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A study of functional and radiological outcome of proximal femoral locking plate fixation in proximal femoral fractures

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Abstract

Background: Unstable intertrochanteric fractures are challenging injuries associated with difficulty in maintaining fracture stability and achieving satisfactory functional recovery. Proximal femoral locking plates provide angular stability and may be useful in the management of unstable fracture patterns.

Aim: To evaluate the functional and radiological outcomes of proximal femoral locking plate fixation in unstable intertrochanteric fractures.

Methods: This prospective study included 30 patients with unstable intertrochanteric fractures treated with proximal femoral locking plate fixation between June 2022 and June 2024. Patients were evaluated clinically and radiologically during follow-up at 6 weeks, 3 months, 6 months, and 12 months. Functional outcome was assessed using the Modified Harris Hip Score (mHHS), while fracture union, alignment, and implant-related complications were assessed radiologically.

Results: The study included 16 males and 14 females, with a mean age of 59.4 years. Falls were the most common mode of injury (66.67%). The mean duration of immobilisation was 6.7 weeks. Weight bearing was initiated at 6 weeks in 22 patients, 8 weeks in 5 patients,

and 10 weeks in 3 patients. The mean mHHS improved from 52.14 at 3 months to 67.07 at 6 months and 79.07 at 12 months. At final follow-up, 6 patients had poor, 7 fair, 6 good, and 7 excellent functional outcomes. Superficial infection occurred in 4 patients, screw breakage in 2, and varus collapse in 1.

Conclusion: Proximal femoral locking plate fixation provided satisfactory functional and radiological outcomes in unstable intertrochanteric fractures. Progressive improvement in functional scores and an acceptable complication rate suggest that it is an effective fixation option for selected unstable fracture patterns.

Keywords: Intertrochanteric Fracture, Proximal Femoral Locking Plate, Functional Outcome, Modified Harris Hip Score, Fracture Fixation, Radiological Outcome.

Introduction

Intertrochanteric fractures are extracapsular fractures of the proximal femur occurring in the region between the greater and lesser trochanters. They represent a major proportion of proximal femoral fractures and are associated with significant morbidity, particularly in elderly patients with osteoporosis and multiple medical comorbidities. With increasing life expectancy and the growing elderly population, the incidence of proximal femoral fractures is expected to increase substantially. These fractures can result in prolonged immobilisation, loss of independence, postoperative complications, and increased mortality, making early and effective treatment essential.[1,2]

The mechanism of injury varies according to age and bone quality. In elderly patients with osteoporosis, intertrochanteric fractures commonly occur following low-energy trauma such as a simple fall from standing height. In younger individuals, these fractures are more frequently associated with high-energy trauma such as road traffic accidents or falls from a height[3]. Osteoporosis plays an important role in fracture development because progressive reduction in trabecular and cortical bone strength decreases the ability of the proximal femur to withstand relatively minor trauma[4].

The stability of an intertrochanteric fracture depends primarily on the integrity of the posteromedial cortex and the lateral wall. Stable fractures generally have an intact posteromedial buttress and lateral wall, whereas unstable fractures may demonstrate comminution of the medial cortex, loss of the lateral wall, reverse obliquity, subtrochanteric extension, or multiple fracture fragments. Such unstable patterns are difficult to reduce and maintain and are associated with a greater risk of secondary displacement, implant failure, varus collapse, and limb shortening[5,6].

Evans emphasized the importance of fracture stability and the role of the medial cortical buttress in maintaining reduction. His classification helped establish the principle that restoration of stability is more important than achieving perfect anatomical reduction in every case [5]. The AO/OTA classification subsequently provided a standardised system for describing proximal femoral fractures. In this classification, 31A2 fractures are multifragmentary pertrochanteric fractures with an incompetent lateral wall, while 31A3 fractures include reverse-obliquity and transverse fracture patterns and are considered unstable configurations[7].

The principal objectives of treatment are to achieve acceptable fracture reduction, obtain stable fixation, allow early mobilisation, promote fracture union, restore hip function, and minimise complications. Conservative treatment has largely been replaced by operative fixation because prolonged immobilisation is associated with complications such as deep-vein thrombosis, pulmonary

complications, pressure sores, muscle wasting, and loss of functional independence[1,8].

Several implants have been developed for the surgical treatment of intertrochanteric fractures. The dynamic hip screw (DHS) has been widely used for stable fracture patterns because it permits controlled collapse at the fracture site. However, its effectiveness may be limited in unstable fractures with lateral wall deficiency, reverse obliquity, or extensive comminution. Excessive sliding can result in limb shortening, medialization of the femoral shaft, loss of reduction, and mechanical failure[6,9].

Intramedullary devices such as the proximal femoral nail have become increasingly popular because of their biomechanical advantages, shorter lever arm, and ability to provide stable fixation in unstable fracture patterns. However, complications such as screw cut-out, malposition, peri-implant fracture, and technical difficulties can still occur[10]. Therefore, selection of an appropriate implant should be based on fracture morphology, bone quality, reduction characteristics, and surgeon experience.

The Proximal Femoral Locking Plate (PFLP) is an anatomically contoured extramedullary implant designed specifically for fixation of proximal femoral fractures. It incorporates multiple locking screws directed into the femoral head and neck and provides angular stability. The locking mechanism allows the plate and screws to function as a fixed-angle construct, which may be advantageous in osteoporotic bone where conventional screw purchase may be inadequate[11,12].

One of the potential advantages of PFLP is the availability of multiple proximal screw holes that allow fixation of different quadrants of the femoral head. This can provide a strong proximal fixation construct in patients with comminuted fractures or poor bone quality. The plate can also be used for fractures with lateral wall deficiency where restoration and maintenance of the lateral buttress are important[12,13].

However, PFLP fixation also has certain limitations. Because it is an extramedullary implant, it may be subjected to considerable bending forces, particularly when fracture reduction is inadequate. Improper plate positioning, inappropriate screw length, varus reduction, and inadequate restoration of the medial buttress can contribute to mechanical failure. Complications including varus collapse, screw breakage or backing out, implant failure, and surgical-site infection have been reported[13-15].

Assessment of treatment outcome requires both radiological and functional evaluation. Radiographs are useful for evaluating fracture reduction, alignment, maintenance of fixation, callus formation, union, limb shortening, and implant-related complications. Functional assessment is equally important because radiological union does not necessarily indicate satisfactory recovery of mobility or activities of daily living.

The Harris Hip Score, and subsequently the Modified Harris Hip Score (MHHS), has been widely used to assess functional outcome following hip surgery. The score evaluates pain, function, gait, activities of daily living, and range of motion, with a maximum score of 100. Higher scores indicate better hip function[16]. The Modified Harris Hip Score has also been shown to be a useful and responsive instrument for evaluating functional recovery following pertrochanteric fractures[17].

Bone quality is another important determinant of fixation stability. Singh's index provides a radiographic method of grading osteoporosis based on the trabecular pattern of the proximal femur. Lower Singh's grades indicate greater loss of trabecular bone and poorer bone quality.

Assessment of bone quality is particularly relevant in intertrochanteric fractures because osteoporotic bone may compromise screw purchase and increase the risk of fixation failure[18].

Previous studies have reported satisfactory union and functional outcomes following PFLP fixation of unstable intertrochanteric fractures. However, complications such as superficial infection, screw migration, varus collapse, and implant failure have also been documented[12-15]. Therefore, further clinical evaluation of this fixation method is important, particularly in patients with unstable fracture patterns.

The present prospective study was undertaken to evaluate the functional and radiological outcome of Proximal Femoral Locking Plate fixation in unstable intertrochanteric fractures. The study also evaluated demographic characteristics, mode of injury, fracture classification, bone quality according to Singh's index, postoperative complications, duration of immobilisation, fracture healing, and functional outcome, as assessed using the Modified Harris Hip Score during follow-up.

Materials and Methods

This was a prospective study of 30 cases of unstable intertrochanteric fractures who underwent operative treatment. During the course of this study, between June 2022 and June 2024, 30 patients with unstable intertrochanteric fractures according to the AO/OTA classification type 31A2.2, 31A2.3, and all of 31A3 were included in the study after obtaining due approval from our Institutional Board. Each patient was included in the study after obtaining due written and informed consent.

Inclusion Criteria

- Patients between the age of 18 and 65 years.
- Patients of both genders with proximal femoral fracture.
- Patients with fresh injuries and previously operated patients with failed fixation (e.g., non-union).
- Patients willing to undergo the procedure.
- Patients without any neurovascular involvement.

Exclusion Criteria

- Patients under the age of 18 years and beyond the age of 65 years.
- Patients not willing to undergo surgery.
- Patients with associated pelvic injuries.
- Patients with open fractures.
- Patients with active infection at the fracture site.
- Patients with neurovascular involvement.

Management Protocol

At our institute, the following protocol was followed for the management of all the patients involved in this study:

- Initial assessment of ABC (Airway, Breathing, and Circulation) was done in the emergency department, and initial treatment was given accordingly.
- After the patient was vitally stable, he/she was examined for distal neurovascular status, i.e., distal pulse and movements. A thorough history was taken, and general examination was done to rule out any other associated fractures.
- X-rays were taken thereafter. Patients were stabilised in the wards by giving gentle skin traction, intravenous analgesics, and serratiopeptidase for swelling. Care was taken to prevent the affected limb from remaining in prolonged external rotation to avoid damage to the common peroneal nerve.
- Limb elevation and calf-pump exercises were given to reduce swelling in dependent parts. In patients with moderate to massive knee swelling, knee aspiration was performed.
- Patients were kept in a head-up position, and chest physiotherapy was initiated preoperatively.

- Patients were examined daily for pressure sores, and preventive care was provided.
- Fractures were classified according to the integrity of the lateral wall after radiographs and CT scans in the requisite patients. Surgery was planned after proper blood investigations, medical fitness, and confirmation of healthy local skin conditions.

Preparation of the patient for surgery

After the patient was medically fit to undergo the surgical procedure:

- Consent for surgery was taken.
- The surgical limb was marked.
- The local area was prepared by shaving, and Savlon scrub was given preoperatively.
- Injectable antibiotics were given the night before surgery and 1 hour before surgery.
- All patients were given an enema 24 hours before surgery.
- All patients were catheterised before surgery if they had not been catheterised in the emergency department.
- Thorough aseptic precautions were taken during the surgery.

Surgical technique for fixation of fracture

All 30 patients were operated on in the supine position on a traction table. The other limb was kept in flexion, abduction, and external rotation. The image intensifier was positioned between the two lower limbs to obtain fluoroscopic images. Undue pressure on the genitalia was prevented by adequate padding of the post in the perineum. The affected limb was kept in traction, adduction, and internal rotation.

Fluoroscopic images in anteroposterior and lateral views of the hip were taken before initiation of surgery to assess the effect of traction and the position of the fractured fragments.

A reduction manoeuvre was performed to achieve closed reduction of the fracture before incision. After acceptable reduction, painting and draping were done under aseptic precautions.

An incision was made on the lateral aspect of the proximal thigh, extending from just above the tip of the greater trochanter up to the level of the lesser trochanter.

The skin and subcutaneous tissue were incised, and the iliotibial band was cut in line with the skin incision. The morphology of the lateral wall was observed with the help of an image intensifier and by direct visualisation.

All patients included in this study were treated with a Proximal Femoral Locking Plate (PFLP).

For fixation with a proximal femoral locking plate, the incision was enlarged according to the length of the plate, and the lateral aspect of the proximal femur was exposed. The lateral wall morphology was identified and primarily reduced and held with either bone clamps, Steinmann pins, or Kirschner wires.

The plate was then applied to the lateral surface of the femur and initially fixed to the shaft with a cortical screw. Multiple cancellous locking screws of appropriate lengths were inserted to hold different quadrants of the femoral head. Lastly, the plate was fixed to the shaft with cortical locking screws.

Post-Operative Protocol

- Patients were given parenteral antibiotics for at least 3 days, and oral antibiotics were continued for 5 days.
- The affected limb was kept on one pillow for the swelling.
- The first postoperative dressing was done after 24 hours, and the drainage tube was removed. The second dressing was done on the 3rd postoperative

day. Stitches were generally removed by postoperative day 12–15.

- Thromboprophylaxis for DVT was given to high-risk patients.
- Patients were discharged around postoperative day 5, considering a healthy stitch line was present.
- Anti-osteoporotic treatment was started for all patients in the postoperative period.

Physiotherapy

- Static quadriceps and hamstring strengthening exercises were started.
- Calf-pump exercises were started.
- Abductor strengthening exercises along with high-sitting knee-bending and knee flexion-extension exercises were initiated on the first postoperative day.
- Weight-bearing exercises were started after radiological signs of union, usually after 6 to 8 weeks.
- Initially, protected toe-touch weight bearing was started, followed by gradual progression to complete and unassisted weight bearing.

Instructions on discharge

- Patients were advised to ensure proper hygiene of the stitch line and avoid wetting the dressing.
- Patients were asked to strictly avoid weight bearing without medical advice.
- Patients were advised to consult the surgeon in case of any soakage or discharge from the stitch line as soon as possible.
- Patients were advised to maintain the operated limb in neutral rotation while lying in bed.
- Patients were advised to avoid hanging the operated limb for prolonged periods to avoid any increase in swelling.
- All patients received abductor strengthening exercises and fall-prevention programs.

Follow-up

Patients were followed up twice every week until the time of stitch removal, after which regular follow-up was conducted at 6 weeks, 3 months, 6 months, and 1 year. At each follow-up visit, the patient underwent thorough clinical and radiological examination.

Both anteroposterior and lateral view radiographs were taken, along with an anteroposterior radiograph of the pelvis, to analyse evidence of union and callus formation. Radiographs were also analysed to ensure that reduction and alignment were well maintained.

The range of motion was checked along with the level of pain at each visit. Any restriction in mobility was thoroughly assessed and noted.

Results and observations

In this prospective study, 30 patients with intertrochanteric fractures treated surgically with a Proximal Femoral Locking Plate (PFLP) between June 2022 and June 2024 were included. The patients were enrolled in the study after obtaining due approval from the Institutional Board and written informed consent from each patient. The demographic characteristics, mode of injury, comorbidities, associated injuries, indications for surgery, fracture classification, Singh's index, postoperative complications, duration of immobilisation, and functional outcome were evaluated.

1. Age and Sex Distribution

Most of the patients enrolled in the study belonged to the 71–80 years age group, with 8 patients in this age group. The youngest patient was 24 years old, while the oldest was 86 years old. The mean age of the patients was 59.4 years. Among the 30 patients, 16 were males, and 14 were females.

Table 1: Age and Sex Distribution of Patients

Parameter	Category	No. of patients
Age group (years)	21–30	4
	31–40	3
	41–50	3
	51–60	4
	61–70	6
	71–80	8
	81–90	2
	Total	30
Sex	Male	16
	Female	14
	Total	30

2. Side Distribution and Mode of Injury

There was an equal distribution of the affected side in the study, with 15 patients having left-sided and 15 patients having right-sided intertrochanteric fractures. The majority of patients sustained the fracture following a trivial fall, accounting for 20 patients (66.67%). Nine patients sustained fractures following road traffic accidents, while one patient sustained an intertrochanteric fracture during a violent episode of convulsion.

Table 2: Side Distribution and Mode of Injury

Parameter	Category	No. of patients	Percentage (%)
Side	Right	15	50.00
	Left	15	50.00
	Total	30	100.00
Mode of injury	Fall	20	66.67
	Accident	9	30.00
	Others	1	3.33
	Total	30	100.00

3. Co-morbidities and Associated Injuries

The majority of patients had one or more comorbidities, with hypertension being the most common comorbidity and present in 8 patients. Four patients had both hypertension and diabetes, while one patient had diabetes alone. Five patients had other comorbidities, including hypertension with asthma, epilepsy, osteogenesis imperfecta, polio with hypothyroidism, and cervical cancer. Twelve patients had no comorbidities.

Most patients had no associated injuries. Three patients had distal-end radius fractures, one patient had bilateral superior and inferior pubic rami fractures, and one patient had a vertebral wedge fracture.

Table 3: Co-morbidities and Associated Injuries

Parameter	Category	No. of patients
Co-morbidities	Hypertension	8
	Diabetes	1
	Hypertension + Diabetes	4
	Others	5
	No co-morbidities	12
	Total	30
Associated injuries	Distal end of radius fracture	3
	Bilateral superior and inferior pubic rami fracture	1
	Vertebral wedge fracture	1
	No associated injuries	25
	Total	30

4. Indication for Surgical Intervention and AO/OTA Classification

Twenty-five patients presented with fresh fractures. Three patients required revision surgery because of implant failure, while 2 patients had non-union.

According to the AO/OTA classification, the largest number of fractures belonged to the 31A2.3 group, comprising 13 patients. Three patients had 31A2.2 fractures, while 3, 4, and 3 patients had 31A3.1, 31A3.2, and 31A3.3 fractures, respectively.

Table 4: Indication for Surgical Intervention and AO/OTA Classification

Parameter	Category	No. of patients
Indication for surgery	Fresh fracture	25
	Implant failure	3
	Non-union	2
	Total	30
AO/OTA classification	31A2.2	3
	31A2.3	13
	31A3.1	3
	31A3.2	4
	31A3.3	3
	Total as provided	26

5. Singh's Index

Singh's index was determined for all patients included in the study using an anteroposterior radiograph of the pelvis with both femora. Grade 3 was the most common finding, observed in 10 patients, followed by Grade 4 in 7 patients and Grade 2 in 6 patients. Five patients had Grade 6 and 2 patients had Grade 5. None of the patients had Grade 1.

Table 5: Distribution According to Singh's Index

Singh's Index Grade	No. of patients
Grade 6	5
Grade 5	2
Grade 4	7
Grade 3	10
Grade 2	6
Grade 1	0
Total	30

6. Postoperative Complications and Duration of Immobilisation

Most patients had an uncomplicated postoperative period. Twenty-six patients did not develop any postoperative complication, whereas 4 patients developed surgical site infection. Three patients recovered with regular dressing, while one patient required local debridement.

The average duration of immobilisation was 6.7 weeks. Twenty-two patients started weight bearing at 6 weeks, 5 patients at 8 weeks, and 3 patients at 10 weeks.

Table 6: Postoperative Complications and Duration of Immobilisation

Parameter	Category	No. of patients
Postoperative complications	Superficial infection	4
	No complication	26
	Total	30
Duration of immobilisation	6 weeks	22
	8 weeks	5
	10 weeks	3
	Total	**30**

7. Modified Harris Hip Score

Patients were followed up for 12 months and were evaluated at 3 months, 6 months, and 12 months using the Modified Harris Hip Score (MHHS), with a maximum score of 100.

The functional outcome was categorized as poor (<70), fair (70–79), good (80–89), and excellent (>90).

At the final assessment at 12 months, 2 patients had died due to natural causes and 2 patients were lost to follow-up. Among the 26 patients evaluated at 12 months, the mean MHHS was 79.07, with the highest score being 98 and the lowest score being 43.

Six patients had a poor outcome, 7 had a fair outcome, 6 had a good outcome, and 7 achieved an excellent functional outcome.

Table 7: Modified Harris Hip Score at Different Follow-up Periods and Functional Outcome at 12 Months

Follow-up / Outcome	Category	Mean score / No. of patients
MHHS at 3 months	Mean score	52.14
	Patients evaluated	29
MHHS at 6 months	Mean score	67.07
	Patients evaluated	26
MHHS at 12 months	Mean score	79.07
	Patients evaluated	26
Functional outcome at 12 months	<70 – Poor	6
	70–79 – Fair	7
	80–89 – Good	6
	>90 – Excellent	7
	Total evaluated	26

8. Late Postoperative Complications

Among the 30 patients treated with a Proximal Femoral Locking Plate, 2 patients developed screw breakage, while 1 patient developed varus collapse at 3 months, for which revision surgery was advised. The remaining 27 patients did not develop any late postoperative complications.

Table 8: Late Postoperative Complications

Late postoperative complication	No. of patients
Varus collapse	1
Screw breakage	2
No complications	27
Total	30

Discussion

The present prospective study evaluated the functional and radiological outcomes of Proximal Femoral Locking Plate fixation in 30 patients with unstable intertrochanteric fractures. The patients were followed clinically and radiologically, and outcomes were assessed with respect to fracture characteristics, bone quality, postoperative complications, duration of immobilisation, and functional recovery. The findings of the present study were compared with those reported in previous studies.

Age and Sex Distribution

In the present study, the mean age of the patients was 59.4 years, with patients ranging from 24 to 86 years. The largest number of patients belonged to the 71–80-year age group, comprising 8 patients. There were 16 males and 14 females.

Intertrochanteric fractures are traditionally considered fractures of the elderly population and are strongly associated with osteoporosis and low-energy trauma[1,2]. However, the inclusion of younger patients in the present study may be explained by the presence of high-energy trauma as an important mechanism of injury.

The relatively balanced male-to-female distribution in the present study differs from the female predominance frequently reported in osteoporotic hip fractures. This

may be related to the inclusion of younger patients and patients sustaining high-energy injuries. In elderly populations, females generally have a higher incidence of hip fractures because of the higher prevalence of postmenopausal osteoporosis[4].

Side Distribution and Mode of Injury

In the present study, there was an equal distribution between the two sides. Fifteen patients had right-sided fractures, and 15 had left-sided fractures.

A trivial fall was the most common mechanism of injury, accounting for 20 patients (66.67%). Nine patients (30%) sustained fractures following road traffic accidents, while one patient sustained the fracture during a violent episode of convulsion.

The predominance of falls as the mechanism of injury is consistent with the established relationship between osteoporosis and low-energy trauma in elderly patients[1,4]. A simple fall can produce an intertrochanteric fracture when the bone is osteoporotic, and the proximal femur has reduced resistance to bending and compressive forces. In contrast, road traffic accidents are more commonly associated with high-energy fractures and may explain the occurrence of intertrochanteric fractures in younger patients.

Comorbidities and Associated Injuries

In the present series, 12 patients had no comorbidities, while hypertension was the most frequent individual comorbidity. Four patients had both hypertension and diabetes mellitus, while one patient had diabetes alone. Five patients had other medical conditions, including hypertension with asthma, epilepsy, osteogenesis imperfecta, polio with hypothyroidism, and cervical cancer.

Comorbidities are common among patients with proximal femoral fractures, especially among elderly individuals. Cardiovascular disease, diabetes mellitus, respiratory disease, and other systemic disorders can influence preoperative optimization, timing of surgery, postoperative mobilization, and functional recovery[1,2].

Five patients in the present study had associated injuries. These included distal-end radius fractures in three patients, bilateral superior and inferior pubic rami fractures in one patient, and a vertebral wedge fracture in one patient. Associated injuries may adversely affect postoperative rehabilitation because they can limit the patient's ability to use walking aids or participate fully in physiotherapy.

Indication for Surgery and Fracture Classification

Twenty-five patients in the present study presented with fresh fractures, while three patients underwent revision surgery for implant failure and two patients were treated for non-union.

The AO/OTA classification showed that 31A2.3 was the most common fracture pattern, occurring in 13 patients. Three patients had 31A2.2 fractures, while 3, 4, and 3 patients had 31A3.1, 31A3.2, and 31A3.3 fractures, respectively.

The predominance of AO/OTA 31A2.3 fractures reflects the unstable nature of the study population. A2 fractures are characterised by multiple fragments and an incompetent lateral wall, while A3 fractures include reverse-obliquity and transverse patterns[7].

Unstable fracture patterns are associated with increased mechanical demands on the implant. The loss of the lateral wall eliminates an important buttress against excessive sliding and lateral migration of the proximal fragment. Similarly, reverse-obliquity fractures create unfavourable mechanical forces that may predispose to medial displacement of the femoral shaft[6,7].

These characteristics provide a rationale for considering fixed-angle locking constructs in selected unstable fractures. However, implant selection alone cannot compensate for poor reduction or inadequate restoration of the medial buttress.

Singh's Index and Bone Quality

Singh's index was evaluated in all patients. Grade 3 was the most frequently observed, occurring in 10 patients, followed by Grade 4 in 7 patients and Grade 2 in 6 patients. Five patients had Grade 6, two had Grade 5, and none had Grade 1.

The predominance of lower Singh's grades indicates that reduced bone quality was common in this cohort. Osteoporosis is an important risk factor for intertrochanteric fractures and may adversely affect implant fixation[18].

The locking mechanism of the PFLP provides angular stability between the screw and plate and may therefore be advantageous in osteoporotic bone. Unlike conventional non-locking screws, the stability of a locking screw does not depend entirely on compression of the plate against the underlying bone[11,12].

However, locking fixation does not eliminate the biological and mechanical limitations of osteoporotic bone. Poor bone stock may still permit screw migration, cut-out, or failure of the entire construct if the fracture is inadequately reduced or excessively loaded[13].

Postoperative Complications

In the present study, 26 patients (86.67%) did not develop any early postoperative complication, while four patients developed superficial surgical-site infection. Three patients were managed successfully with regular dressings, whereas one patient required local debridement.

The infection rate observed in the present study is comparable with previously reported rates in studies evaluating proximal femoral locking plates. PFLP studies have reported wound infection as one of the common early complications, although the majority of infections have been superficial and manageable with appropriate treatment[12-15].

The relatively low complication rate in the present study may be attributed to appropriate perioperative antibiotic administration, aseptic surgical technique, postoperative wound care, and timely management of superficial infections.

Nevertheless, surgical-site infection remains clinically relevant because infection may delay rehabilitation and, in severe cases, compromise the fixation construct.

Duration of Immobilization and Weight Bearing

The mean duration of immobilization in the present study was 6.7 weeks. Twenty-two patients commenced weight bearing at 6 weeks, five patients at 8 weeks, and three patients at 10 weeks.

The timing of weight bearing was determined by fracture stability and radiological evidence of healing. Early mobilization is desirable after hip fracture surgery because prolonged immobilization can contribute to muscle wasting, joint stiffness, thromboembolic events, pulmonary complications, and loss of independence[1,8].

However, unstable fracture patterns treated with plate fixation may require protected weight bearing until adequate callus formation and mechanical stability are achieved. Excessive loading before sufficient healing may increase the risk of loss of reduction or implant failure, particularly in osteoporotic bone[13].

The postoperative physiotherapy protocol in the present study included static quadriceps and hamstring exercises, calf-pump exercises, abductor strengthening, knee

mobilization, and gradual progression from protected weight bearing to full weight bearing. Such rehabilitation is essential for restoration of hip function and prevention of postoperative stiffness and muscle weakness.

Modified Harris Hip Score

Functional recovery demonstrated a progressive improvement during follow-up. The mean Modified Harris Hip Score increased from 52.14 at 3 months to 67.07 at 6 months and 79.07 at 12 months.

This progressive improvement suggests that functional recovery continued with fracture healing and rehabilitation. Early postoperative limitation of function is expected because of pain, muscle weakness, restricted weight bearing, and reduced mobility. With progressive fracture consolidation and physiotherapy, patients generally regain hip function over subsequent months.

At 12 months, 26 patients were available for functional assessment. The mean MHHS was 79.07, with a maximum score of 98 and a minimum score of 43. Six patients had poor outcomes, seven had fair outcomes, six had good outcomes, and seven had excellent outcomes.

Therefore, 13 of the 26 patients assessed at 12 months achieved good or excellent functional outcomes.

The findings are broadly comparable with previous studies evaluating proximal femoral locking plate fixation. Mahajan et al. reported satisfactory functional outcomes following proximal femoral locking compression plate fixation of unstable pertrochanteric fractures[13]. Other investigators have similarly reported progressive improvement in Harris Hip Scores following fixation of unstable intertrochanteric fractures[12,14].

The Modified Harris Hip Score is particularly useful because it incorporates pain and functional parameters rather than relying solely on radiographic union. Vishwanathan et al. demonstrated that the Modified Harris Hip Score is a valid and responsive instrument for evaluating patients with pertrochanteric fractures in the Indian population.[17]

The final mean MHHS of 79.07 in the present study indicates an overall satisfactory functional recovery, although not all patients achieved a good or excellent result. Poor functional outcomes may be related to advanced age, associated injuries, comorbidities, poor bone quality, postoperative complications, delayed weight bearing, and residual deformity.

Radiological Outcome

Radiological evaluation was performed using anteroposterior and lateral radiographs of the affected hip along with an AP pelvis radiograph. Radiographs were used to assess fracture union, callus formation, alignment, reduction, and maintenance of fixation.

Maintenance of acceptable reduction is particularly important in unstable intertrochanteric fractures. Varus malalignment can increase the mechanical load on the implant and may contribute to progressive collapse and failure. Restoration of the medial and lateral buttresses is therefore essential for maintaining stability[5,6].

The locking plate provides multiple fixed-angle screws in the proximal fragment, which may improve resistance to angular displacement. Nevertheless, the quality of fracture reduction remains a major determinant of outcome. A technically well-positioned plate cannot compensate for an unstable fracture that has been left in varus or has inadequate medial support[13,15].

Late Postoperative Complications

In the present study, two patients developed screw breakage and one patient developed varus collapse at three months, while 27 patients did not develop any late postoperative complication.

Varus collapse is an important complication following fixation of unstable intertrochanteric fractures. It may result from inadequate reduction, poor bone quality, loss of medial cortical support, excessive loading, or failure of the implant construct.

Previous studies of PFLP fixation have also documented mechanical complications including varus collapse, screw migration, screw backing out, and implant failure[12-15]. These complications highlight the importance of accurate reduction, appropriate plate positioning, correct screw length, and restoration of the proximal femoral biomechanics.

The occurrence of screw breakage in two patients in the present study may be related to repeated cyclic loading of the implant in the presence of an unstable fracture pattern. Locking plates provide angular stability, but they remain subject to mechanical fatigue if fracture healing is delayed or if the construct is exposed to excessive forces.

The patient who developed varus collapse at three months was advised revision surgery. This emphasises that although PFLP can provide satisfactory fixation in many unstable fractures, mechanical failure remains possible and patients require regular clinical and radiological follow-up.

Conclusion

Proximal femoral locking plate fixation provided satisfactory functional and radiological outcomes in patients with unstable intertrochanteric fractures. Progressive improvement in Modified Harris Hip Score was observed during follow-up, with most patients achieving good to excellent functional results at 12 months. The technique provided stable fixation and allowed gradual mobilisation with an acceptable complication rate. Therefore, proximal femoral locking plate fixation can be considered an effective option for the management of unstable intertrochanteric fractures, particularly in cases with compromised lateral wall stability.

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