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A comparative study to assess the functional outcome in proximal humerus fractures treated surgically with philos plate (Proximal humerus internal locking system) and percutaneous k-wire fixation

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Abstract
Background: Proximal humerus fractures are common and debilitating injuries and incidence of them are increasing especially in elderly. Treatment of unstable, displaced, and comminuted fractures of the proximal humerus remains challenging. Significant controversy continues regarding the best methods of treating displaced proximal humerus fractures. Fracture classification has been inconsistent and surgical treatment have been variable.
Most studies indicate that for the majority of good results of fractures of this region are obtained by conservative methods. Some studies state that operative treatment is better, depending on type of fracture and the quality of the bone. This present study is aimed to assess the functional outcome in proximal humerus fractures treated surgically with PHILOS (Proximal Humerus Internal Locking System) plate and percutaneous K-wire fixation in the indicated group of patients.
Aim: To assess the functional outcome in proximal humerus fractures treated surgically with PHILOS (Proximal Humerus Internal Locking System) plate and percutaneous K-wire fixation in the indicated group of patients.
Methods: This is a prospective study, period from December 2019 to August 2021, and a minimum of 50 sites of proximal humerus fractures were attended in the casualty and OPD were evaluated clinically and radiographically.
Results: Functional assessment using NEER's score was found to be significantly more in group A subjects as compared to group B subjects at 6 weeks, 12 weeks and 6 months. At 6th week, TRU score was found to be significantly more in Group B subjects as compared to Group A subjects.
Conclusions: In the present study it is concluded that PHILOS plate provide stable fixation even in comminuted multi-fragmented osteoporotic proximal humerus fracture with advantage of anatomical reduction and early rehabilitation.

Keywords: Proximal humerus fracture, NEER'S Score, philos plating, K-wire, functional outcome

Introduction
Proximal humerus fractures accounts nearly 4% and 26% of all fractures and humerus fracture respectively, and are second most commonest upper extremity fracture and also third most common fracture in osteoporotic individual after fractures around the hip and distal radius [1]. These fractures may present at any stage, but in elderly its incidence increases rapidly. Low bone mineral density and an increased risk of falls in elderly are some risk factors associated with proximal humerus fractures. Fall from standing height onto an outstretched arm is mostly associated with this fracture, making it the most commonest injury mechanism, but in patient's whose age is less than 50 years, the mechanism of injury generally is high energy trauma, such as road traffic accidents, fall from height or athletic injuries.
This injury has immense importance when it affects young and middle age groups, as it may lead to temporary disability and loss of working hours, which makes restoration of the function of the limb of great importance.
Since the complexity in nature of fracture of proximal humerus, fracture displacements, associated soft tissue injuries and their mode of injuries, there are many controversies

regarding treatment options. Additionally, there has been varied thinking regarding care of fractures around shoulder, with continuing debates and contention, additionally even good anatomical reduction may result to poor outcomes unless there is diligent post-operative rehabilitation making it more challenging [2, 3, 4].

Studies done in past mostly indicates that the majority of good results for these fracture types were obtained just by conservative methods [3]. Some studies showing operative treatment as a better treatment modality depending upon fracture type and bone quality [4]. There are some morbidity and undesirable sequelae even after managing such fractures. The complications are non-union, neurovascular injury, chronic edema, infection, avascular necrosis, adhesive capsulitis, elbow stiffness and soft tissue atrophy of the immobilized limb which delays healing and also result in disability. The goal of this study is to evaluate clinically and radiographically, the efficacy, functional outcome and time taken for fracture union following surgery with PHILOS plating and percutaneous K-wire fixation in proximal humeral fractures are assessed using the Neer's score.

Methodology

This study was carried out in Narayan Medical College and Hospital, Jamuhar. This is a prospective study, period from December 2019 to August 2021, and proximal humerus fractures with minimum of 50 sites who attended in the OPD and casualty were admitted in this hospital and were evaluated clinically and radiographically.

50 sites of proximal humerus fractures were randomly divided in two groups-

Group A- PHILOS (Proximal Humerus Internal Locking System) Plate and

Group B- Percutaneous K-wire fixation and were included in the study based on the following criteria:

Inclusion criteria

1. >18 years of age
2. Both female and male patients
3. Complex fracture of proximal humerus

Exclusion criteria

1. Age <18 yrs
2. Compound fractures
3. neurovascular deficits

According to Neer's trauma series, radiologic evaluation of shoulder were done which consists of: lateral 'Y-view' of scapula, true anteroposterior (AP) view of the scapula, an axillary view.

Fractures were classified according to the Neer's classification and patients were shifted to the ward after initial temporary immobilization with Universal shoulder immobilizer. All the routine investigations were done on all the patients pre- operatively with complete medical and anaesthetic fitness of patient for surgery.

At least one unit of compatible blood was kept in reserve for all patients who underwent surgery.

Method of Treatment

After diagnosing the proximal humerus fracture, and if the patient falls into the inclusion criteria, they were informed about the study and proceeded with the surgery after getting written and informed consent.

The fractures were classified according to Neer's system [4] of proximal humerus fracture classification by using radiological images.

This classification system is based on the number and displacement of the four anatomical segments of the proximal humerus i.e. greater tuberosity, lesser tuberosity, head of humerus and shaft of humerus.

All open reduction and Internal fixation with PHILOS plating were done by deltopectoral approach.

Post-operative care

Post-operatively limb was immobilized in arm pouch, post 12th day of operation sutures were then removed and if secure fixation was achieved, mobilization was started in the second week with shoulder pendulum exercises as per patient's tolerance.

Immediate post-op X- Rays were done routine A-P and scapular view to assess the reduction of fracture and stability of fixation.

If the bone was severely osteoporotic and fixation was less than rigid, motion was delayed, otherwise displacement of the fracture fragments could have occurred.

Shoulder pendulum exercises were permitted by the second or third week and gentle passive forward flexion and internal and external rotation exercises by the third or fourth week. By the fourth to sixth week, active exercises were started.

Patients were discharged with arm pouch and advise to continue pendulum exercises. Patients underwent rehabilitation as per protocol.

Patients were followed from 6 weeks to 6 months on OPD basis at intervals of 6 weeks, 12 weeks and 6 months.

During this period in each visit clinical evaluation of wound healing, pain, shoulder function and range of movements were assessed and recorded.

Clinically fracture was considered united when there was no tenderness at the fracture site and full shoulder function is present.

Radiographically fracture was regarded as united when there is no visible fracture line.

Results were evaluated by the use of Neer's score based on pain, function, range of motion and anatomy for each case assessed and recorded.

Results

Data was analysed using Statistical Package for Social Sciences (SPSS) version 21, IBM Inc. Descriptive data was reported for each variable. Descriptive statistics such as mean and standard deviation for continuous variables was calculated.

Summarized data was presented using Tables and Graphs. Shapiro Wilk test was used to check the normality of the data. As the data was found to be normally distributed bivariate analyses was performed using Independent t test and. Comparison of categorical variables was done using Chi square test. Level of statistical significance was set at p-value less than 0.05 and was denoted as *.

Table 1: Comparison of Mean age in study groups

	Group	N	Mean	Std. Deviation	Std. Error Mean
Age	Group A	25	43.80	11.416	2.283
	Group B	25	43.20	12.003	2.401
P value					0.600

Table 1 shows Comparison of Mean age in study groups. No significant difference was seen in the distribution of mean age in Group A and Group B subjects when compared using independent t test as $p>0.05$.

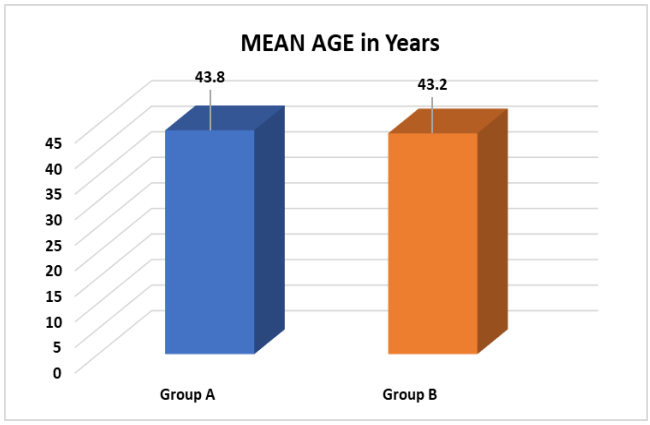


Fig 1: Comparison of Mean age in study groups

Table 2: Gender wise distribution of subjects in study group

			Gender		Total
			F	M	
Group	Group A	N	15	10	25
		%	60.0%	40.0%	100.0%
	Group B	N	11	14	25
		%	44.0%	56.0%	100.0%
Total		N	26	24	50
		%	52.0%	48.0%	100.0%
P value					0.198

Table 2 shows Gender wise distribution of subjects in study group. No significant difference was seen in the distribution of male and female subjects in two study groups when compared using Chi square test as $p>0.05$.

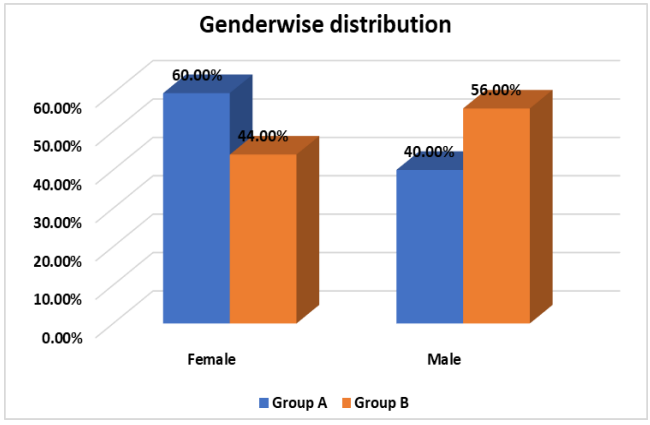


Fig 2: Gender wise distribution of subjects in study group

Table 3: Distribution of study subjects according to mechanism of injury

			MOI		Total
			FALL	RTA	
Group	Group A	N	8	17	25
		%	32.0%	68.0%	100.0%
	Group B	N	7	18	25
		%	28.0%	72.0%	100.0%
Total		N	15	35	50
		%	30.0%	70.0%	100.0%
P value					0.500

Table 3 shows Distribution of study subjects according to mechanism of injury. No significant difference was seen in the distribution of mechanism of injury in two study groups when compared using Chi square test as $p>0.05$.

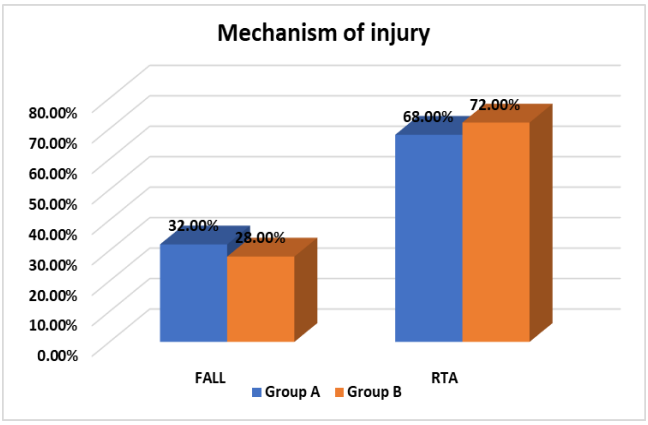


Fig 3: Distribution of study subjects according to mechanism of injury

Table 4: Distribution of study type according to NEER's type of fracture

			NEER's type of fracture			Total
			2 Part	3 Part	4 Part	
Group	Group A	N	13	9	3	25
		%	52.0%	36.0%	12.0%	100.0%
	Group B	N	14	7	4	25
		%	56.0%	28.0%	16.0%	100.0%
Total		N	27	16	7	50
		%	54.0%	32.0%	14.0%	100.0%
P value						0.807

Table 4 shows Distribution of study type according to NEER's type of fracture. No significant difference was seen in the distribution NEER's type of fracture in two study groups when compared using Chi square test as $p>0.05$.

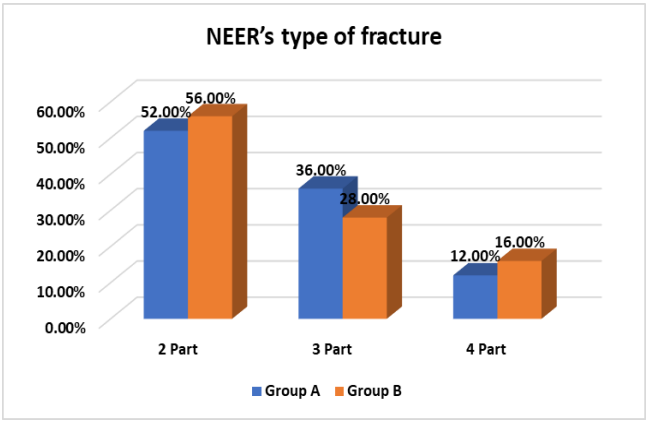


Fig 4: Distribution of study type according to NEER's type of fracture

Table 5: Comparison of mean NEER's score among two study groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	P value
6 weeks	Group A	25	64.32	4.571	.914	0.0001*
	Group B	25	59.60	3.464	.693	
12 weeks	Group A	25	77.56	5.370	1.074	0.001*
	Group B	25	71.64	5.992	1.198	
6 months	Group A	25	85.84	6.574	1.315	0.001*
	Group B	25	78.88	7.742	1.548	

Table 5 shows Comparison of mean NEER's score among two study groups. NEER's score was found to be significantly more in group A subjects as compared to group B subjects at 6 weeks, 12 weeks and 6 months when compared using Independent t test as $p<0.05$.

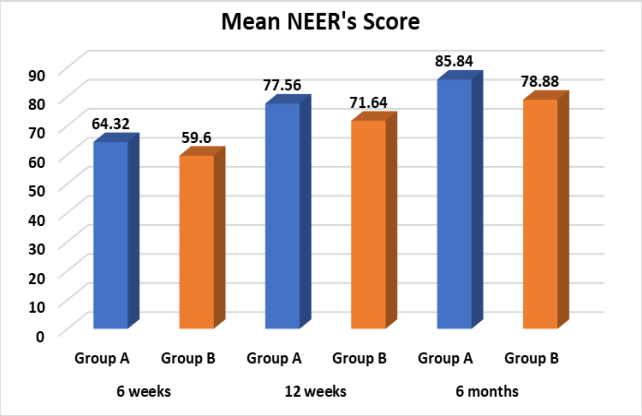


Fig 5: Comparison of mean NEER's score among two study groups

Table 6: Comparison of mean TRU score in two study groups

	Group	N	Mean	Std. Deviation	Std. Error Mean
TRU (weeks)	Group A	25	11.04	1.541	.308
	Group B	25	12.64	1.977	.395
P value					0.002*

Table 6 shows Comparison of mean TRU score in two study groups. At 6 week, TRU score was found to be significantly more in Group B subjects as compared to Group A subjects when compared using Independent t test as $p<0.05$.

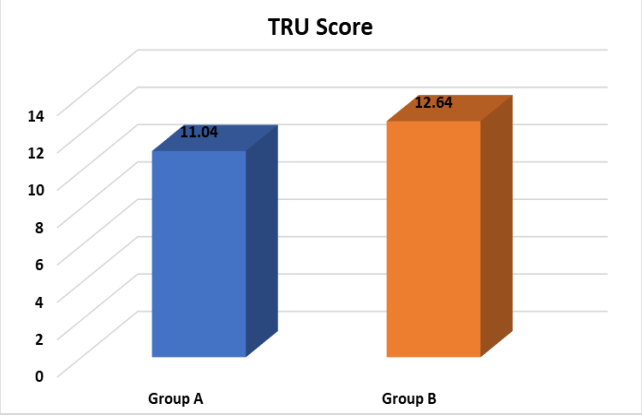


Fig 6: Comparison of mean TRU score in two study groups

Discussion

4-5% of all fractures of long bones are constitute by Proximal humeral fractures. Because of increase in osteoporosis among geriatric population and young population with RTA incidence of Proximal humeral fractures is increasing. Proximal humerus fractures that are Undisplaced can be treated conservatively but fracture which are displaced, for better outcomes require surgical treatment as they are one of the most difficult fractures to treat. With many studies these observation was found to be consistent [5], which revealed 50% history of fall, 5% history of assault and 45% road traffic accidents out of the 40 cases studied. In one of the study 25% had history of fall and 75% had road traffic accident in a series of sixteen cases studied.

Comparing with the published series, we find that the high velocity injury emergence of due to RTA has changed the complete outlook. Due to cancellous nature of bone the Union of proximal humerus fracture has never been as mentioned in many studies [6, 7] unless articular of humerus or anatomical neck is involved, compromising bone of its blood supply.

Percutaneous K wires Surgical procedures has advantages of less blood loss, less soft tissue damage but do not ensure anatomical reduction and has limitations such as there is long period of recovery and mobilization is delayed whereas PHILOS plate pre-contoured has revolutionized proximal humerus fracture treatment with better results in respect with stable anatomical reduction which is great importance in surgery, higher rate of union especially in osteoporotic bone with ease of reconstruction of comminute irreducible fractures. There is a disadvantage of blood loss and excessive soft tissue dissection, increased risk of avascular necrosis of humeral head and risk of injury to neurovascular structure. Favourable results are seen in long term follow-up of patients managed with PHILOS plating, with better Neer's score observed in Group A than Group B patients [8, 9].

Study done by Dolfi *et al.*, he concluded that all patients with Neer's complex type of fractures were not having same response to fixation by k wires or pins [10].

Zyto *et al.*, in his study when compared surgical approach with conservative treatment found that there were no complications with conservative treatment [11].

Kenner, Nho and Magovern concluded better scores with percutaneous fixation and reported fewer complications [12].

With minimal invasiveness advantage, fixation with percutaneous k wire may present an effective treatment for 2 or 3 part fractures. So in present study overall results of percutaneous K-wires were more unfavourable than studies done by jaberg *et al.* [13] and Smejkal *et al.* [14] Patients treated with PHILOS plate were having more better functional results than patients treated with percutaneous k-wire fixation.

Fazal *et al.* concluded that stable fixation with minimal implant related problems was seen with PHILOS plate fixation and to achieve acceptable functional results enabled early range of motion exercises [15].

Akshatvijay *et al.* [16] concluded patients treated with PHILOS plate were having mean Neer's score for ROM was significantly more.

Study done by Anshuman *et al.* [17], in his study he concluded that there is a advantage of treating proximal humerus fracture with compression locking plate. In comminuted fractures and in Osteoporotic bones in elderly patients there is a compression of fragment, angular stability, thus making early mobilization.

Another study done by Singh CM *et al.* [18], concluded that fractures with type III and type IV (Neer's) treated with K-wires fixation for proximal humerus fractures gives inferior results than PHILOS.

Hence in our study it was concluded that even in multi fragmented osteoporotic proximal humerus fractures, excellent stable construct were achieved with the advantages of early mobilization and accurate reduction.

For 2 or 3 part proximal humerus fractures, fixation with percutaneous K-wires may present an efficient treatment option with its advantages of less soft tissue dissection and minimal invasiveness. Patients treated with PHILOS plate were having better functional results than those treated with percutaneous K-wire fixation.

Conclusion

In last few years, due to increase in road traffic accidents and changes in life style, the incidence of proximal humeral fractures has increased. In these injuries, the best management in our study is operative treatment with PHILOS plating for adults and percutaneous K-wire fixation in elderly. However, studies have shown non-operative and operative treatments, both give favorable results.

Proper surgical management of these complex fractures is obtaining proper radiological views, Clinical evaluation, activity levels and age of the patient holds the key for realistic. According to Neer's classification, 3D CT scan was used to classify complex fracture pattern and to determine the treatment of choice.

Proximal humeral fractures in younger patients, are caused by high energy trauma (65%).

Even less severe trauma in older patients with osteoporosis, can produce significant injury. After cancellous bone has become weakened by senility and osteoporosis, this occurs in more frequently in older patients.

Proximal humerus Fractures are complex injuries mainly including two articulating surfaces the subacromial arch and the glenohumeral joint.

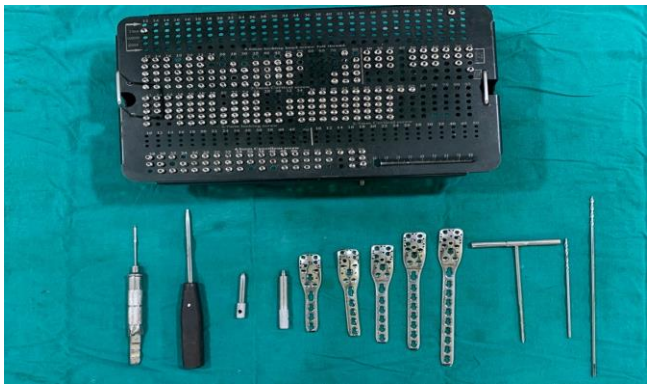
Management modality od this type of treatment mainly depends on the patient's goals, the quality of the bone encountered, the surgeon's familiarity with the techniques and pattern of the fracture.

Fixation of principle is including the restoration of the anatomy, with minimal injury to the soft tissues preserving the vascular supply, reconstruction of the articular surface, and stable fixation should be applied.

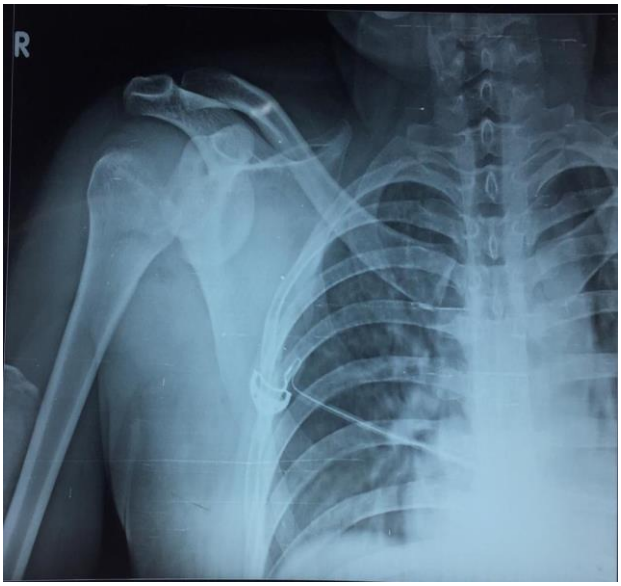
Case illustrations

Philos plating

Armamentarium



Pre-Operative



Radiograph

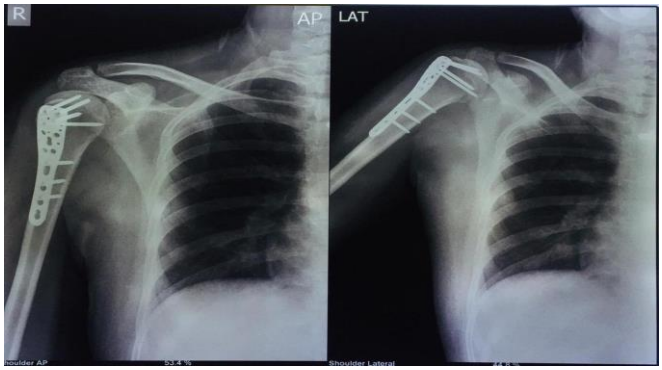
Intraoperative

Skin Incision for Deltopectoral Approach

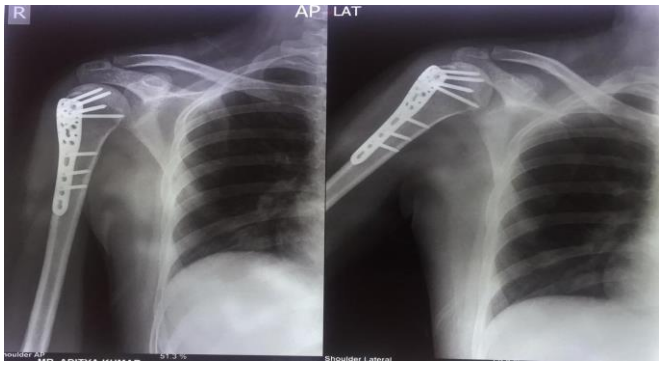
Cephalic Vein Seen In Deltopectoral Groove

Image Intensifier Picture Philos Plate *in situ*

Post-operative



Follow Up Radiograph – 6th Week



Follow Up Radiograph – 6th Month

K-Wire Armamentarium

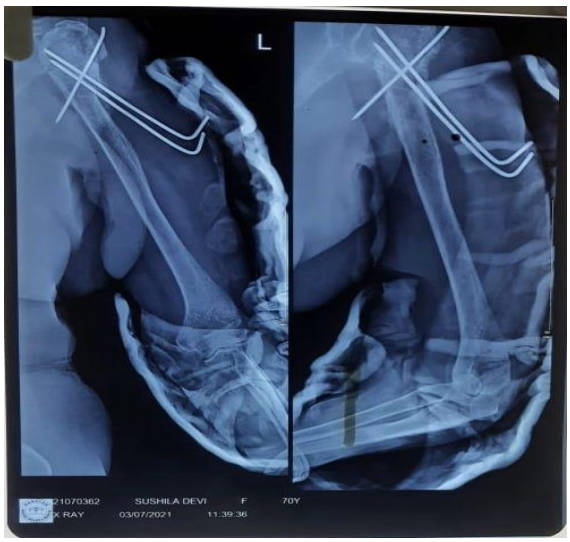
Pre-Operative

Intraoperative

Fixation with k-wire

Immediate Post-Op Radiograph

Post-Operative



Follow Up-6th Week

Follow Up 6th Month

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