important injury for all trauma surgeons.

The incidence of fracture of the scaphoid has been on increase in automobile and fast outdoor sports injuries. During such accidents it would be very difficult for the patients to recollect the exact mechanism of injuries due to pre-occupied apprehensive state of mind. But the fracture is common in active young men, many of whom are bread winners for their families. They are significantly disabled if prolonged immobilization is needed to

achieve union Acute un-displaced scaphoid fracture can be treated non-operatively by immobilization in a cast, with successful union in 88–95% of patients.^{3,4} It is the displaced scaphoid fracture that present problem in management. Displacement is seen in 30% of scaphoid fracture. Displacement of greater than 1 mm is associated with a 55% risk of avascular necrosis of proximal pole of the scaphoid. With >1 mm of displacement, the risk of fracture complications secondary to either ligamentous or vascular injury seems to rise significantly as shown by series of scaphoid fracture reported by Eddeland et al.,⁶ in which they found a 19% incidence of pseudoarthrosis in 93 fractures with less than 1 mm of displacement, while 23 of 25 fractures(92%)with greater than 1 mm displacement failed to unite Satisfactory healing of the displaced scaphoid fracture demands an accurate reduction and its maintenance, which is very difficult to obtain without internal fixation. Most literatures suggest poor result in displaced fracture treated non-operatively. The best results of treatment of displaced fracture have utilized a technique of open reduction and internal fixation⁵ (Fig. 1).

The aim of our study was to evaluate the clinical and radiological outcome of acute displaced scaphoid fracture treated with open reduction and internal fixation.

* Corresponding author at: 145c, Gautam Nagar, Near Gujjar Dairy, Behind Indian Oil Building, New Delhi, 110049, India.

E-mail address: amitdr87@gmail.com (A. Kumar).

Fig. 1. Oblique view of the right wrist joint showing displaced scaphoid fracture at waist.

2. Material and methods

In this prospective study thirty cases of acute displaced scaphoid fracture were included on the basis of selection criteria as follows:

Inclusion criteria-

- a Age group of 20–50yrs.
- b Fracture less than 30 days duration.
- c Displaced scaphoid fracture. (>1 mm)
- d Patients who gave their consent to undergo the procedure.

Fig. 2. Post operative radiograph right wrist at 6 month follow up showing union.

Patients with comorbid condition preventing surgical intervention, poor condition of local tissue, and any other injury to same extremity, making surgery inadvisable were excluded (Fig. 2).

All the patients were subjected to clinical and radiological examination. Postero-anterior (PA), lateral, and scaphoid view of both wrist are obtained along with 3D CT scan of involved limb. The radiographs were assessed to see the displacement on the basis of one of the following criteria:-

- a Minimum gap of 1 mm between fracture fragments.
- b Lateral intrascaphoid angle of >45°.
- c Antero-posterior intrascaphoid angle of <35°.
- d Scapholunate angle of >60°.
- e Radiolunate angle of >15°.
- f A height to length ratio of the scaphoid of ≥ 0.65 on lateral radiograph.

All patients with displaced fractures were taken for open reduction and internal fixation with Herbert headless screw performed by senior orthopaedic surgeon. Patients were given pre-operative antibiotics, which included a third generation cephalosporin and an amino glycoside 30 min prior to the operation. All the patients were given either general anaesthesia or regional anaesthesia. Before proceeding for the operation adequate anaesthesia of the limb was assured. Patient was then taken up for surgery. Procedure was done in supine position under tourniquet. For scaphoid waist and distal pole fracture volar approach, and for proximal pole dorsal approach was used. Post-operatively patient was followed for 6 month at every 4week interval by the operating surgeon and then three monthly for total duration of 18 months. At each follow-up patients were asked to fill the questionnaire of mayo wrist score and PRWE and clinical examination necessary for completion of questionnaire was done, and the radiological outcome is measured in terms of union based on roentgenographic grading system (Fig. 3).

3. Observation and results

The mean age of patient in our study was 30 years and range from 22 to 48 years. 53.4% of fractures occurred in 21–30 year age group and 36.7% of fracture occur in 31–40 year age group and 10% fracture occur in more than 40 year age group. Scaphoid fracture was found to be more common in 40 year and below in our study. Majority of patients in our study were male. Injury was most common right side and waist was the most commonly fractured

Fig. 3. Clinical photograph of patient showing full dorsiflexion at 3 month period.

Fig. 4. clinical photograph of patient showing full palmar-flexion at 3 month period.

region in scaphoid. The clinical and functional outcome was evaluated by Mayo wrist score and Patient rated wrist evaluation (PRWE). The radiological outcomes are graded on a scale where grade 1 is the excellent result, grade 2 is good result, grade 3 is fair result and grade 4 is poor result (Fig. 4).

3.1. Mayo wrist score evaluation

In Mayo Wrist there is a total of 100 points which are divided among the evaluator's assessment of pain (25 points), active flexion/extension arc as a percentage of the opposite side (25 points), grip strength as a percentage of the opposite side (25 points), and the ability to return to regular employment or activities (25 points). Pain is rated as none (25 points), mild (20 points), moderate (10 points), or severe (0 points) by the evaluator, based on the patient's subjective description. The total score ranges from 0 to 100 points with higher scores indicating a better result. An excellent result is defined as 90–100 points, good is 80–89, fair is 65–79 points, and poor is less than 65 points (Table 1).

The mean value of mayo wrist score was 47.30 at 4 week of follow-up period. There was a gradual increase in the score at each follow-up. In initial follow-up there was more improvement in the score with the mean value of 64.83 at 8week and 83.5 at 12week period. It means at the end of 8week patient had satisfactory clinical and functional outcome which progresses into good result at the end of 12week. In subsequent follow-up period at 16wk, 20wk, and 24wk, the mean score was 93.6, 95.67, and 96.67 respectively which shows an excellent clinical and functional outcome. This data also suggested that patient has satisfactory outcome at the end of 8wk period, and good and excellent clinical and functional outcome at 12wk and 16wk.

Table 1
Mayo wrist score at every 4 week follow-up for 24 week.

Mayo wrist score	Mean $\pm$ SD	Min – Max
4 week	47.30 $\pm$ 7.07	30 – 55
8 week	64.83 $\pm$ 11.02	35 – 80
12 week	83.50 $\pm$ 14.92	50 – 100
16 week	93.67 $\pm$ 13.45	50 – 100
20 week	95.67 $\pm$ 10.73	60 – 100
24 week	96.67 $\pm$ 8.54	65 – 100

3.2. Patient rated wrist evaluation

The PRWE is a 15-item questionnaire designed to measure wrist pain and disability in activities of daily living. It allows patients to rate their levels of wrist pain and disability from 0 to 10, and consists of 2 subscales:

1. Pain subscale: It contains 5 items each of which is further rated from 0 to 10. The maximum score in this section is 50 and minimum 0
2. Function subscale: It contains total 10 items which is further divided into 2 sections i.e. specific activities (having 6 items) and usual activities (having 4 items). The maximum score in this section is 50 and minimum 0.

Pain and functional subscales are added to obtain final score maximum total of 100 and minimum of 0.

Lower indicating better outcome (Table 2).

There was a gradual decrease in the score value at each follow up period with maximum decrease in the first three follow up, indicating the maximum improvement in pain and functional activities occur in first three month period which was more or less constant at subsequent follow up.

3.3. Radiological evaluation

Patient were subjected to radiographs PA, lateral and scaphoid views at 12 and 24 weeks post operatively. Radiological outcomes of the fixation were graded based on following criteria by radiologists of our institute including both residents and consultants. Preoperative radiographs were not provided to radiologists and no information regarding procedure being open or closed reduction was disclosed to assessing radiologist (Tables 3 and 4).

Grade 1(excellent result)	Normal appearance and union. No osteopenia & fracture line
Grade 2(good result)	union with osteopenia
Grade 3(fair result)	Non-union but a good clear outline of the Scaphoid. No evidence of necrosis
Grade 4(poor result)	Non-union and a poor outline, With evidence of necrosis.

The above table suggests that 13 out of the 30 patients has grade1 (excellent) radiological outcome, 14 out of the 30 patients has grade 2 (good) radiological outcome and rest of the three patients had grade 3 i.e fair result at the end of the 12 week period. Subsequently at 24 week follow up a total of 27 patient out of thirty have grade 1 radiological outcome, two have grade 2 radiological outcome and one of them has still grade 3 result. It means most of patients (90%) have normal appearance and union i.e. grade1 result at the end of 24 week. It also indicates that most of the patients

Table 2
Patient rated wrist evaluation at every 4 week follow-up for 24 week.

PRWE	Mean $\pm$ SD	Min – Max
4 week	48.85 $\pm$ 6.76	42 – 70
8 week	31.27 $\pm$ 9.02	24.5 – 60
12 week	19.93 $\pm$ 8.95	12 – 46
16 week	18.78 $\pm$ 6.77	12 – 44
20 week	17.08 $\pm$ 6.11	11.5 – 44
24 week	15.98 $\pm$ 5.62	11.5 – 42.5

Table 3
Radiological outcome at 12 week.

Outcome	Frequency	Percentage
Grade 1	13	43.3%
Grade 2	14	46.7%
Grade 3	3	10%
Grade 4	0	0%

who have grade 2 outcome at 12 week, have grade 1 outcome at 24 week. Out of the three patient who had grade 3 outcome at 12 week, only two of them went into fair appearance and union i. e grade 2. Out of three one of them still had grade3 outcome i.e. non-union with a good clear outline of fracture. None of the subjects migrated to grade 4 appearance.

The clinical, functional, and radiological outcome was also compared for different types of fracture pattern and was found to be significant.

4. Discussion

Fracture of the scaphoid is a unique injury, delayed treatment or neglected fracture may lead to its non-union and may cause painful and severely disabled wrist. The various treatment methods used for the treatment of displaced scaphoid fracture are closed reduction and cast, percutaneous fixation, or open reduction and internal fixation.

Various previous literature shows that closed reduction and casting for displaced scaphoid fracture have higher non-union rate; as per results listed in Table 5. As per our knowledge there is no recent study evaluating functional outcomes of displaced fracture scaphoid with open reduction presenting a significant number of cases as included in our study. Enhanced fixation techniques and instrumentation as well as disadvantages of cast treatment have encouraged early surgical treatment of this fracture. Our study is done for assessment of clinical, functional, and radiological outcome in displaced scaphoid fracture, treated by open reduction and internal fixation using Herbert screw.

As shown by Table 5 closed treatment of displaced scaphoid fracture leads to non- union in as much as 70% of cases, urging the need to rapidly diagnose the fracture and sharp monitoring in serial visits to detect any displacement. CT scan should be used in all patients with suspicion of scaphoid fracture to confirm diagnosis and prevent any displacement due to missed fracture treated conservatively. The mean age of patient was 30 years, which indicate that this is a fracture of young people who are involved in more outdoor activities. This was also seen in similar studies by JJ Dias et al¹⁰ (mean age was 29.9yr) and Retting et al¹¹ (mean age 25 years). The majority of patients in our study were male (90%) and right sided limb injury was more common (86.7%). Cooney et al¹² showed that most commonly fracture of scaphoid occur at waist (66.66 percent). This was also seen in our study, in which 70 percent of fracture occurred at waist.

Table 4
Radiological outcome at 24 week.

Outcome	Frequency	Percentage
Grade 1	27	90%
Grade 2	2	6.7%
Grade 3	1	3.3%
Grade 4	0	0%

Table 5
Results of closed treatment of displaced scaphoid fractures.

Study	Fractures	Union	Non-union	Mal-union
Dickison and Shannon (1944) ⁷	6	2 (33%)	4 (66%)	–
Mazet and Hohl (1963) ⁸	15	1 (7%)	8 (53%)	6 (40%)
Eddenland et al. (1975) ⁶	25	2 (8%)	23 (92%)	–
Cooney et al. (1980) ⁹	13	4 (31%)	6 (46%)	3 (23%)
Total	59	9 (15%)	41 (70%)	9 (15%)

Clinical and functional outcome was determined by Mayo wrist score and PRWE. Both score ranged from 0 to 100 points. In Mayo wrist score pain, functional status, range of motion, and grip strength was determinant and the outcome is classified into four grade with 90–100 excellent, 80–90 good, 60–80 satisfactory, and below 60 is poor, where as in PRWE the higher score indicates more pain and functional disability and lower score indicates less pain and less disability. In our study, at initial 4wk follow up the Mayo wrist score was at lower grade and PRWE shows higher score. This indicates that patient had more pain and poor function. With subsequent follow up at 8wk and 12wk the Mayo wrist score improved and PRWE declined. Patient had also able to do unemployed to restricted employed work at 8wk as compared to the study by Bagatur et al.¹³ in 2002, which showed that the mean time to return to employment was 4 to 7wk.

In our study 90 percent of the fractures had united by 12wk and 96.7% by 24wk. This showed that there was higher union rate with open reduction and internal fixation with Herbert screw in concordance with a study by Michael E. R. Retting et al.¹¹ where fourteen acute displaced scaphoid waist fractures were treated with open reduction and internal fixation out of which 13 get united (93%). Filan and Herbert¹⁴ evaluated 33 patients with displaced scaphoid waist, who had open reduction and internal fixation, and found 88% union rate. For percutaneous screw fixation, among all studies reviewed by Haroon Majeed¹⁵ there was a total cohort of 274 patients, with an average age of 27.8 years. Union rate was 98.5 %, with an average time to union of 46 days and average time to return to manual work of 40 days. This review included only minimally displaced fracture. Our study presents union rate of 96.7% with return to employment at 8 weeks for displaced fracture which are often difficult to fix with percutaneous technique. No recent study has been done highlighting the role of open reduction with such sample size and emphasizing the good outcome of ORIF in current age of image intensification guided procedures. Our study though, suffers performance bias as all the operative procedure was performed by the same team. Post operative ct scans were not done and only x ray based evaluation was done.

5. Conclusion

To conclude, though MRI is the investigation of choice to detect occult fracture, computed tomography should be integral part of investigation in displaced fracture scaphoid to assess degree of displacement and decide further course of treatment. Use of open reduction and internal fixation by using Herbert screw in acute displaced scaphoid fracture has good clinical, functional, and radiological outcome and early recovery and should be considered in displaced fractures. The stability provided by Herbert screw aid in early mobilisation which prevents complications associated with these fractures.

Conflict of interest

None.

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