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Management of Unstable Intertrochanteric Fractures with Proximal Femur Locking Compression Plate - A Prospective Study

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Abstract:

Backgound: *Peritrochanteric fractures are those occurring in the region extending from the extracapsular basilar neck region to the region along the lesser trochanter before the development of the medullary canal.[2]. The focus of surgical research regarding internal fixation in the late twentieth century was to minimize implant failure and avoidance of cut-out of the femoral head and neck fixation components. Because many of these fractures are associated with osteoporosis, the current paradigm shift regarding hip fracture care relates to optimization of fracture reduction and new designs of implant component fixation in osteoporotic bone with conceptual design changes in fixation stability and augmentation of the bone-implant interface. The Proximal Femur Locking Compression Plate is a recently developed implant for the management of peritrochanteric fractures. It is a fixed angle anatomically contoured plate that acts as an internal fixator. The plate can buttress the lateral fragment and the locking screws have better stability in osteoporotic bones. Being a limited contact plate it preserves the periosteal blood supply. It can be used as a biological plate in comminuted sub-trochanteric fracture by MIPPO technique. It can be used in the indirect reduction of a sub-trochanteric fracture by initially fixing to the proximal fragment and then reducing the plate to the shaft.*

Materials and methods: *This is a prospective study with sample size 20 where unstable imtertrochanteric femur fractures in patients aged 40 years and above of AO type 31A2 and 31A3 were surgically treated with proximal femur locking compression plates. The patients were reviewed at 6wks, 12wks, 6mths and at 1yr. During follow up x-rays were taken to assess radiological union. The patients were assessed clinically for tenderness at fracture site and range of movements of the hip and knee. Functional assessment was done using Harris hip score.*

Results: *The functional outcome was assessed using the Harris Hip Scoring System. The results of this study were Excellent in 45%, Good in 45% and Fair in 10%. There were no Poor results in this study. The average Harris Hip Score in this study was 86.9. This is comparable to the Luo et al study who had an average Harris score of 85. GC Zha et al in their study of 110 patients reported good to excellent results.Fair results in two patients in this study were due to knee stiffness, abductor weakness, co-morbid illness and obesity with pre-existing osteoarthritis of both knees*

Conclusion: *Unstable intertrochanteric fractures can be effectively managed by Proximal Femur Locking Compression Plate provided a complete anatomical reduction is obtained.*

Key Word: *Proximal femur locking compression plate;intertrochanteric femur fracture;Harris hip score*

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I. Introduction

Intertrochanteric fractures are commonly encountered fractures in day to day life associated with aging and osteoporosis. They are associated with low energy falls in the elderly and high energy trauma in young patients. Incidence is higher in women compared to men. Low energy falls account for approximately 90% of hip fractures in patients over 50 years of age,with a higher proportion of females.[2] Cummings et al.[3] hypothesised conditions for a fall to cause hip fracture (1)impact near the hip (2) diminished protective response (3) decreased shock absorbers-muscle and fat (4) insufficient bone strength.

Unstable intertrochanteric fractures account for approximately one quarter of all hip fractures in elderly and its incidence is increasing.[1] The Dynamic Hip Screw has remained the mainstay of management of stable

intertrochanteric fractures. Management of unstable intertrochanteric fractures has always been difficult especially in the presence of osteoporosis. There has been a constant evolution of newer design of implants to tackle these osteoporosis associated fractures. Difficulties faced in the management of comminuted intertrochanteric fractures are (a) obtaining anatomic reduction with medial cortical continuity (b) stable fixation in osteoporotic bones.

Proximal femoral locking compression plate is a newly introduced implant which provides angular stable plating of these complex comminuted osteoporotic fractures. The first description in literature of the use of PFLCP was given by Hasenboehler et al in 2007. Locking plate technology has evolved in an effort to overcome the limitations of conventional plating primarily for improving fixation in osteopenic bone. The locked plate is a fixed angle device because angular motion does not take place at the screw-plate interface. The locking plate allows for minimally invasive percutaneous bridging fixation techniques. The locking plate allows the surgeon for indirect fracture reduction techniques while providing stable fixation.

The focus of surgical research in internal fixation in the late twentieth century is to minimize implant failure and avoidance of cut out of the head and neck fixation components.[2] Dynamic hip screw in the management of unstable intertrochanteric fractures resulted in excessive collapse, shortening and medial displacement of the shaft[(6)]. Cement augmented DHS[(7)] was used but it had a different mode of failure other than screw cut out. DHS was then used with a trochanteric stabilising plate to support the lateral wall and prevent medial displacement[(8)]. Intramedullary fixation with sliding hip screw provided stable fixation and controlled collapse for unstable fractures[(10)]. It came out with the complication of fracture of the shaft distal to the tip of the nail. Bipolar hemiarthroplasty was done for unstable fractures claiming early rehabilitation. But calcar replacement femoral components may be needed. Replacement is better indicated for previous implant failure and in neoplastic fractures.[2]Reverse oblique fractures are better managed with Dynamic condylar screw fixation or intramedullary nail .Proximal Femur Locking Compression Plate[(13)] is comparable biomechanically to fixed angle blade plate and avoids the need for an extensile approach required for blade plate. It has the features of DCS but avoids the need for excessive bone removal. PFLCP is a good option for stable fixation of comminuted intertrochanteric fractures[(15)]. There are very few studies on PFLCP in the management of unstable intertrochanteric fractures[(16,17)]. The current study focusses on the functional outcome and complications associated with the use of PFLCP.

II. Materials And Methods

The present study on unstable intertrochanteric fractures treated by proximal femoral locking compression plate was conducted in the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital,Chennai-3 during the period of September 2018 to December 2019.

Study design:
Prospective study
Sample size:
20 patients
Inclusion criteria:
1. Unstable Intertrochanteric fractures in patients aged 40 yrs. and above
2. Boyd and Griffin Types II, III and IV
3. AO Types 31A2 and 31A3

Exclusion criteria :
1. Patients below the age of 40yrs.
2. Boyd and Griffin Type I
3. AO Type 31A1
4. Neoplastic fractures
5. Failed previous fixation
6. Non-union Intertrochanteric fracture
7. Open fractures
8. Patients unfit for surgery due to medical reasons

Management:

On admission all patients were examined clinically and screened for head injury. Radiological investigation and routine blood investigations were taken. The patients were put on skeletal or skin traction. Evaluation of any previous medical illness and cardiac status was done. After getting anaesthetic fitness they were taken up for surgery. Informed consent was obtained prior to surgery after explaining the nature of the procedure and the complications. All the patients were operated under regional anaesthesia.Pre-operative

templating was done using the x-ray of the unaffected hip. The fractures were classified according to Boyd and Griffin[5] and AO system. Osteoporosis was assessed by Singh's index[6]. Bisphosphonates was not used in any of the patient before or after surgery. Oral calcium supplementation of 1200mgs per day was used for those with osteoporosis. Parenteral antibiotic started one hour prior to surgery and continued for five days post-operatively. All the patients were operated on a fracture table. C-arm image intensifier was used.

Implant:

The proximal femoral locking compression plate[18,190] (Fig-1.1,1.2)is a stainless steel pre-contoured limited contact plate. The proximal portion is anatomically contoured to the shape of the lateral aspect of the proximal femur. There are separate plates for left and right side to accommodate for the average ante-version of the femoral neck. The proximal two holes in the plate are designed to accept 7.3 mm cannulated locking screws with the first hole in $95^{o}$and the second hole at 120^{o} angles to the plate shaft. The third proximal screw hole is placed at an angle of 135^{o} to the plate shaft and accepts a 5mm locking screw. The rest of the screw holes in the plate are combi holes for 5mm locking or 4.5mm regular cortical screws. The plates are available from sizes of two to sixteen holes.

The proximal two screws are 7.3mm cannulated locking screws. These are self-tapping screws. The guide wire used for them is 2.5mm threaded tip guide wire. The drill bit used for them is 5mm cannulated drill bit. The third proximal screw and the rest of the locking screws are 5mm self-tapping locking screws. The drill bit used for them is a 4.5mm drill bit. The combi holes accept 4.5mm cortical screws that help in approximating the plate to the shaft. The drill bit used is 3.2mm for the 4.5mm cortical screws. There are two locking sleeves. The large sleeve is for the proximal two 7.3mm locking holes for passing the guide wire. The small sleeve is for the 5mm locking hole for the drill bit.

FIG-1.1

FIG-1.2

First proximal screw - 95^{o} , Second proximal screw - 120^{o}
Third proximal screw - 135^{o}

Surgical approach:

The approach is the standard lateral approach for the proximal femur. Around 15cms of skin incision is required. The incision extends from the tip of the greater trochanter. Vastus lateralis is incised and retracted anteriorly to expose the lateral aspect of the shaft. The plate is placed over the lateral aspect of the proximal femur and position of the plate confirmed with image intensifier[22,23,24].

Insertion of the proximal screws[40]

After confirming plate position the guide wire is inserted into the first proximal hole through the sleeve. The guide wire for this 95^{o} screw is aimed to reach the midportion of the infero-medial quadrant of the head of the femur in the AP view and slightly posterior to the central in the lateral view. This accommodates an ante-verted position for the second screw. The guide wire should reach but not penetrate the subchondral bone. Before inserting the second guide wire, correct sagittal plane alignment of the plate is confirmed. Guide wires

are inserted in the next two proximal screw holes. Length of the first screw is measured with the direct measuring device over the guide wire. The screw hole is pre drilled with the 5mm cannulated drill bit over the guide wire. Appropriate size 7.3mm cannulated screw is inserted over the guide wire and locked. The screw head must be flush with the plate. The second 7.3mm screw is inserted in a similar manner. The third proximal screw, a 5mm locking screw is inserted after drilling the hole with the 4.5mm drill bit.

The plate(Fig 2) is then fixed to the shaft with cortical and locking screws. The 4.5mm cortical screws should always be applied before the placement of locking screws in the plate shaft. This will help to achieve approximation of the plate to the shaft. The wound is closed in layers with suction drain.

FIG 2

Follow up

The patients were reviewed at 6wks, 12wks, 6mths and at 1yr. During follow up x-rays were taken to assess radiological union. The patients were assessed clinically for tenderness at fracture site and range of movements of the hip and knee. Functional assessment was done using Harris hip score.

Fig3: Boyd and Griffin Type 2 intertrochanteric femur fracture treated with proximal femur plating with good union

Statistical analysis:

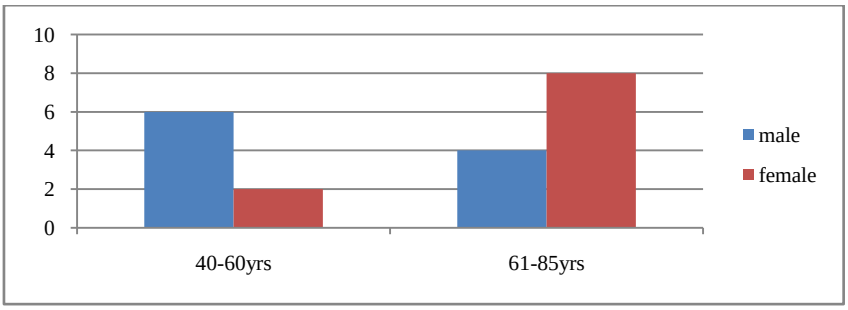
Statistical analysis was done using SPSS software version 17.Mean and standard deviation for age,duration of union,type of fracture,scoring system was done.Comparision studies were done with confidence interval 95% and $p<0.05$.Descriptive statistics were applied and frequency distribution was found for each case under evaluation.

III. Results

Age

The age of the patients operated in this study ranged from 40yrs to 83yrs with the mean age of 61yrs.

Age	Male	Percentage	Female	Percentage	Total	Percentage
40-60	6	30	2	10	8	40
61-85	4	20	8	40	12	60



Sex

There were 10 male and 10 female patients in the study.

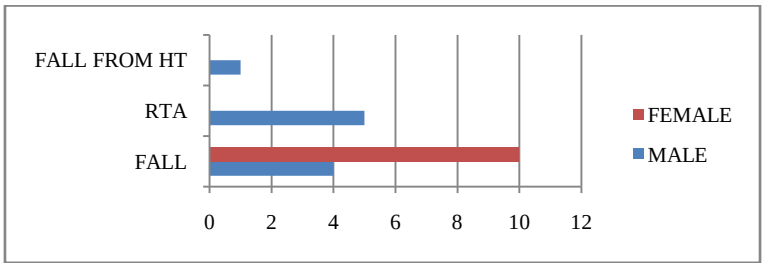
Male	10
Female	10

Mode of injury

The modes of injury in this study were fall from standing and road traffic accident with one patient had a fall from height.

Mode of injury	No. of patients	Percentage
Fall	14	70
RTA	5	25
Fall from height	1	5

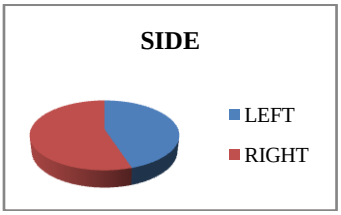
All the 5 cases of RTA occurred in males. Fall from standing was the most common mode of injury in elderly females.



Mode	Sex		Percentage
Fall	Male	4	20
	Female	10	50
RTA	Male	5	25
	Female	0	0
Fall from height	Male	1	5
	Female	0	0

Side of injury

Side	No.of patients	Percentage
Left	9	45
Right	11	55



Associated injury

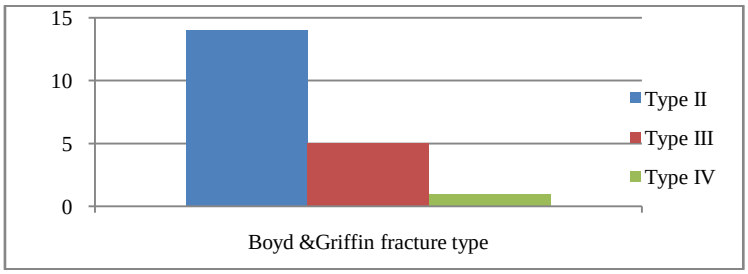
In this study only three patients had associated injury in the form of abrasion elsewhere in the body in two and distal radius fracture in one that was managed conservatively.

No associated injury	17
Abrasion	2
Distal radius fracture	1

Fracture type

The fractures were classified according to Boyd and Griffin types and AO system

Boyd and Griffin Type	No of patients	Percentage
Type II	14	70
Type III	5	25
Type IV	1	5

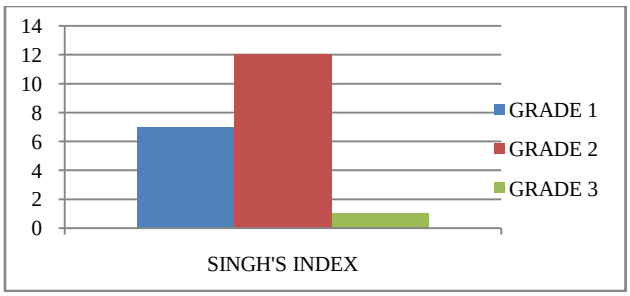


AO	No of patients	Percentage
Type 31A2	15	75
Type 31A3	5	25

Singh's index

All the patients in this study had evidence of osteoporosis based on the radiological grading with GRADE 6 being normal, GRADE 3 definite osteoporosis and GRADE 1 severe osteoporosis.

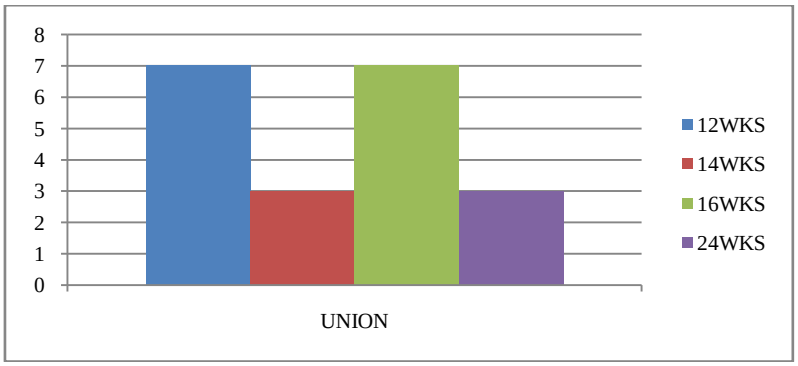
SINGH'S INDEX	NO OF PATIENTS
GRADE 3	1
GRADE 2	12
GRADE 1	7



Union

All the 20 cases in the study had fracture union at the last follow up. The union time was 12 wks in 7 patients, 14 wks in 3 patients, 16 wks in 7 patients and 6 mths in 3 patients. 85% fractures united in 12 to 16 wks. The average union time was 15.5 wks. The union rate was 100% at 6 mths.

Union time	No of patients	percentage
12 wks	7	35
14 wks	3	15
16 wks	7	35
24 wks	3	15

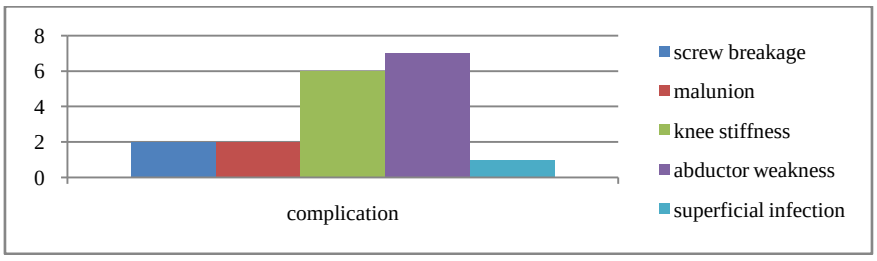


Complications:

The following complications were encountered in this study.

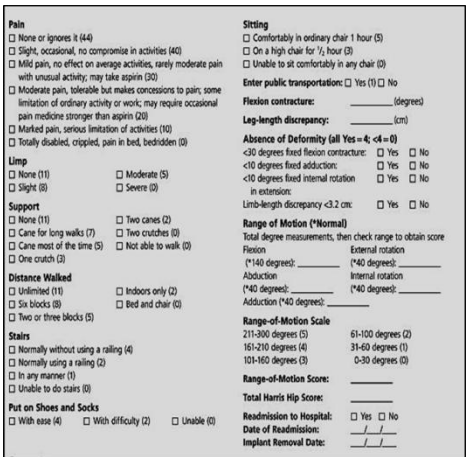
- Proximal screw breakage – 2 cases. In the first case, the 120^{o} proximal screw was found broken at 6wks follow up x ray. The 95^{o} proximal screw was found broken at 6mths follow up. On analysis of the neck-shaft angle of this patient the following observations were made. At immediate post-op the neck-shaft angle was 126^{o}, at 6wks it was 114^{o}, at 3mths it was 106^{o} and at 6mths it was 100^{o}. At 1yr follow up the neck-shaft angle remained at 100^{o}. The reason for screw breakage in this case was due to inadequate achievement of medial cortical continuity at reduction. The lack of stability had led to screw breakage and secondary varus collapse and malunion.
- Malunion – 2 cases. In one case the malunion was due to primary varus reduction and fixation. The other case was due to proximal screw breakage and secondary varus collapse and malunion. Both the cases had 2cms of limb shortening and were treated conservatively with raised footwear.
- Knee stiffness – 6 cases. This complication improved with physiotherapy.
- Abductor weakness – 7 cases. This was improved with physiotherapy and some of the patients resorted to using a cane for support to avoid lurching.
- Superficial infection occurred in one patient and subsided with parenteral antibiotics.

Complication	**No of cases**	**Percentage**
Screw breakage	2	10
Mal-union	2	10
Knee stiffness	6	30
Abductor weakness	7	35
Superficial infection	1	5
Non-union	0	0
Screw cut out	0	0



Harris hip score

Based on functional assessment by Harris hip scoring system the results were good to excellent in 90% of the cases. 10% of the cases had fair results. There was no poor result in the study.



Pain
☐ None or ignores it (44)
☐ Slight, occasional, no compromise in activities (40)
☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
☐ Moderate pain, tolerable but makes concessions to pain; some limitation of ordinary activity or work; may require occasional pain medicine stronger than aspirin (20)
☐ Marked pain, serious limitation of activities (10)
☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp
☐ None (11) ☐ Moderate (5)
☐ Slight (8) ☐ Severe (0)

Support
☐ None (11) ☐ Two canes (2)
☐ Cane for long walks (7) ☐ Two crutches (0)
☐ Cane most of the time (5) ☐ Not able to walk (0)
☐ One crutch (3)

Distance Walked
☐ Unlimited (11) ☐ Indoors only (2)
☐ Six blocks (8) ☐ Bed and chair (0)
☐ Two or three blocks (5)

Stairs
☐ Normally without using a railing (4)
☐ Normally using a railing (2)
☐ In any manner (1)
☐ Unable to do stairs (0)

Put on Shoes and Socks
☐ With ease (4) ☐ With difficulty (2) ☐ Unable (0)

Sitting
☐ Comfortably in ordinary chair 1 hour (5)
☐ On a high chair for ½ hour (3)
☐ Unable to sit comfortably in any chair (0)

Enter public transportation: ☐ Yes (1) ☐ No

Flexion contracture: _____(degrees)

Leg-length discrepancy: _____(cm)

Absence of Deformity (all Yes = 4; <4 = 0)
<30 degrees fixed flexion contracture: ☐ Yes ☐ No
<10 degrees fixed adduction: ☐ Yes ☐ No
<10 degrees fixed internal rotation in extension: ☐ Yes ☐ No
Limb-length discrepancy <3.2 cm: ☐ Yes ☐ No

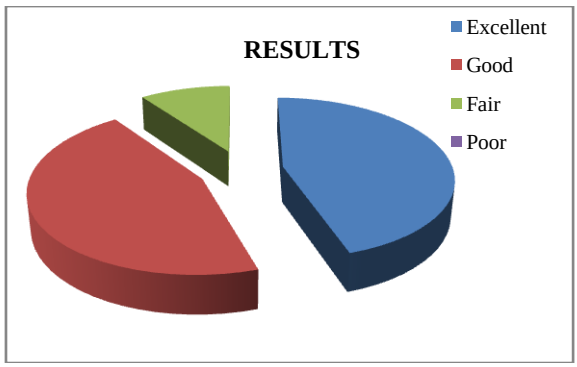
Range of Motion (*Normal)
Total degree measurements, then check range to obtain score
Flexion (*140 degrees): _____
Abduction (*40 degrees): _____
Adduction (*40 degrees): _____
External rotation (*40 degrees): _____
Internal rotation (*40 degrees): _____

Range-of-Motion Scale
211-300 degrees (5)
161-210 degrees (4)
101-160 degrees (3)
61-100 degrees (2)
31-60 degrees (1)
0-30 degrees (0)

Range-of-Motion Score: _____
Total Harris Hip Score: _____

Readmission to Hospital: ☐ Yes ☐ No
Date of Readmission: ___/___/___
Implant Removal Date: ___/___/___

RESULT	HARRIS SCORE	NO OF PATIENTS	PERCENTAGE
EXCELLENT	90-100	9	45
GOOD	80-89	9	45
FAIR	70-79	2	10
POOR	<70	0	0



IV. Discussion

Unstable intertrochanteric fractures demand perfect anatomical reduction and stable fixation. Their association with elderly osteoporotic bones necessitates the search for an implant that has good holding power in osteoporotic bones. There has been a constant evolution of newer implants for the management of these fractures. The Proximal Femoral Locking Plate is a recently developed implant for the management of complex proximal femoral fractures. This study was done to evaluate the outcome of PFLCP in the management of unstable intertrochanteric fractures.

The study was conducted on 20 cases of unstable intertrochanteric fractures. The unstable fractures were identified based on Boyd and Griffin classification. Types II, III and IV are unstable fractures. In AO system of classification Types 31A2 and 31A3 are unstable fractures.

The minimum age of the patient operated in this study was 40 and the maximum age was 83. The mean age of the patient in this study was 61. In other studies, the mean age was 67 in the study byPurushothaman et al, 75 in the study by GC Zha et al and 80 in the study by Stevenson et al.

This study had equal number of male and female patients. There were 10 male and 10 female patients. GC Zha et al in his study of 110 patients had 38 male and 72 female patients.

The most common mode of injury is fall from standing in an elderly female. Fall is the injury mode in 70% and RTA in 25% of the patients in this study. Females constituted 71% of the fall group. RTA as the mode of injury was seen exclusively in males.

Boyd and Griffin Type II was the most common type of fracture encountered in this study with an incidence of 70%. Type III had an incidence of 25%. Stevenson et al in their study of 14 patients had 6 AO 31A2 and 8 AO 31A3 types.

This study had one case of associated fracture of the distal radius that was managed conservatively.

Fracture union

All the fractures in this study had union. The union rate was 100% at 6 months. Two patients had malunion in varus position. The average union time was 15.5 wks. Since compression cannot be achieved with this implant one of the expected complication is non-union. But in the present study non-union was not encountered in any of the patient. Purushothaman et al reported 74% union rate at 6 mths. GC Zha et al in their study reported 98%union rate at 6mths and one case of non-union at three months in their series of 110 patients. Stevenson et al reported 100% union rate. The average healing time in Luo et al study was 11.9 wks.

Complications

Complications related to implant was seen in 10% in the form of proximal screw breakage. The average time to failure was 42 days. There were 2 cases of varus malunion. Both these complications were due to inadequate reduction of the fracture and lack of medial cortical opposition.

Glassner et al reported complications in 7 out of 10 cases with implant breakage in 4 and loss of fixation in 3 cases. The average time to failure in their study was 37.9 days. Johnson et al reported implant related complications in 11 of 28 patients in the form of bending, backing out, fracture or cut through of the proximal screws and plate fracture. They identified the following errors in the surgical technique as the cause for failure of the implant

- Leaving the plate proud proximally produces greater bending moment at the screw base increasing the toggle at the screw plate interface leading to fatigue failure or backing out of the screw
- Cross threading the proximal screws
- Mal-positioning of the proximal screws within the femoral neck and head

Purushothaman et al reported 3 cases of proximal screw breakage out of 20 patients and 5 cases of fixation failure. Stevenson et al reported 4 implant related complications out of 14 patients in the form of bending, backing out or breakage of the proximal screws. GC Zha et al reported only 1 case of implant breakage in a series of 110 patients. Wieser and Babst reported 4 cases of secondary varus collapse of the fracture with hardware failure with a complication rate of 29%. Luo et al reported complications in 7 out of 51 patients. Other complications like knee stiffness and abductor weakness improved with physiotherapy.

V. Results

The functional outcome was assessed using the Harris Hip Scoring System. The results of this study were Excellent in 45%, Good in 45% and Fair in 10%. There were no Poor results in this study. The average Harris Hip Score in this study was 86.9. This is comparable to the Luo et al study who had an average Harris score of 85. GC Zha et al in their study of 110 patients reported good to excellent results.Fair results in two patients in this study were due to knee stiffness, abductor weakness, co-morbid illness and obesity with pre-existing osteoarthritis of both knees.

Conclusion

- Proximal Femoral Locking Compression Plate is one of the good options in the management of unstable intertrochanteric fractures in elderly individuals with osteoporosis
- 100% union rate which includes 10% of malunion has been achieved in this study with an average healing time of 15.5 weeks. The two cases of malunion were due to primary inadequate anatomical reduction.
- Implant related complication rate was less in this study compared to other studies
- Good to Excellent functional results were obtained in 90% of the cases
- Unstable intertrochanteric fractures can be effectively managed by PFLCP provided a complete anatomical reduction is obtained

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