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PERCUTANEOUS FIXATION VERSUS NON-OPERATIVE TREATMENT IN ACUTE NON-DISPLACED AND MINIMALLY DISPLACED SCAPHOID FRACTURES: A COMPARATIVE ANALYSIS

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Abstract

Background: Scaphoid fracture is one of most common fractures of carpal bones. These injuries most commonly occur due to a fall on an outstretched hand resulting primary impacts on the scaphoid waist which is the most vulnerable segment of the bone. Non-displaced and minimally displaced scaphoid fractures have been treated conservatively with below-elbow thumb spica cast immobilization, which comes with complications. To overcome these limitations, minimally invasive surgical techniques such as percutaneous screw fixation is implicated. This study is conducted to compare the clinical and radiological outcomes of percutaneous screw fixation versus conservative cast immobilization in patients with acute non-displaced or minimally displaced scaphoid waist fractures.

Methods: This prospective comparative study was conducted at Saveetha Medical College over a period of two years (January 2023 to January 2025), including 50 patients with acute scaphoid fractures. Patients were divided into two groups: Group A (n=25) underwent percutaneous fixation, and Group B (n=25) received cast immobilization. Outcomes assessed included time to radiological union, functional scores (Modified Mayo Wrist Score, DASH), return to work, and complication rates.

Results: The mean time to union was significantly shorter in Group A (7.4 ± 1.2 weeks) compared to Group B (11.2 ± 2.5 weeks, $p<0.001$). Group A also showed better functional outcomes with higher Modified Mayo Scores (91.6 vs. 84.2, $p=0.002$) and lower DASH scores (8.2 vs. 14.6, $p<0.01$). Complication rates were lower in the surgical group, with no cases of non-union, while the conservative group had three cases of non-union and four delayed unions. The mean time to return to work was earlier in Group A (5.6 weeks vs. 9.3 weeks, $p<0.001$).

Conclusion: Percutaneous screw fixation offers superior radiological and functional outcomes with faster recovery and fewer complications compared to conservative management in acute non-displaced or minimally displaced scaphoid fractures. It should be considered as a preferred option, especially for active individuals requiring early return to activity.

Keywords: Scaphoid fracture, percutaneous fixation, conservative treatment, wrist injury, fracture union, DASH score, Mayo score

INTRODUCTION

The scaphoid stands out among the carpal bones as the one most frequently injured, accounting for roughly 60–70% of all carpal fractures and close to 11% of fractures across the hand [1]. Such injuries occur disproportionately in young, active men, particularly during the second and third decades of life, reflecting occupational and recreational exposure. The typical inciting mechanism is the well-known “fall on an outstretched hand” (FOOSH), where hyperextension coupled with radial deviation transfers force directly through the scaphoid waist, the bone’s most vulnerable segment [2]. While many of these fractures appear radiographically non-displaced or only minimally displaced, the peculiar vascular arrangement of the scaphoid complicates their management. Blood supply enters from the distal pole and proceeds retrograde, leaving the proximal third the last to be perfused [3]. Consequently, fractures involving this region carry a higher likelihood of delayed union, non-union, and even avascular necrosis (AVN) [4]. Conservative treatment most often immobilization in a below-elbow thumb spica cast for 8–12 weeks has long been the standard for stable, non-displaced fractures and has generally yielded favorable union rates [5]. Yet, extended casting can result in notable drawbacks: wrist stiffness, muscle wasting,

longer absence from work or sport, and dissatisfaction among patients with high activity requirements [6]. In response to these limitations, minimally invasive surgical methods such as percutaneous screw fixation have become increasingly popular. By means of a small incision, devices like the Herbert or Acutrak headless compression screws allow for anatomical reduction with rigid stabilization, enabling early mobilization and a shorter period of functional disability [7,8]. Multiple comparative studies have reported quicker radiological union, higher functional scores, and earlier return to daily activities with fixation than with immobilization, as also illustrated in Figure 1, where operative fixation demonstrates earlier healing and mobilization compared to cast treatment [9,10].The evidence suggests that modern percutaneous techniques, particularly when employing headless compression screws, achieve consistently high rates of union in acute, non-displaced fractures [11]. Still, consensus remains elusive: the non-operative route avoids surgical exposure but prolongs immobility, while surgical fixation offers faster recovery at the cost of procedural risks. Thus, the optimal choice must weigh fracture stability, patient demands, complication profiles, and the desired pace of rehabilitation. In this context, the present study aims to directly compare clinical and radiological outcomes between percutaneous screw fixation and conservative casting in patients with acute non-displaced or minimally displaced scaphoid waist fractures.

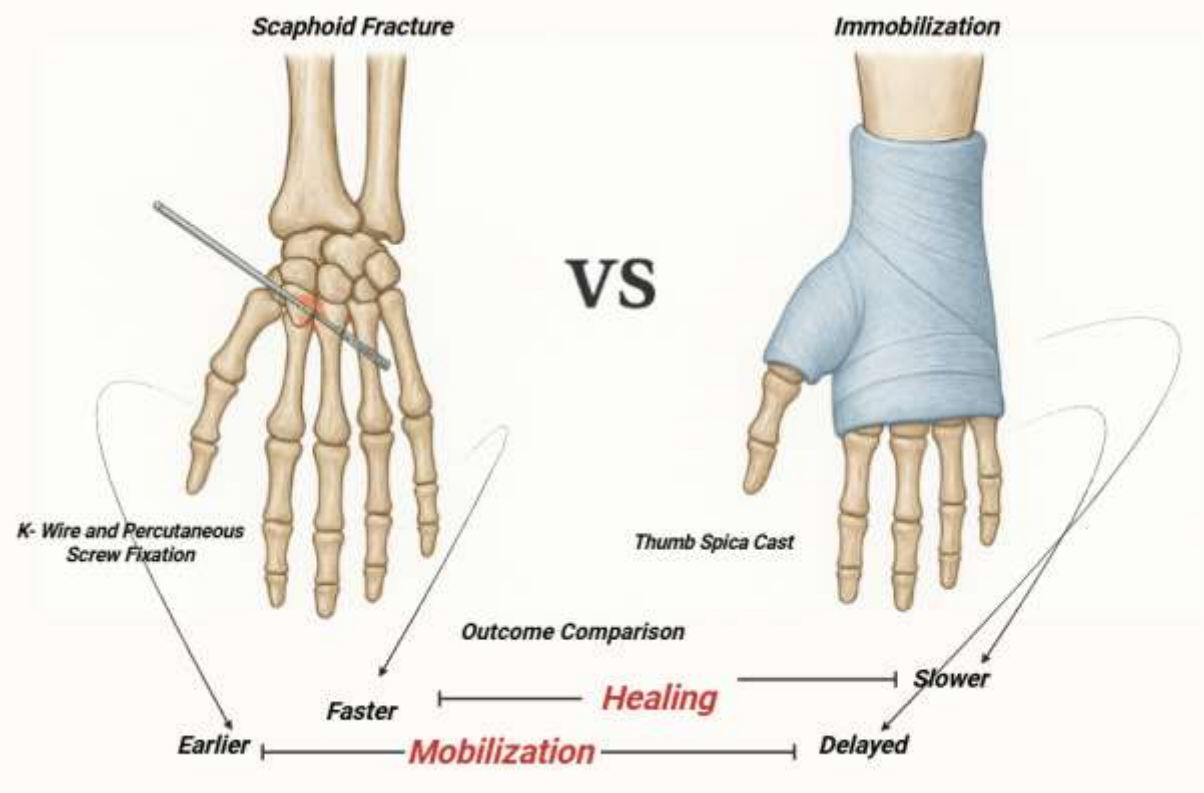

Figure 2. Comparison of percutaneous screw fixation versus thumb spica cast in acute scaphoid fractures. Surgical fixation enables faster union and earlier mobilization, whereas conservative casting leads to slower healing and delayed recovery.

MATERIALS AND METHODS

Study Design:
A prospective comparative clinical study was conducted to evaluate and compare the outcomes of percutaneous fixation versus non-operative management in patients diagnosed with acute non-displaced or minimally displaced scaphoid fractures. This study is carried out in the Department of Orthopaedics, Saveetha Medical College and Hospital, Chennai, over a period of 2 years, from January 2023 to January 2025. The study is conducted after obtaining approval from the Institutional Ethics Committee of Saveetha Medical College and Hospital. All patients provided written informed consent prior to enrolment.

Sample Size:
A total of 50 patients were included in the study, with 25 patients each in:

- Group A: Treated with percutaneous screw fixation
- Group B: Treated with conservative (cast) management

Inclusion Criteria:

- Patients aged 18–60 years
- Acute scaphoid waist fractures (Herbert type B1/B2) diagnosed within 2 weeks of injury
- Non-displaced or minimally displaced fractures (≤1 mm displacement on radiographs or CT scan)
- Closed fractures
- Willing to provide informed consent and comply with follow-up

Exclusion Criteria:

- Fractures with >1 mm displacement
- Proximal pole fractures or comminuted fractures
- Associated carpal bone injuries or wrist dislocations
- Open injuries
- Delayed presentation (>2 weeks after trauma)
- Previous wrist surgeries or pathological fractures
- Patients with poor compliance or follow-up loss risk

All patients presenting with wrist pain following trauma were clinically evaluated and underwent standard wrist X-rays (AP, lateral, scaphoid views) and CT scans if needed for confirmation of fracture displacement and classification. Eligible patients were counselled and included in the study after informed consent. Patients were allocated into two groups based on shared decision-making, clinical suitability, and consent:

- Group A (Operative group): Underwent percutaneous fixation using a headless compression screw under fluoroscopic guidance.
- Group B (Conservative group): Treated with thumb spica cast immobilization for 6–12 weeks.

Surgical Procedure (Group A): Percutaneous fixation was done under regional anaesthesia. A volar or dorsal approach was selected based on fracture location. Under fluoroscopy, a guidewire was inserted centrally through the scaphoid, followed by cannulated screw insertion (e.g., Herbert or Acutrak screw). Sterile dressing was applied, and wrist splint was given for 2 weeks post-op.

Patients were followed at 2, 6, 12, and 24 weeks, and at 1-year post-treatment of both Group A & Group B. Clinical evaluation included pain (VAS score), wrist range of motion, and grip strength. Radiological union was assessed via X-rays and confirmed by CT scan if required. Functional outcome was measured using the Modified Mayo Wrist Score and DASH score.

Primary Outcomes measured by the time to radiological union & Rate of union at final follow-up. Secondary Outcomes measured as Functional outcomes with Mayo Wrist Score, DASH score. The expected and most common complications are non-union, malunion, AVN.

Statistical Analysis:

Data was entered into Microsoft Excel and analysed using SPSS (version 25). Continuous variables were analysed using t-test, and categorical data using Chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 50 patients were enrolled, with 25 assigned to percutaneous fixation (Group A) and 25 managed conservatively in a cast (Group B). The baseline demographic profile demonstrated no statistically meaningful differences between the two groups (Table 1). Both cohorts were comparable in mean age (29.6 ± 6.5 vs. 30.2 ± 7.2 years, $p = 0.71$), sex distribution, and laterality of involvement. In fact, the overwhelming mechanism of injury was a fall on an outstretched hand (FOOSH), observed uniformly in all patients. This similarity in baseline parameters ensured a reliable comparison of outcomes. Healing kinetics, however, diverged strikingly. Patients in Group A achieved radiological consolidation significantly earlier, with a mean union time of just 7.4 ± 1.2 weeks, compared to 11.2 ± 2.5 weeks in Group B ($p < 0.001$). By 12 weeks, 96% of surgically treated wrists had united, in contrast to only 76% of those treated with immobilization, and three patients in the conservative arm ultimately evolved into non-union (Table 2). Functional recovery mirrored these radiological trends. At six months, the distribution of Modified Mayo Wrist Scores clearly favored operative fixation: nearly two-thirds of the surgical cohort achieved “excellent” outcomes, compared with only one-third of conservatively treated patients. Conversely, “fair” and “poor” categories were more heavily represented in the cast group. The average functional score was markedly superior in Group A (91.6 ± 6.2) relative to Group B (84.2 ± 8.4; $p = 0.002$). In line with these findings, Disabilities of the Arm, Shoulder and Hand (DASH) indices were also lower in the percutaneous cohort (8.2 ± 4.1 vs. 14.6 ± 5.8; $p < 0.01$), underscoring better patient-perceived function (Table 3). The complication profile highlighted another dimension of divergence. Conservative treatment was associated with a higher overall complication rate (32% vs. 12%). Non-union occurred exclusively in the cast group, while delayed union beyond 12 weeks was also more prevalent. One case of proximal pole avascular necrosis was reported among non-operatively managed patients. By contrast, the percutaneous group recorded only minor issues such as superficial

infection and hardware-related irritation, with no loss of fixation or implant failure (Table 4). A practical consideration for patients return to work and activity showed substantial differences between the two modalities. On average, surgical patients resumed occupational duties at 5.6 ± 1.5 weeks, almost four weeks sooner than those immobilized in a cast (9.3 ± 2.2 weeks, $p < 0.001$). Moreover, by the three-month mark, 88% of patients in the fixation cohort had regained their previous activity level, compared with just 56% in the conservative group (Table 5). These contrasts are visually illustrated in Figure 1, which presents a bar diagram summarizing comparative outcomes across the principal clinical endpoints. Taken together, these observations demonstrate that percutaneous fixation not only accelerates bone healing but also confers functional and occupational advantages, with fewer biologically significant complications, when contrasted against traditional conservative immobilization in patients with acute non-displaced or minimally displaced scaphoid waist fractures.

Table 1. Demographic Profile

Parameter	Group A (Percutaneous) (n=25)	Group B (Conservative) (n=25)	p-value
Mean age (years)	29.6 ± 6.5	30.2 ± 7.2	0.71
Male : Female ratio	20:5	19:6	0.74
Dominant hand involved	15 (60%)	16 (64%)	0.78
Mechanism: FOOSH	25 (100%)	25 (100%)	-

Table 1. Demographic characteristics and baseline parameters of patients in percutaneous fixation (Group A) and conservative management (Group B) groups. Data presented as mean ± standard deviation for continuous variables and n (%) for categorical variables. FOOSH = Fall on outstretched hand. p-values calculated using independent t-test for continuous variables and chi-square test for categorical variables.

Table 2. Time to Radiological Union

Group	Mean Time to Union (weeks)	Union at 12 Weeks (%)	Non-union (%)
Group A (Percutaneous)	7.4 ± 1.2	24/25 (96%)	0
Group B (Conservative)	11.2 ± 2.5	19/25 (76%)	3 (12%)
p-value	< 0.001	-	-

Table 2. Radiological union outcomes comparing percutaneous fixation versus conservative management of scaphoid fractures. Union rates assessed using plain radiographs at 12-week follow-up. Data presented as mean ± standard deviation and n (%). p-value calculated using independent t-test for time to union and chi-square test for union rates.

Table 3. Functional Outcome (at 6 Months)

Score Category	Group A (n=25)	Group B (n=25)	p-value
Excellent (90–100)	16 (64%)	8 (32%)	-
Good (80–89)	7 (28%)	10 (40%)	-
Fair (65–79)	2 (8%)	6 (24%)	-
Poor (<65)	0	1 (4%)	-
Mean Score	91.6 ± 6.2	84.2 ± 8.4	0.002
Mean DASH Score	8.2 ± 4.1	14.6 ± 5.8	< 0.01

Table 3. Functional outcomes at 6-month follow-up assessed using modified Green and O'Brien scoring system and Disabilities of Arm, Shoulder and Hand (DASH) questionnaire. Scores categorized as excellent (90-100), good (80-89), fair (65-79), and poor (<65). Data presented as n (%) and mean ± standard deviation. p-values calculated using Mann-Whitney U test for categorical scores and independent t-test for mean scores.

Table 4. Complications

Complication	Group A (n=25)	Group B (n=25)	p-value
Non-union	0	3 (12%)	-
Delayed union (>12 wks)	1 (4%)	4 (16%)	-
AVN (proximal pole)	0	1 (4%)	-
Superficial infection	1 (4%)	0	-
Hardware irritation	2 (8%)	-	-
Total complications	3 (12%)	8 (32%)	0.08

Table 4. Complications observed during the study period in both treatment groups. AVN = Avascular necrosis. Data presented as n (%). Hardware irritation applicable only to percutaneous fixation group. p-value for total complications calculated using Fisher's exact test.

Table 5. Return to Activities

Parameter	Group A (n=25)	Group B (n=25)	p-value
Mean time to return to work (weeks)	5.6 ± 1.5	9.3 ± 2.2	< 0.001
Patients returning to previous activity level by 3 months	22 (88%)	14 (56%)	0.012

Table 5. Return to functional activities comparing both treatment modalities. Previous activity level defined as pre-injury work and sports participation without restrictions. Data presented as mean ± standard deviation and n (%). p-values calculated using independent t-test for continuous variables and chi-square test for categorical variables.

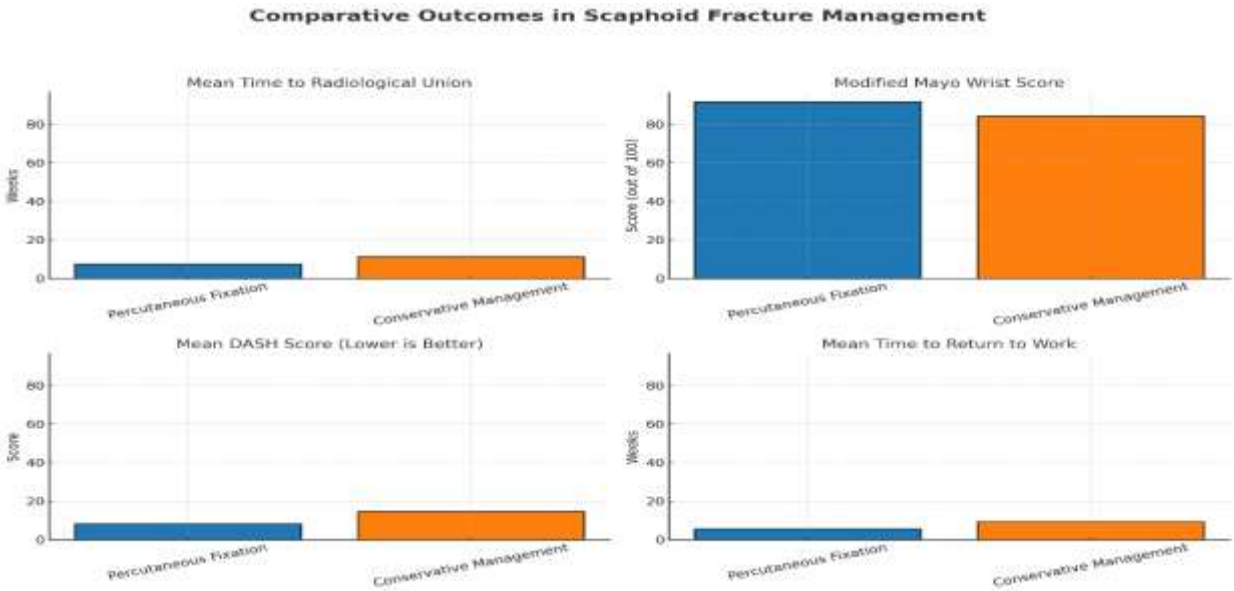

Figure 2: bar diagram of the outcomes in scaphoid fracture management

DISCUSSION

Fractures of the scaphoid waist continue to intrigue clinicians because of their paradoxical nature: often subtle on radiographs, yet capable of evolving into non-union or even avascular necrosis owing to the bone's retrograde arterial inflow [12,13]. Historically, the orthopaedic consensus has leaned toward conservative immobilization for

stable, non-displaced injuries, but the development of percutaneous internal fixation has shifted the paradigm by promising accelerated union and early return of function [14,15]. In the present series, patients treated with screw fixation united in an average of 7.4 weeks, which was significantly quicker than the 11.2 weeks observed in the cast group. These results echo Bond et al., who reported near-identical union times of 7.2 versus 12.7 weeks between operative and non-operative care [16]. Likewise, Adolfsson and colleagues highlighted that early mobilizationpermitted by internal stabilizationwas a decisive factor in functional restoration [17]. Functional performance in our cohort reflected this radiological advantage. Modified Mayo Wrist Scores and DASH indices were both superior among surgically treated individuals, with almost two-thirds of them achieving “excellent” grading at six months. This is consistent with reports by McQueen and Dias, who argued that rigid fixation curtails the stiffness and disuse atrophy associated with long immobilization [18,19]. Complications also diverged across groups. The conservative arm demonstrated three cases of non-union and four delayed unions, figures that resonate with the 10% non-union rates historically documented in conservatively managed scaphoid waist fractures by Inoue and Shionoya [20]. Although proximal pole AVN is classically described, our single case in the conservative cohort reinforces the warnings of Gelberman et al. that vascular compromise can emerge insidiously [13]. In contrast, the fixation group only saw transient hardware-related irritations and one superficial infectionfindings that mirror international data suggesting low morbidity with percutaneous techniques when appropriately executed [23]. Another dimension worth noting is socioeconomic. Surgical patients in our study resumed occupational roles within 5–6 weeks, whereas those immobilized in casts required nearly double that interval. Previous investigations by Vinnars and Davis have underscored that prolonged casting, while non-invasive, carries hidden costs in the form of lost productivity and reduced patient satisfaction [21,22]. This perspective is especially pertinent for younger adults engaged in physically demanding professions.

That said, surgical intervention is not exempt from drawbacks. Even though our complications were minor and manageable, the potential for hardware problems, wound issues, or operative mishaps exists, and the decision must be individualized.

LIMITATIONS

Several caveats should temper interpretation. First, the modest sample size limits generalizability, and treatment allocation was not randomized but influenced by shared clinician–patient decision-making, introducing a degree of selection bias. Second, our follow-up period, although adequate for documenting osseous union, may not be sufficient to capture late sequelae such as radioscaphoid arthritis or degenerative collapse. Broader randomized trials with longer surveillance are necessary to delineate the full spectrum of outcomes.

CONCLUSION

Taken collectively, the evidence from this comparative analysis reinforces that percutaneous screw fixation offers a distinct advantage over conservative casting in acute, non-displaced or minimally displaced scaphoid waist fractures. It promotes earlier radiographic union, superior functional recovery, and swifter reintegration into occupational and recreational activities**,** while maintaining a low complication burden. Nevertheless, conservative immobilization remains a reasonable alternative for patients with lower functional demands or contraindications to surgery. The optimal strategy, therefore, should be individualized, weighing biological healing potential, patient expectations, and socioeconomic context. Looking ahead, multi-center randomized studies with long-term follow-up will be essential to refine clinical guidelines and definitively establish the place of percutaneous fixation in the modern management algorithm of scaphoid fractures.

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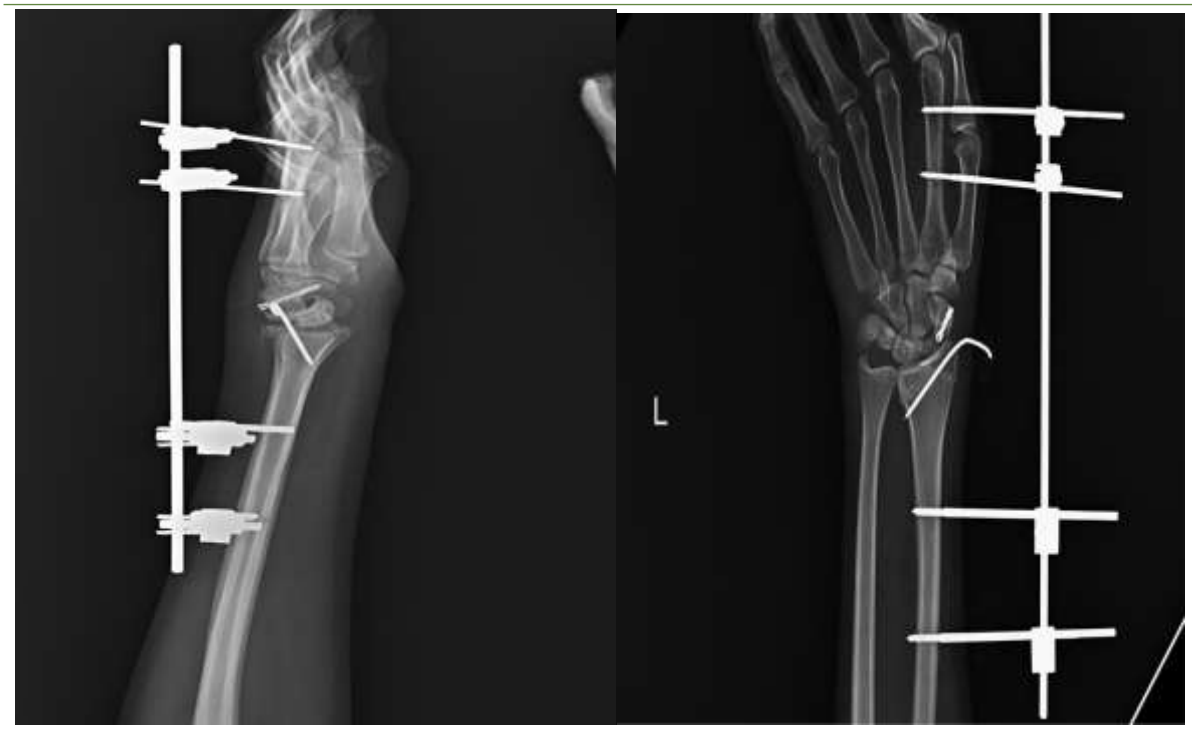
Pre op. Xray



2 weeks Post op x ray

6 weeks post op x ray