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Functional and radiological outcomes of unstable proximal femur fixed with anatomical proximal locking compression plate

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Abstract
Introduction: Per trochanteric fractures are defined as fractures that start at the extra capsular region of the basilar neck and proceed through or below the greater trochanter along the lesser trochanter. Nearly 50% of all proximal femoral fractures are per trochanteric fractures. The goal is to investigate the issues associated with unstable proximal femur fractures treated using proximal femur locking compression plates (PF-LCP) and their functional and radiological outcomes.
Material and methods: A total of 30 cases were included in our prospective study with unstable per trochanteric fractures treated with proximal femoral locking compression plate between May 2021 and May 2022. These proximal femoral fractures included unstable – intertrochanteric with sub trochanteric extension and sub trochanteric with intertrochanteric extensions. At six weeks, three months, and six months, clinical and radiological follow-ups were conducted as per the standard procedure. Standard anteroposterior and lateral X-rays of the operated hip were used to evaluate radiological outcomes such as union and neck-shaft angles. A modified Harris Hip Score was used to evaluate clinical and functional outcomes.
Results: Among the 30 cases, the mean age was 40+/-14.6 years and the most common mode of injury was road traffic accidents. They were treated with PF-LCP. The average radiological time of union was 13.7+/-1.74 weeks. The mean average of Harris Hip Score in our study was 86.4 with 11 excellent (35%), 15 good (50%), and 4 fair (15%). The neck-shaft angle for 90% of patients was between 120˚-135˚. One patient developed varus collapse which eventually failed to unite, and two patients had screw pull out.
Conclusion: There has always been debate over the best implant to employ for treating unstable per trochanteric fractures. We conclude that the use of PF-LCP is a reliable, stable option. It offers excellent to good bone healing, lesser complications, and more biomechanical stability.

Keywords: Pertrochanteric fracture, proximal femur fracture, PFLCP, Harris Hip Score.

Introduction
Per trochanteric fractures are defined as fractures that start at the extracapsular region of the basilar neck and proceed through or below the greater trochanter along the lesser trochanter. [1]. Nearly 50% of all proximal femoral fractures are per trochanteric fractures, with death rates ranging from 4.5% to 22 % [2, 3]. They are a significant contributor to old age impairment. These fractures are linked to functional impairment, decreased mobility, and loss of independence [4]. While sliding hip screws (SHS) are typically used to treat stable intertrochanteric fractures, unstable fractures still provide a difficulty due to the wide range of implant options and fewer specific indications, as well as mechanical complication rates that can reach 20% [4-7]. The PFLCP (proximal femoral locking compression plates) have some biomechanical advantages, intramedullary implants are typically chosen for the fixation of unstable fractures [5, 6]. However, additional medullary procedures are preferable when nailing is challenging or inappropriate for complex fracture patterns with comminution or when the medullary canal is too small for the intramedullary implantation. In addition to the medullary implant a contact-limited implant called PFLCP enables several angularly stable fixations [2]. It is stronger and stiffer than conventional angular stable implants, especially in osteoporotic fractures, and it preserves greater bone stock after implantation [2].

Another crucial component for stabilizing unstable trochanteric fractures is the intact lateral trochanteric wall; when this wall is broken, the fixation system collapses. While using percutaneous plating to treat unstable trochanteric fractures, this complication has not yet been documented. Locking plates with lateral wall buttresses are helpful for keeping unstable fractures reduced [4, 7]. Infection, non-union, malunion, decubitus ulcers, fat emboli, deep vein thrombosis, pulmonary embolism, pneumonia, myocardial infarction, stroke, and mortality are complications related to these injuries that result in substantial morbidity. The goal is to investigate the issues associated with unstable proximal femur fractures treated using proximal femur locking compression plates (PF-LCP) and their functional and radiological outcomes. Patients who underwent proximal femur locking compression plate surgery for an unstable proximal femur fracture were monitored functionally using the Harris Hip Score and radiographically using the neck-shaft angle measurement.

Materials and Methods

This was a prospective study of 30 patients with unstable per trochanteric fractures treated with PF-LCP who visited the emergency room between May 2021 and May 2022. This study was granted approval from the institution's ethical review board. All patients over the age of 18, without another ipsilateral limb fracture, with a standard pre-ambulatory status, who have an unstable per trochanteric fracture (reverse oblique intertrochanteric/sub trochanteric fracture, lateral wall disruption), posteromedial comminution, which makes the fracture configuration unstable were included. The study excluded patients with pathological fractures, polytrauma, open fractures, and the paediatric population. At the time of admission, a comprehensive clinical and radiological evaluation was performed on every patient. Using conventional radiography, hip AP and Lateral images were obtained, and the type and pattern of the fracture were recorded. The limb's neurovascular condition was assessed, and the results were documented in the case files. The fractures were classified into three types (AO) 31A: 3 - proximal femur; 1A - trochanteric region; 31A1 - simple per trochanteric; 31A2 - multifragmentary per trochanteric lateral wall incompetent; and 31A3 - intertrochanteric (reverse obliquity) according to the AO classification. 31A2 and 31A3 fractures were included in our investigation (Figure 1). The neck-shaft angle, surgical complications, and functional outcomes were measured by the modified Harris Hip Score at six weeks, six months, and twelve months. These were the primary endpoints.

The patients' surgical fitness was evaluated after normal blood tests. Any comorbid conditions were noted in the case files and identified. After receiving the patients' informed, signed consent, the procedure was performed on them. On the fracture table, the patients were in the supine position. Before performing the procedure, spinal anaesthesia was administered. All patients got a single intravenous injection of 1 g of cefazolin 30 minutes ahead of surgery. When required, either a lateral minimally invasive or lateral traditional method was employed. The fractures were straightened out by proximally fixing the angular stable screws into the head-neck fragment and using the plate as a reduction tool. An anterolateral approach was used, if necessary, to expose the femoral head and neck. It is recommended to start inserting screws in the Alpha hole before continuing. Following the installation of head screws, fluoroscopy was used to verify the appropriate positioning of the plate and screw length. The wound was closed in layers and then covered with a sterile bandage.

Postoperative radiographs were done to evaluate how well the fracture reduction and fixation went. Patients in both groups got intravenous antibiotics for a total of 5 days. On the second postoperative day, wound inspection and dressing was done. Patients were taught physiotherapy exercises and partial weight bearing was started after 6 weeks postoperatively or following the clinical and radiographic union of fracture.

At six weeks, three months, and six months, clinical and radiological follow-ups were conducted as per standard procedure. Standard anteroposterior and lateral X-rays of the operated hip were used to evaluate radiological outcomes such as union and the neck-shaft angles. A modified Harris Hip Score was used to evaluate clinical and functional outcomes. All grading and follow-up information was documented in the patient case records. The information was analysed using IBM SPSS Version 22. Continuous variables were expressed as mean and SD, whilst categorical variables were expressed as numbers and percentages. The chi square test was used to compare categorical variables. A P value of less than 0.05 was used to determine statistical significance.

Results

30 patients with unstable per trochanteric fractures operated between May 2021 and May 2022, complying with the inclusion criteria were assessed. All patients were operated by the same surgeon and were available for a 12 month follow up of the functional and radiological outcomes. The mean age of the study population was 40+/-14.6 years, with 4 patients aged more than 60 years and five patients less than 30 years. The most common mode of injury was RTA (road traffic accident; n=16 patients), and a minority of the study group sustained these fractures following fall from height (n=5). There were no perioperative complications reported in the study group. The mean duration of this surgery was 127+/-11.27 minutes. The average blood loss reported during the surgery was 193+/-67 ml.

The radiological union was assessed based on the obliteration of the fracture line and the trabecular continuity of at least three out of four cortices between the two fragments in antero-posterior (AP) and lateral X-ray views. Mean radiological union time was 13.7+/-1.74 weeks, with 27 patients achieving union between 10-15 weeks, and three patients took more than 15 weeks for union. Two patients had non-union and required re-surgery and showed signs of the union in further follow-ups. The mean neck-shaft angle for 90% of patients was between 120˚-135˚. Out of the 30 patients, one patient developed varus collapse failed to unite, and two patients had screw pull out. One patient developed wound related complication in form of superficial skin infection which was treated with antibiotic and eventually subsided (Figure 5). There was no mortality reported during the study period.

Discussion

Stable fractures of the proximal femur can be easily treated with osteosynthesis with conventional implants with predictable results. However, management of unstable fractures is a challenge for the surgeon because of difficulty in obtaining anatomical reduction. Conventionally, the medial and posteromedial fracture fragments have been important elements in determining the severity of the per trochanteric hip fractures. However, the importance of the lateral

trochanteric wall in stabilizing the per-trochanteric fractures has been recognized by several authors [8-13]. Numerous internal fixation devices have been utilised in management of per trochanteric fractures due to increased incidence of complications documented after treatment with implants such as dynamic hip screw, dynamic condylar screw, angular blade plates and cephalomedullary nails. Lack of satisfactory implant in surgical treatment of per-trochanteric fractures resulted to series of evolution in design of a perfect implant.

The 4.5/5.0 mm proximal femoral locking compression plate (PF-LCP) is a limited-contact, angular, stable construct designed specifically for fractures in the proximal femoral region [13]. Unlike the conventional compression plate, the screw head 'locks' into the PF-LCP, thereby creating an angular, stable construct [14]. Hence, the PF-LCP does not falter at the screw bone interface and gives strong anchorage in osteoporotic bones [15, 16]. To tackle complex fracture patterns, PF-LCP provides option through multiple locking screw holes. In addition, the PF-LCP functions as an internalized external fixator, and there is no need for close plate-to-bone contact. More biological healing is enabled due to minimal pressure on periosteum [17, 18]. Our major group of patients belonged to 40-50 years age group with mean average age 40.3 years ranging from 19-71 years which contrasts with higher age groups reported by western authors. Our study results are like other Indian studies such as that of Madu *et al.* [18] and Chalise *et al.* [19]. There were 14 males and 16 females in our study (Figure 2). This is in contrast to major female preponderance as observed by Dousa P. *et al.* (20) and Pajarinen J. *et al.* [21]. Out of 30 cases in our study, RTA was the most common mode of injury with 16 patients (more than 50%), which is similar to other studies having road traffic accidents as most common mode of injury followed by second most common cause- simple fall which included fall in bathroom and fall from bed (Figure 3). Osteoporosis is the main cause of the fractures due to simple fall, which usually occurs in elderly people. The least common mode of injury was fall from height with 5 patients (less than 20%). However, most of the fractures that occurred in patients younger than 62 years were either due to road traffic accidents or fall from height. Right side was more commonly involved than the left side (Figure 4).

The maximum and minimum hospital stay of patients in the present study was 16 days and 5 days respectively. The average stay was 10 days which is significantly lesser compared to the study Gunadham *et al.* where average duration of stay was 18 days (22). PFLCP has high rate of fracture healing with the advantage of biological fixation, simple and reliable fixation methods, strong anti-rotation effect and limited occurrence of complications. So it can be a feasible alternative to the treatment of per trochanteric femoral fractures.

Operative procedure for open reduction internal fixation of proximal femur with proximal femoral locking compression plate usually leads to more blood loss compared to MIPO. The mean average blood loss in our study was 193.56 ml which is lower than studies by Gunadham *et al.* [22], Madu *et al.* [23] and Nishikant Kumar *et al.* [24].

The neck shaft angle was calculated radiographically after the fracture was united. The mean average neck shaft angle in our study was 129.23 which was higher compared to study by Malkesh D (Table 2). Shah *et al.* of 125.9 [25]. There were 2 (6.6%) cases of non-union in our study out of 30 cases. The average union time was 13.16 weeks. 13.5 weeks was the average union time in the study by Nishikant Kumar *et al.* which was almost similar compared to our study. Union was achieved in 28 cases (93.4%) out of 30 cases which are significantly higher compared to Nishikant Kumar *et al.* [24] series with 80% union.

The functional outcome was assessed using Harris Hip Score. The mean average of Harris Hip Score in our study was 86.4 with 11 excellent (35%), 15 good (50%) and 4 fair (15%) (Table 1). We achieved similar result as compared to that of Sun-Jun Hu *et al.* (26) series 86.5 with 16 excellent, 22 good, 5 fair and 2 poor, but significantly better result than Lee *et al.* [27] series having Harris Hip Score of 76.46 +/- 16.03.

Our study has few limitations; it is a case series and not a comparison between two surgical techniques. Also it is not a randomized controlled trial. It is a single centre study on smaller group with follow up of only one year. A study with a larger sample size and longer follow up will help evaluate better the outcomes in the general population.

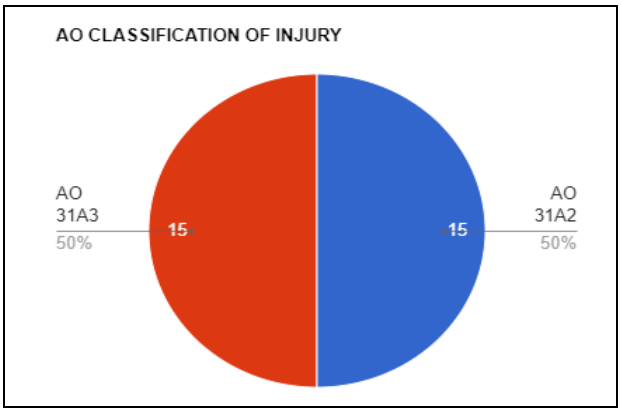

Fig 1: AO Classification of Injury

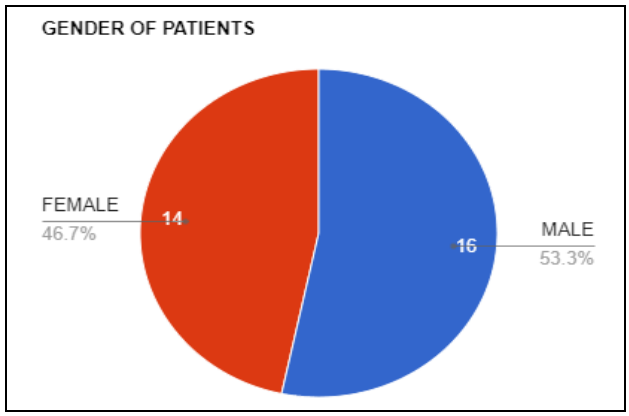

Fig 2: Genders of Patients

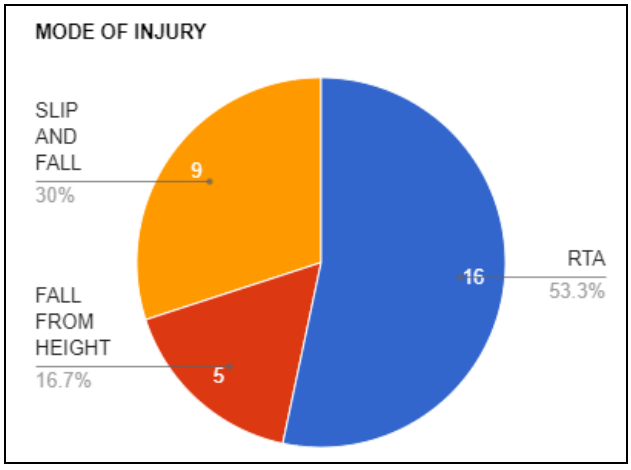

Fig 3: Mode of Injury

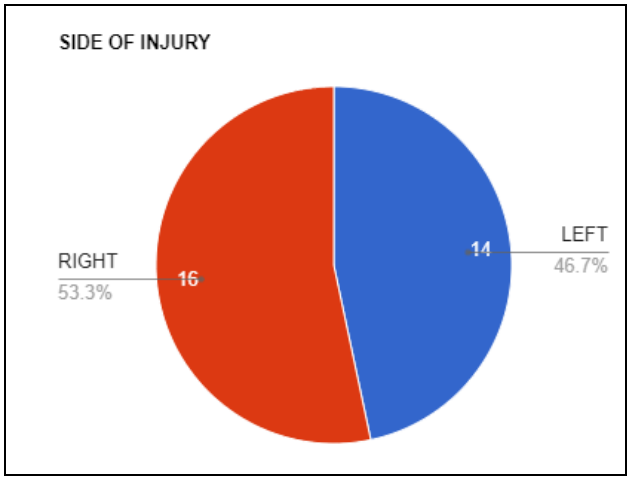

Fig 4: Side of Injury

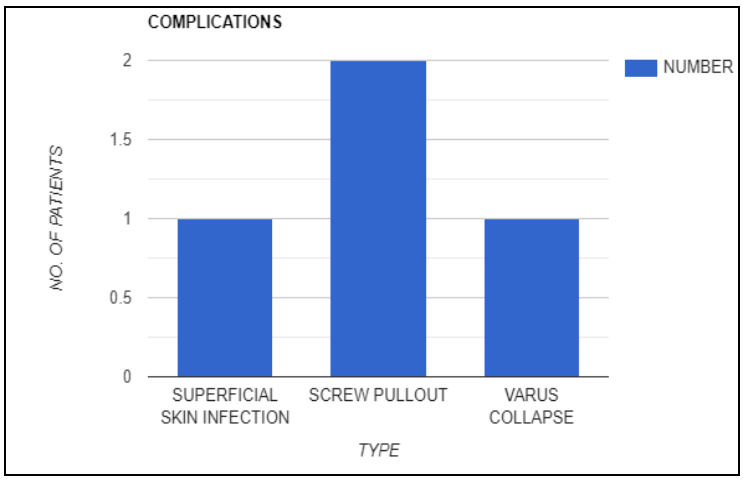

Fig 5: Complications

Table 1: Functional outcome

Outcome	No. of Patients	Percentage
Excellent	11	35%
Good	15	50%
Fair	4	15%
Total	30	100%

Table 2: Patient Demographics and Data

S. No	Age	Gender	Side	Mode of injury	Ao classification 31	Surgical Time (mins)	Blood Loss (ml)	Hospital Stay	Fracture Union (weeks)	Neck shaft angle	Harris hip score post op	6 Weeks	3 Months	6 Months	12 Months
1	34	F	Right	Rta	A2	122	250	10	11	122	68	75	78	79	80
2	44	M	Left	Slip and fall	A2	132	162	12	13	125	71	78	83	90	95
3	42	M	Left	Fall from height	A2	153	142	12	14	134	68	74	77	79	84
4	50	F	Right	Rta	A3	128	163	16	10	132	64	73	80	84	86
5	24	M	Right	Rta	A3	125	128	8	15	124	65	74	82	89	92
6	19	M	Right	Slip and fall	A3	167	250	6	13	121	69	75	82	87	91
7	48	F	Left	Slip and fall	A2	131	120	10	12	130	64	79	84	86	90
8	39	M	Left	Fall from height	A3	124	165	12	14	135	62	65	67	69	71
9	28	F	Left	Rta	A2	134	240	10	12	131	69	74	85	87	89
10	22	M	Right	Rta	A3	142	310	9	11	129	64	73	77	79	80
11	18	M	Right	Slip and fall	A3	146	340	7	14	132	64	73	78	80	84
12	41	F	Left	Fall from height	A3	141	165	9	15	127	71	79	87	91	93
13	54	F	Left	Rta	A2	125	141	11	16	126	63	73	76	79	82
14	59	F	Right	Slip and fall	A3	126	147	14	12	124	67	74	75	78	79
15	67	M	Right	Rta	A2	137	142	16	13	124	68	74	76	78	79
16	32	M	Left	Rta	A2	142	131	12	14	134	68	76	83	95	93
17	26	F	Left	Slip and fall	A2	127	132	10	10	136	65	79	87	89	90
18	42	M	Left	Rta	A3	129	144	6	11	134	63	70	74	76	80
19	53	F	Right	Rta	A3	125	240	6	13	137	64	74	85	89	90
20	43	M	Right	Rta	A3	135	240	8	15	138	63	73	83	87	89
21	62	F	Left	Slip and fall	A2	137	310	10	16	132	68	79	86	90	93
22	71	F	Right	Rta	A3	141	340	14	16	132	64	74	83	86	88
23	43	F	Left	Rta	A2	147	165	13	14	126	67	75	82	86	88
24	36	M	Right	Fall from height	A2	142	141	12	15	132	67	73	80	82	84
25	39	M	Right	Rta	A2	131	180	10	12	124	65	70	72	74	78
26	61	M	Left	RTA	A2	132	190	5	11	127	75	80	86	92	96
27	24	F	Left	Slip and fall	A3	144	220	6	12	130	68	79	85	91	94
28	28	F	Right	Fall from height	A3	126	250	8	13	124	68	78	80	82	84
29	31	M	Right	RTA	A2	115	124	8	14	123	72	76	83	85	84
30	26	F	Right	Slip and fall	A3	114	135	8	14	132	68	75	84	85	88

Conclusion

There has always been debate over the best implant to employ for treating unstable per trochanteric fractures. In this study, we applied anatomic, fixed-angle plates to per trochanteric fractures, and over the course of follow-up, we observed significant improvement in functional and radiological outcomes. In the management of per trochanteric femoral fractures, we conclude that the use of PF-LCP is a reliable, stable option. We noted that the type of fracture and its severity in the proximal femur has an important bearing on the implant to be used. It offers excellent to good bone healing, lesser complications, and more biomechanical stability.

Conflict of Interest

Not available

Financial Support

Not available

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