

Treatment of Proximal Humerus Fractures using PHILOS Plate and Functional Outcome Measure by Shoulder Function Index (SFInX)Nilesh Kothari¹, Sumit Mathapati², Rajesh Chouhan³, Priyank Deepak^{4*}¹Senior Resident, Department of Orthopaedics, Amaltas Institute of Medical Sciences, Dewas, Madhya Pradesh, India²Consultant, Department of Orthopaedics, ESIC hospital, Solapur, Maharashtra, India³Senior Resident, Department of Orthopaedics, RD Gardi Medical College, Ujjain, Madhya Pradesh, India⁴Senior Resident, Department of Orthopaedics, Nalanda Medical College and Hospital, Agam Kuaan, Patna, Bihar, India

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Corresponding Author: Dr Priyank Deepak

Conflict of interest: Nil

Abstract:

Background: Proximal humerus fractures always remained a challenging problem for most orthopedics surgeons due to the high incidence of complications. The majority of undisplaced proximal humeral fractures can be treated with a sling immobilization and physical therapy, however, approximately 20% of displaced proximal humeral fractures require surgery. The surgical modalities use arc transosseous suture fixation, closed reduction and percutaneous fixation, open reduction and internal fixation with conventional plates, locking plate fixation, and hemiarthroplasty which have shown to have mixed results.

Material and Methods: The study was conducted in the Department of Orthopaedics, Amaltas Institute of Medical Sciences, Dewas, for a period of one year from January 2023 to December 2023. In our study 30 patients were included aged 18 to 75 years of either sex were included in the study.

Results: We studied 30 patients with proximal humerus fractures. The mean age of the patients was 52.4 years. The male-to-female ratio was 3:2. The Mode of injury was by RTA in 18 (60%) patients and fall at ground level in 12 (40%) patients. The average surgical duration was 91+11.3 minutes. The radiological union was seen at 13+4.1 weeks. Results assessed with the Shoulder Function Index Scoring System 70% have achieved excellent and satisfactory results, 26.7% average, and 3.33% poor results.

Conclusion: The PHILOS plate has multidirectional screws, which will lead to more stable internal fixation of fracture fragments and helps in the early mobilization of the patients. The repair of the RC ensures functional restoration of the tuberosity, Secondary reduction loss is rare if fixation is stable. An aggressive dedicated rehabilitation regime including ROM exercises and strengthening exercises will ensure a good functional outcome.

Keywords: Shoulder Function Index (SFInX), proximal humeral internal locking system (PHILOS),

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Introduction

Proximal humerus fractures always remained a challenging problem for most orthopedic surgeons due to the high incidence of complications. It is the most common fracture affecting the shoulder girdle in adults. Proximal humerus fractures are the third most common nonvertebral osteoporotic fracture after proximal femur and colles fractures, accounting for >10% of fractures, above the age of 65 years [1]. In young individuals, high-velocity trauma is the cause of these fractures whereas simple falls can be the cause in older individuals because of osteoporosis. The majority of undisplaced proximal humeral fractures can be treated with a sling immobilization and physical therapy [2], however, approximately 20% of displaced proximal humeral fractures require surgery [3]. Conservative treatment

is usually associated with nonunion, malunion, and avascular necrosis resulting in a painful dysfunction [4 5]. The surgical modalities use arc transosseous suture fixation, closed reduction and percutaneous fixation, open reduction and internal fixation with conventional plates, locking plate fixation, and hemiarthroplasty which have shown to have mixed results [3,6]. Several complications such as K wire penetration, varus collapse, cut-out or back-out of the screws and plates, nonunion, avascular necrosis (AVN), nail migration, and rotator cuff impingement syndrome. A proximal humeral internal locking system (PHILOS) has been developed to solve these complications, especially to improve fracture fixation in elderly osteoporotic bones. it minimizes soft tissue dissection and gives both axial and angular stability, hence, reducing the risk of fracture

displacement [7]. Our study was to evaluate complications following proximal humerus fracture fixation using a PHILOS plate and functional outcome.

Materials and Method: The study was conducted in the Department of Orthopaedics, Amaltas Institute of Medical Sciences, Dewas, for a period of one year from January 2023 to December 2023. In our study 30 patients were included aged 18 to 75 years of either sex were included in the study. The inclusion criteria were skeletally matured patients with closed fracture proximal humerus with a displacement of > 1cm and a varus angulation of >45°. Severely comminuted, open fractures and valgus-impacted fractures were excluded from the study.

collection of data: As the patients arrived at the casualty, demographic details and mechanism of injury were collected. A careful detailed physical examination is carried out. Assessment for associated injuries is done. X-ray of the shoulder AP view is taken for all patients. Occasionally CT scan with 3D reconstruction is advised based on the requirement after seeing the x-ray. The fractures are then classified according to Neer's Classification. All the necessary preoperative work-up for the patients was done in the form of hematological and radiological examinations and fitness for surgery was obtained. Well-written informed consent was taken from all the patients. Prior Ethical Committee approval was obtained before commencing the study.

Surgical Technique Patients were positioned supine under general anesthesia with the beach chair position (the head end of the table was elevated 30-45 degrees to the horizontal). A small bump was placed behind the patient's back to turn the patient slightly to the opposite side with the affected shoulder off the edge of the table. Intravenous antibiotics are given before skin incision. Place proper padding to avoid compression of neurovascular structures. The skin was prepared with povidone-iodine (10%) solution and draped. A deltopectoral approach was utilized and the necessary surgical steps were followed. A 9 cm to 12 cm incision starting from the coracoid process was taken along the line of the deltopectoral groove. The inter-nervous plane between the

deltopectoral and the pectoralis major muscle was identified and separated. The cephalic vein was retracted laterally or medially depending upon the exposure. The subscapularis muscle was made taut with external rotation and incised in line with its fibers. The fracture fragments were identified as and the hematoma was cleared off completely. Tag sutures were taken through the rotator cuff muscles for later repair. K-wires were used in the humeral head as joysticks and Preliminary and checked in both the orthogonal views. PHILOS plate was applied about 8 mm distal to the greater tuberosity and around 2-4 mm posterior to the bicipital groove to avoid subacromial impingement. The plate was first fixed to the distal fragment and then screws were inserted in the head as per the woodpecker technique. The final reduction was checked in both the orthogonal views. The previously tagged sutures of the rotator cuff were passed through the holes in the plate and sutured. Meticulous closure was done in all the cases.

Post-operative protocol: The shoulder was immobilized with an arm pouch. Intravenous Antibiotics will be given till 3rd postoperative day followed by 5 days of oral antibiotics.

The sutures will be removed on the 15th postoperative day. Most of the functional outcomes following a fracture of the proximal humerus are directly dependent on a good rehabilitative program initiated as early as 1st week depending on fixation, stability, and healing. The following is recommended. rehabilitation program under the supervision of a physiotherapist. Pendulum exercises started from the 1st week post-surgery. Gentle passive forward flexion and rotation exercises were initiated in the 2nd week, Active range of motion exercises and resistive exercises were started in 4-6 weeks. Strengthening exercises were started 10 to 12 weeks after surgery.

Follow-up: Patients were Followed up at 2 weeks, 6 weeks, 3 months and 6 months thereafter. The range of motion was monitored along with physiotherapy for functional recovery. Check x-rays were taken at post-operative days 2, 6 weeks, and 3 months and 6 months. The functional outcome was assessed by using SFInX, and DASH scores at 6 weeks, 3 months, and 6 months.



Figure 1: Deltopectoral Approach Marking

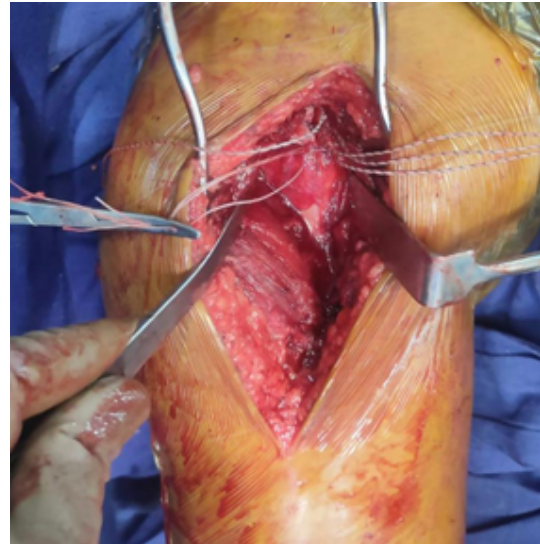


Figure 2: Tag Sutures through RC Muscles

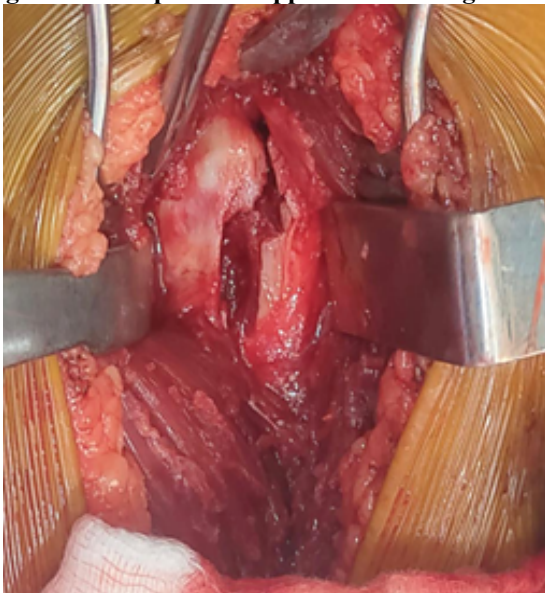


Figure 3: Fracture Fragment



Figure 4: Fractures are reduced and fixed with PHILOS plate and tag sutures



Figure 5: Xray Shoulder AP view

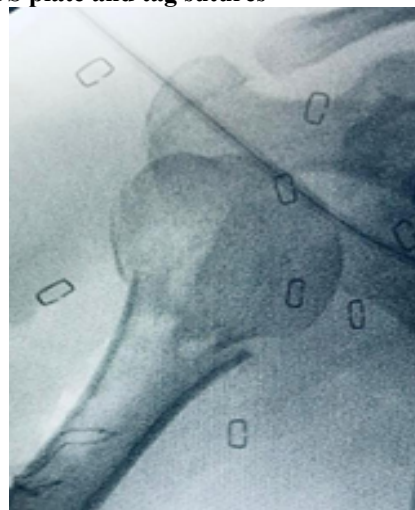


Figure 6: C-Arm Image

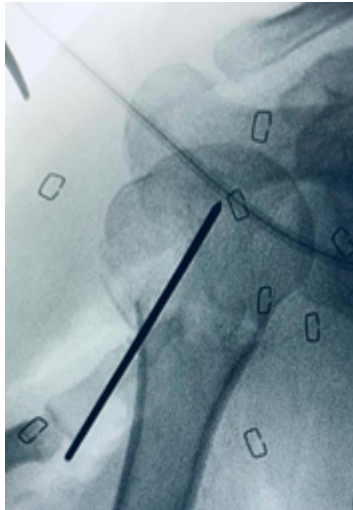


Figure 7: Humeral Head Joy Sticking and Temporary fracture fixation by K-wire.

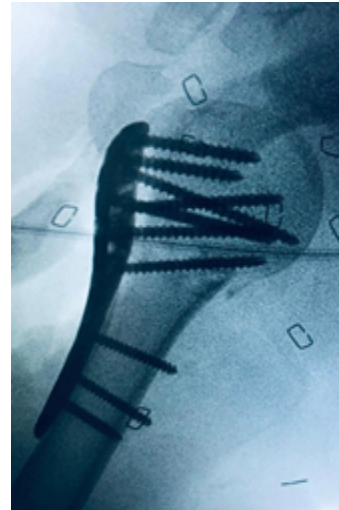


Figure 8: Plate Position and Screw Size in AP view.

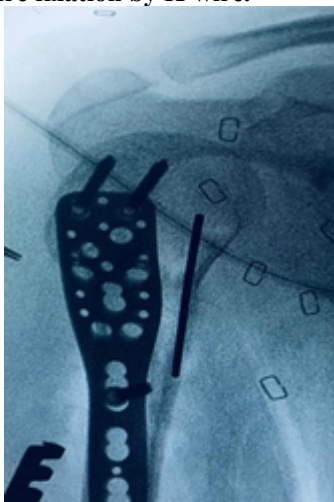


Figure 9: Plate position in LAT view



Figure 10: Postoperative Xray

Results

We studied 30 patients with proximal humerus fractures. All patients were examined clinically and radiologically. Patients were operated on with a PHILOS plate and received similar postoperative care. The final analysis by SFInX and DASH score

was done at 6 weeks, 3 months, and 6 months, The patients in our study aged between 19 years and 71 years.

The maximum incidence was in the age group of 40-60 years accounting for 60.00%. The mean age was 52.4 years.

Table 1: Distributions based on Age Group

Age Group	Frequency	Percentage
< 40 Years	4	13.33%
40 to 60 Years	18	60.00%
> 60 Years	08	26.66%
TOTAL	30	100%

our study group had a significant male predominance consisting of 18 male patients (60%) and 12 female patients (40%). The male-to-female ratio was 3:2.

Table 2: Distributions based on Sex

Sex	Frequency	Percent
Female	12	40
Male	18	60
Total	30	100.0

in our study, there were 3(10%) cases of 2-part fractures,18(60%) cases of 3-part fractures, 9(30%) cases of 4-part fractures.

Table 3: Distributions based on Neer's classification

PART	Frequency	Percent
2 PART	3	10
3 PART	18	60
4 PART	9	30
Total	30	100.0

All 20 (66.7%) cases had right-sided involvement while left-sided involvement was seen in 10 (33.3 %) cases.

Table 4: Distributions based on the Side involved

Side	Frequency	Percentage
Left	10	33.3%
Right	20	66.7%
Total	30	100.00%

The Mode of injury was by RTA in 18 (60%) patients, and fall at ground level in 12 (40%) patients. The average surgical duration was 91+11.3 minutes. The radiological union was seen at 13+4.1 weeks.

Table 5: The mean SFInX score comparison between males and females at different durations.

Variable	Sex	N	Mean Score	Std. Deviation	T-test	P Value	Result
SFInX Score at 6weeks	Male	18	48.71	3.797	-0.854	0.374	Non-Sig
	Female	12	50.17	4.961			
SFInX Score at 3Month	Male	18	54.52	6.358	0.119	0.886	Non-Sig
	Female	12	54.17	8.139			
SFInX Score at 6-Month	Male	18	65.46	8.128	0.335	0.723	Non-Sig
	Female	12	64.24	11.002			

Table 6: The mean DASH score comparison between males and females at different durations.

Variable	Sex	N	Mean Score	Std. Deviation	T-test	P Value	Result
DASH Score 6weeks	Male	18	61.99	9.836	0.146	0.874	Non-Sig
	Female	12	61.39	11.730			
DASH Score 3Month	Male	18	40.74	14.423	-0.558	0.568	Non-Sig
	Female	12	43.93	16.367			
DASH Score 6Month	Male	18	32.49	9.120	-1.439	0.149	Non-Sig
	Female	12	38.46	13.082			

Table 7: SFInX score distribution

SFInX Score	Poor	Average	Excellent
6 WEEKS	4	15	11
3 MONTHS	2	9	19
6 MONTHS	1	8	21

Table 8: Sensitivity and Specificity of SFInX Tool based on DASH Tool as Goldstandard tool (6 weeks)

SFInX Outcome At 6WEEKS		Dash Outcome At 6 weeks		Total
		Normal	Not Normal	
Normal	Count	15	3	18
	%	83.3%	25%	60.00%
Abnormal	Count	3	9	12
	%	16.7%	75%	40.00%
Total	Count	18	12	30
	%	100.0%	100.0%	100.0%
Variable	Value	Df	P Value	Result
Chi-Square Tests	16.747 ^a	1	0.000	Sig
Sensitivity	75.00%			High
Specificity	83.33%			High
PPV	75.00%			High
NPV	83.33%			High
Accuracy	86.54%			High

The P value < 0.05 shows that there was a significant association between the outcomes of the two methods.

The higher value of sensitivity 75.00% and PPV 75.00% shows that the positive diagnosis as an abnormal outcome by SFInX score is quite similar to the Abnormal outcome diagnosed by the DASH tool.

Similarly, the higher value of specificity 83.33% and NPV 83.33% shows a higher degree of similar

diagnosis of Normal outcome by SFInX score and DASH tool.

Also, the quite higher value of accuracy 86.54% proves that the SFInX score method can be used as an alternate method to the DASH tool for correct diagnosis of Abnormal as well as Normal outcomes at 6 week duration.

Table 9: Sensitivity and Specificity of SFInX Tool based on DASH Tool as Goldstandard tool (3 Months)

SFInX Outcome At 3 Month		Dash Outcome At 3 Month		Total
		Normal	Not Normal	
Normal	Count	19	2	21
	%	90.47%	22.30%	70.00%
Not Normal	Count	2	7	9
	%	9.53%	77.70%	30.00%
Total	Count	21	9	30
	%	100.0%	100.0%	100.0%
Variable	Value	Df	P Value	Result
Chi-Square Tests	22.523	1	0.000	Sig
Sensitivity	77.70%			High
Specificity	90.47%			High
PPV	77.70%			High
NPV	90.47%			High
Accuracy	92.85%			High

The P value < 0.05 shows that there was a significant association between the outcomes of the two methods.

The higher value of Sensitivity 77.70% and PPV 77.70% shows that the positive diagnosis as an Abnormal outcome by SFInX score is quite the same as the Abnormal outcome diagnosed by the DASH tool.

Similarly, the higher value of Specificity 90.47% and NPV 90.47% shows a higher degree of similar diagnosis of Normal outcome by SFInX score and DASH tool.

Also, the quite higher value of accuracy 92.85% proves that the SFInX score method can be used as an alternate method to the DASH tool for correct diagnosis of Abnormal as well as Normal outcomes at a 3-month duration.

Table 10: Sensitivity and Specificity of SFInX Tool based on DASH Tool as Gold standard tool (6 Month)

SFInX Outcome At 6 Month		Dash Outcome At 6 Month		Total
		Normal	Not Normal	
Normal	Count	23	0	23
	%	95.8%	0.0%	74.6%
Not Normal	Count	1	6	7
	%	4.2%	100.0%	25.4%
Total	Count	24	6	30
	%	100.0%	100.0%	100.0%
Variable	Value	Df	P Value	Result
Chi-Square Tests	25.989	1	0.000	Sig
Sensitivity	100.00%			High
Specificity	95.8%			High
PPV	87.50%			High
NPV	100.00%			High
Accuracy	96.69%			High

Discussion

The best management of proximal humerus fractures is still inconclusive. Proper patient selection and thorough knowledge of the anatomy and biomechanical principles are the prerequisites for a successful surgery. Accurate anatomical reduction

gains, a pattern of the fracture. the quality of the bone encountered and early fracture fixation are significant to get a good final functional outcome. in our study The ages of patients varied between 19 years and 71 years. The majority of the patients were in the age group 40-60 years. These constitut-

ed 18 (60%) of the total study subjects. The mean age in Our study was found to be 52.4 years. These findings were similar to the studies by Dolfi Herscovici et al [8] which reported a mean age of 52 years, Neer's study et al [9] reported a mean age of 55.3, Roland p Jacob et al [10] reported a mean age of patients is 49.5, Gerber C et al [11] reported a mean age of 44.9 years. Our study showed a male preponderance of 60% with a Male to Female ratio of 3:2. This is relatable to a study by Agarwal S, et al [12]. who reported a male-to-female ratio of 1.7:1, Roland p Jacob et al [10] reported a male-to-female ratio of 2:1. Our study shows that most Proximal humerus fractures are traumatic fractures in men over the age of 45. The prevalence of PHF increases as the population ages. The risk of fracture begins to increase linearly in women in their fifties, this is due to a lack of post-menopausal treatment and its awareness. Our study showed the most common mode of injury to be road traffic accidents with an incidence of 60%. The other 40% of patients were injured by falls at ground level. These findings were consistent with a similar study by Patil SN, et al [13]. who reported 70 % of cases from road traffic accidents 181, Koji Yamamoto [14] et al reported 75% of cases from road traffic accidents. The study of the type of fracture in our series revealed 3(10%) were 2-part fractures, 18(60%) were 3-part fractures and 9(30%) were a 4part fracture and Neer's [9] study shows, 31(26.5%) were 2part fractures, 43(36.8%) were 3 part fractures and 43(36.8%) were 4 part fractures. In a study done by Dolfi Herscovici, 20(50%) were 2-part fractures, 16(40%) were 3-part fractures and 4(10%) were 4 part fractures. In our series 3(10%) had shoulder stiffness and 2(6.6%) had superficial infection most of these patients were elderly and were unwilling to undergo a rigorous rehabilitation program. In patients complicated with Stiffnes, phase-wise physiotherapy was started after the clinical union was confirmed. They ended up with satisfactory results. The complications in other series like the study done by Neer [9], 3 had a post-operative infection, 4 had malunion, 7 had nonunion and 8 had avascular necrosis of the humeral head, Richard Hawkins [15] et al reported 2 had implant loosening and 2 had avascular necrosis of the humeral head. Results assessed with the shoulder function index scoring system 70% have achieved excellent and satisfactory results, 26.7% average, and 3.3% poor results. Student T test for two sample mean was applied to compare the mean score, which shows that there was a non-significant difference between male and female scores at all the time intervals. (P>0.05)

At 6 weeks the mean DASH score of males 61.99 was non significantly more than the mean score 61.39 of for females. (P>0.05)

At 3 Months the mean DASH score of males 40.74 was non significantly less than the mean score

43.93 of for females. (P>0.05)

At 6 Months the mean DASH score of males 32.49 was non significantly less than the mean score 38.46 of for females. (P>0.05)

Student T test for two sample mean was applied to compare the mean score, which shows that there was a non-significant difference between male and female scores at all the time intervals. (P>0.05)

At 6 weeks the mean SFInX score of males 48.71 was non significantly less than the mean score 50.17 of for females. (P>0.05)

At 3 Months the mean SFInX score of males 54.52 was non significantly more than the mean score 54.17 of for females. (P>0.05)

At 6 Months the mean SFInX score of males 65.46 was non significantly more than the mean score 64.24 of for females. (P>0.05)

SFInX score and the DASH tool at 6 weeks, 3 months, and 6-month duration, which was determined by the chi-square test of association between two variables. The P value < 0.05 shows that there was a significant association between the outcomes of the twomethods.

To determine the effectiveness of the new SFInX score method at a 6-week, 3-month, and 6-month duration, the sensitivity, specificity, Positive predictive value PPV, Negative predictive value NPV, and accuracy were calculated. [16]

The higher value of sensitivity 100% and PPV 87.5% shows that the positive diagnosis as an Abnormal outcome by SFInX score is quite similar to the Abnormal outcome diagnosed by the DASH tool.

Similarly, the higher value of specificity 95.83% and NPV 100% shows a higher degree of similar diagnosis of Normal outcome by SFInX score and DASH tool. [17]

Also, the quite higher value of accuracy 96.69% proves that the SFInX score method can be used as an alternate method to the DASH tool for correct diagnosis of Abnormal as well as Normal outcomes at a 6-month duration. Similarly, the SFInX can be used as an evaluative instrument in clinical research investigating the clinical management of people with proximal humeral fractures. High-quality evidence and treatment guidelines are currently lacking, indicating that randomized controlled trials evaluating management strategies in this population are required. Functional outcomes measured by well-developed measures such as the clinician observed SFInX, should be used. [18,19]

Finally, we can conclude that at a 6-week, 3-month, and 6-month duration, we can use the SFInX score method also instead of the DASH tool to diagnose

the abnormality in the patient. There are some limitations in the study like small sample size and follow-up duration, therefore, we could not assess whether the score improved or not after 1 year of surgery

Conclusion:

The PHILOS plate has multidirectional screws, which will lead to more stable internal fixation of fracture fragments and helps in the early mobilization of the patients. The repair of the Rotator cuff ensures functional restoration of the tuberosity, Secondary reduction loss is rare if fixation is stable.

An aggressive dedicated rehabilitation regime including ROM exercises and strengthening exercises will ensure a good functional outcome.

So, we can conclude from our study that SFInX measures shoulder function by judgment of actual ability to perform daily tasks in which the shoulder is involved. It has content relevant to patients and clinicians, feasible for use in clinical and home settings This study comprehensively evaluated the measurement properties of the SFInX in people recovering from a proximal humeral fracture. SFInX system has near similar significance as compared to that of the gold standard DASH score.

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