



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(1): 380-391
© 2023 IJOS

<https://www.orthopaper.com>

Received: 14-11-2022

Accepted: 19-12-2022

Dr. Ashish A Damor
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

Dr. Viswanath H Chavali
Professor, Department of
Orthopaedics Medical College
Baroda & SSG Hospital,
Maharaja Sayajirao University,
Vadodara, Gujarat, India

Dr. Tejas D Leuva
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

Dr. Yamik N Damor
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

Dr. Akhilesh K Ramanuj
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

Dr. Abhishek B Singh
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

Corresponding Author:

Dr. Ashish A Damor
Department of Orthopaedics
Medical College Baroda & SSG
Hospital, Maharaja Sayajirao
University, Vadodara, Gujarat,
India

A study of patients with failure of proximal femoral nail fixation

Dr. Ashish A Damor, Dr. Viswanath H Chavali, Dr. Tejas D Leuva, Dr. Yamik N Damor, Dr. Akhilesh K Ramanuj and Dr. Abhishek B Singh

DOI: <https://doi.org/10.22271/ortho.2023.v9.i1f.3320>

Abstract

A prospective study with an attempt to evaluate 36 cases of proximal femoral nailing taking into consideration the various modifiable and non-modifiable factors associated with failure of PFN like bone quality, fracture geometry, fracture reduction, implant selection, placement and to suggest possible explanations and recommendations to avoid such complication. The objectives of this study is to evaluate the possible radiographic findings leading to implant failure in PFN since the index surgery & to evaluate the type, outcome and complications of implant extraction & revision surgery in patients with a failed PFN. We followed up the patient for a minimum of six months at every six weekly intervals. At every follow up the patients were assessed clinically for pain, swelling, mobility at fracture site, joint stiffness, signs of infection, wound status and radio-logically (X-ray) for union status, alignment implant status and infection. Final assessment was done on based on the Modified Harris Hip score. We considered the outcome as favourable when fracture union was achieved with fair/good/excellent/poor score was considered as unfavourable outcome. All data was collated, compared and analysed using descriptive statistics.

Keywords: PFN failure, migrating interlocking head screws, Z & reverse Z effect, revision surgery in failed PFN, varus collapse, non-union, screw cut out, shortening

Introduction

- Intertrochanteric fractures are extra-capsular fractures that occur in the region between greater trochanter and lesser trochanter of femur often extending to the subtrochanteric region [1].
- Many conservative approaches has been used during old times but none gave favourable results [2].
- Intertrochanteric femur fractures are the most frequently operated fractures having the highest post-operative fatality rate amongst surgically treated fractures.
- Lagenbeck attempted internal fixation of the reduced fracture in 1850 using an intramedullary nail [3].
- Russel Taylor reconstructed intramedullary nail for peritrochanteric & subtrochanteric fractures.
- Amongst all cephalomedullary nailing techniques, PFN is the most preferred technique due to its minimally invasive intramedullary system intended to improve the management of unstable trochanteric fractures. However, the evolution of this procedure may include complications associated with the migration of interlocking head screws, varus collapse, screw cut out, peri-implant fracture, non-union, delayed union, shortening etc.
- In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra-and subtrochanteric femoral fractures.
- A retrospective multicentric trial [4] of 8930 patients with proximal femur fractures over 60 years of age found out that 19% patients had post-operative medical complications. No complications were reported in 81% patients after fracture union. Non-union was reported in only 1% patients of elder age which was usually treated by Total hip replacement. In the younger patients; osteotomy, bone grafting & revision implant surgery were preferred mode of treatment following PFN failure. Implant malfunctions accounts for 5% of cases

ending in failure which includes implant fatigue failure, shaft fixation with broken or bent screws, femoral head medial penetration & screw cut out.

- In a prospective study of 55 patients^[5] having proximal femoral fractures treated with the PFN from 1997 to 2000, 34 patients achieved what was close to anatomic reduction of the main fracture fragments. Immediate full weight bearing was permitted in 49 patients. During the follow-up period of 15 months, complications occurred in 12 patients. 2 patients had a cut-out of the implant because they used too short proximal gliding screws. In 5 patients, closed fracture reduction could not be done and open fracture reduction with use of cerclage became necessary. Author suggested that careful surgical technique and modification of the PFN can reduce the high complication rate.
- Another study done by Ruecker *et al.*^[6] reported outcome of PFN with integrated cephalocervical screws and linear compression in 100 consecutive patients. In this elderly population, 48 patients were available for the 1-year follow-up examination (mean time 18.76 4.5 months, range 12-27 months). These 48 fractures consisted of 11 stable, 29 unstable, and 8 reverse obliquity fractures. Within the follow-up period, 2 fractures treated early in the series had collapsed into varus, with resultant protrusion of the implant into the acetabulum requiring hip arthroplasty. An initial, acceptable closed reduction was not achieved in either case and subsequent screw position was suboptimal (anterior-superior quadrant placement of the screws) in both. The remaining 46 fractures healed without any shift into varus (96%). Importantly, there were no neck malunions (0%) or nonunions (0%). Specifically, 35 fractures did not exhibit further compression (73%), whereas 13 fractures had secondary compression of less than 5 mm using both methods of measuring neck collapse on standard radiographs. No femoral shaft fractures occurred (0%). There were no instances of nail or screw fatigue (bending) or failure (fracture) in this series (0%). TAD was within 5 mm in all cases. No patient complained clinically of leg length discrepancy or lateral hip pain. The mean pre-fracture Harris hip score (75.1 ± 13.4) was significantly reduced at the time of follow-up (70.3 ± 14.5 , $P = 0.003$); 58% of the patients recovered their pre-fracture status. They concluded that PFN is a reliable implant for the treatment of intertrochanteric femoral fractures. Its design provides for stability against rotation and minimizes neck malunions (shortening) through linear intraoperative compression of the head/neck segment to the shaft.

Materials and Methods

This prospective cohort study was carried out at the Department of Orthopaedics in a 1500 bedded state run tertiary care hospital attached to a post graduate teaching institute located in Central Gujarat, from 28/12/2021 to May 2022 after obtaining due permission from the Institutional ethical committee.

Sample size

Total 36 patients with failure of proximal femoral nail fixation were enrolled in the study.

Study population

Patients presenting to department of orthopaedics enrolling

under proximal femoral fractures treated with Proximal Femoral Nail and consenting to participate in the study defined by inclusion and exclusion criteria.

Inclusion criteria

All adult patients who have had an intertrochanteric fracture treated surgically by PFN and presenting to us with complaint suggestive of failure of PFN including:

- a) Migrating interlocking head screws (Z & Reverse Z effect).
- b) Varus collapse.
- c) Screw cut out.
- d) Peri-implant fracture.
- e) Non-union.
- f) Supratrochanteric shortening > 2.5cm as evident by digital Bryant's classification.

Exclusion criteria

- a) Patients less than 20 years of age.
- b) A previous hip fracture treated by PFN sustaining significant fresh trauma leading to fracture/breakage of implant around the proximal femur.
- c) All cases of infected PFN or complications arising out of it.
- d) Patients with any bone pathology or pathological IT fractures.
- e) Non cooperative patients with poor communication skills.

Intertrochanteric fracture classification used for this study is Boyd & Griffin^[7].

Follow-up period

We followed up the patient for a minimum of six months at every six weekly intervals. At every follow up the patients were assessed clinically for pain, swelling, mobility at fracture site, joint stiffness, signs of infection, wound status etc. and radio-logically (X-ray) for union status, alignment implant status and infection. Final assessment was done on based on the Modified Harris Hip score. We considered the outcome as favourable when fracture union was achieved with fair/good/excellent, poor score is considered as unfavourable outcome.

Scoring

Modified Harris Hip Score: Add up the assigned points for each item, divided by max score (91) x 100 to create a percentage.

A higher score = a higher level of physical function (100% = full function)

MHHS score = (sum of items/91) x 100. The details of the study area should also be provided.

Results

- Out of 36 patients enrolled in our study 6 patients were lost to follow up, with Remaining 30 patients with proximal femoral nail fixation failure during follow up period 16 patients (54%) were treated with Implant extraction, 10 patients (33%) patients were treated with Revision surgery, 4 patients (13%) were treated with joint replacement surgery. No patients were kept under conservative management post PFN fixation failure.
- At final follow up, 54% patients had poor results as assessed by Modified Harris Hip Score.
- In older age group of patients outcome was better with Total hip replacement as compared to revision surgery,

while patients who underwent only a total implant extraction had a poor outcome (on the basis of Modified Harris Hip score).

- In young age group of 20-40 years patients with PFN fixation failure had good outcome (on the basis of Modified Harris Hip score) post total implant extraction & were able to return to activity of daily living without any limp/pain. No revision surgery or joint replacement needed.

Clinical & radiological results

Case No: 1

- 69 Year old female c/o Backed out of proximal screws in 4 month post-op c/o proximal femoral nailing right in case of closed fracture intertrochanteric right without Neurovascular Deficit.
- Trauma due to slip of foot.
- Presentation of failure at 18th week:

Migrating Interlocking Head Screws (Z & Reverse Z Effect)
Varus Collapse
Screw Cut Out
Shortening

- **Treatment:** Total implant extraction.
- **Outcome:** Poor (according to MHHS).
- Clinical results after 2 month post implant extraction (MHHS: poor outcome).

→ Severely restricted Adduction, Internal rotation, extension & flexion of hip right.



Fig 1: Pre op x-rays

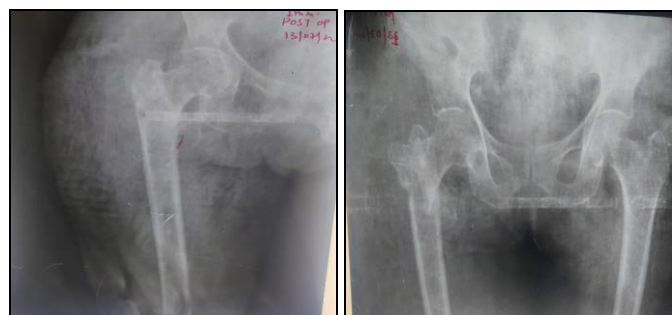


Fig 2: Post-op X-rays



Fig 3: Clinical photos

Case No: 2

- A 56 Year old male c/o Backed out of proximal screws in 5 months post op c/o proximal femoral nailing left in case of closed fracture intertrochanteric right without Neurovascular Deficit.
- Trauma due to slip of foot.

Table 1: Presentation of failure at 20th week

▪ Migrating Interlocking Head Screws (Z & Reverse Z Effect)
▪ Varus Collapse
▪ Screw Cut Out
▪ Shortening

- **Treatment:** Total implant extraction.
- **Outcome:** Poor (according to MHHS).
- Clinical results after 2 month post implant extraction (MHHS: poor outcome).

Severely restricted Adduction, Internal rotation, extension & flexion of hip left.



Fig 4: Pre-op X-ray



Fig 6: Clinical Photos



Fig 5: Post-op X-ray

Case No: 3

- A 40 year old male c/o Peri implant fracture subtrochanteric femur left with breakage of implant in case of 7 month old post op case of proximal femoral nailing with wire loop with recon plate done in case of closed fracture subtrochanteric femur left without Neurovascular deficit.
- Trauma due to fall due to RTA due to collision between two wheeler.

Table 2: Presentation of failure at 28th week

• SCREW Cut Out
• Peri-Implant Fracture

- **Treatment:** Total implant extraction with proximal femoral plating with recon plate over proximal femur.
- **Outcome:** Fair (according to MHHS).
- Clinical results after 1 month post implant extraction (MHHS: Fair outcome).

→ Minimally restricted Adduction, Internal rotation, extension & flexion of hip right.

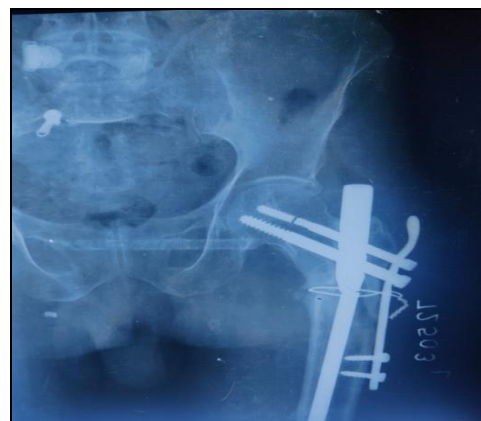


Fig 7: Pre-op x-ray



Fig 8: Post op x-rays



Fig 9: Clinical photos

Case No: 4

- A 50 year old male case of backed out of proximal screw in case of 4 months old post op c/o proximal femoral nailing left done in case of closed fracture subtrochanteric femur left without neurovascular deficit.
- Trauma due to fall due to RTA due to slip of two wheeler.

Table 3: Presentation of failure at 18th week

▪ Migrating Interlocking Head Screws (Z & Reverse Z Effect)
▪ Varus Collapse
▪ Screw Cut Out
▪ Non Union

- **Treatment:** Total implant extraction with Total Hip Replacement left.
- **Outcome:** Excellent (according to MHHS).
- Clinical results after 1 month post implant extraction (MHHS: Excellent outcome).

→ Minimally restricted Adduction, Internal rotation, extension & flexion of hip right.



Fig 10: Pre op x-ray



Fig 11: Post-op x-ray





Fig 12: Clinical photos

Pre-operative radiographic evaluation

Table 4: Type of Fracture Based on Boyd-Griffin Classification

Fracture Type	No. of Patients	Percentage (%)
I	6	16
II	14	39
III	10	28
IV	6	17
Total	36	100

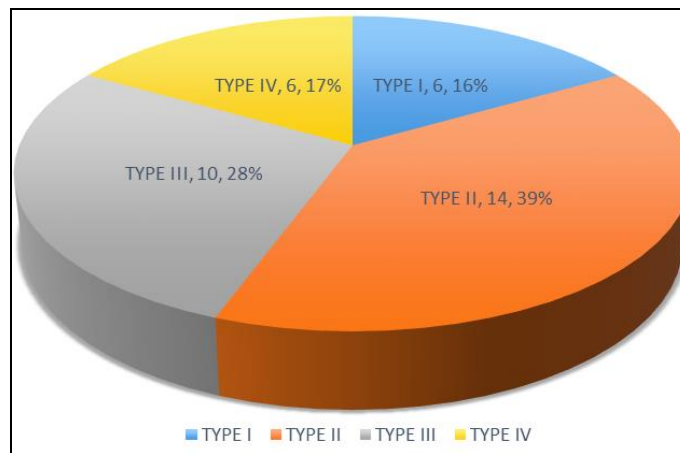


Fig 13: Distribution of patients according to Boyd & Griffin classification

Table 5: Trabecular Status (According to Singh's Index-of Unaffected Hip)

Grade	No. of Patients
I	4
II	8
III	6
IV	12
V	2
VI	4

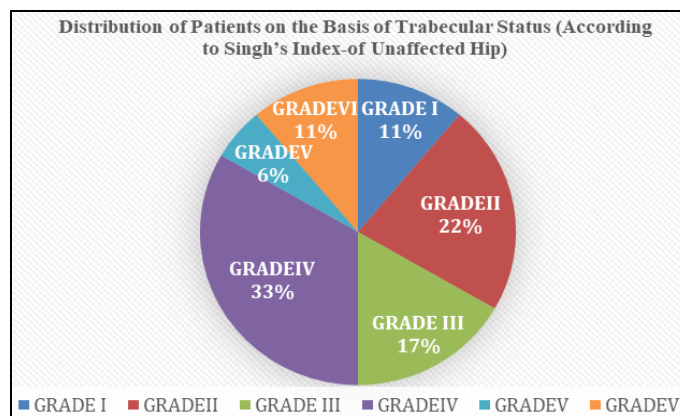


Fig 14: Post-operative radiographic evaluation

Table 6: Distribution of patients on the basis of Immediate Post-operative reduction status of Implant

Proximal Femoral Nail (n=36)	Varus Reduction	Valgus Reduction	Posteromedial contact
Long PFN (30)	7	11	12
Short PFN (6)	1	3	2

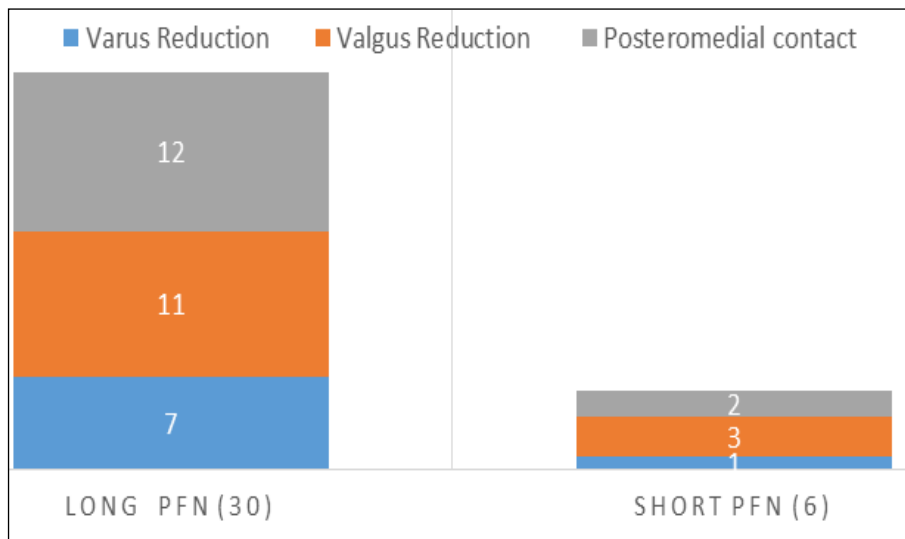


Fig 15: Distribution of patients on the basis of immediate post-operative reduction status of implant

Table 7: Distribution of patients on the basis of Degree of Proximal Femoral Nail

	Degree	n=36
Long	130	24
	135	6
Short	130	4
	135	2

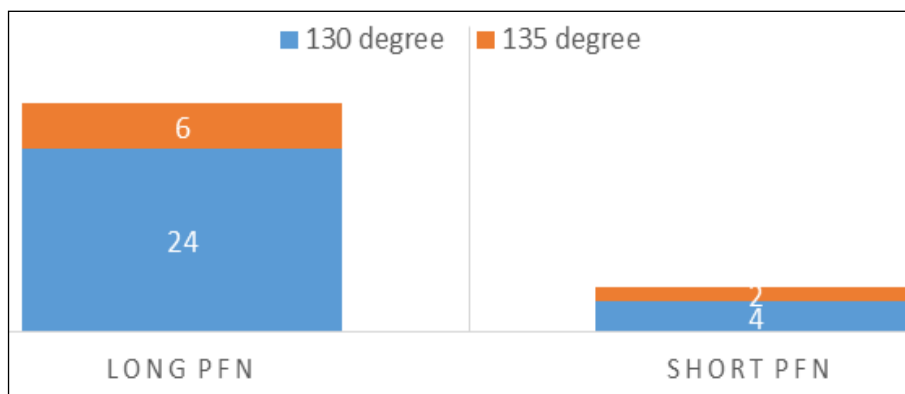


Fig 16: Distribution of patients on the basis of degree of proximal femoral nail

Table 8: Distribution of patients on the basis of proximal femoral screws

	Superior	Central	Inferior
Anterior	2	3	1
Central	3	8	2
Posterior	4	10	3

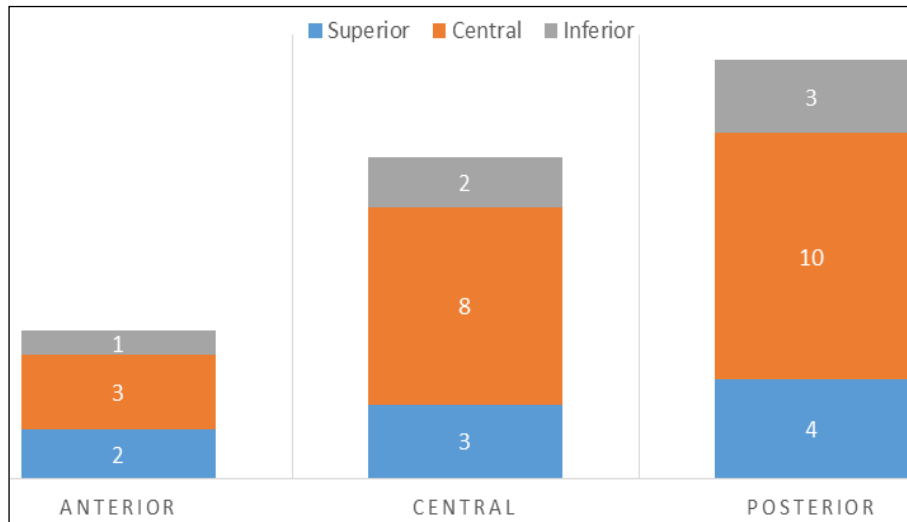


Fig 17: Distribution of patients on the basis of proximal femoral screws

Table 9: Radiographic Evaluation at the Time of Failure of PFN Fixation

Presentation of Failure	No. of Patients	Percentage (%)
Migrating Interlocking Head Screws (Z & Reverse Z Effect)	9	25
Varus Collapse	9	25
Screw Cut Out	8	22
Peri-Implant Fracture	1	3
Non Union	1	3
Shortening (Supratrochanteric/Infratrochanteric)	8	22

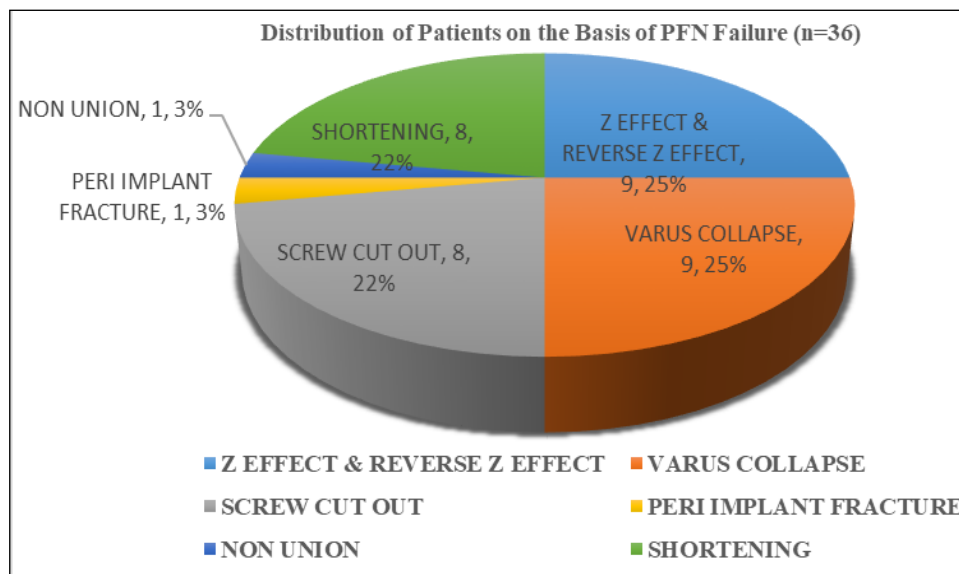


Fig 18: Distribution of patients on the basis of PFNF failure (n= 36)

- Out of 36 patients enrolled for the study, 6 patients expired during the 6 months of follow up period.
- At final follow up out of 36 patients enrolled, we had 30 patients remaining in our study treated for implant failure.

Table 10: Treatment

Type	Number of patients treated
Total Implant Extraction	16
Revision Surgery	10
Joint Replacement	4

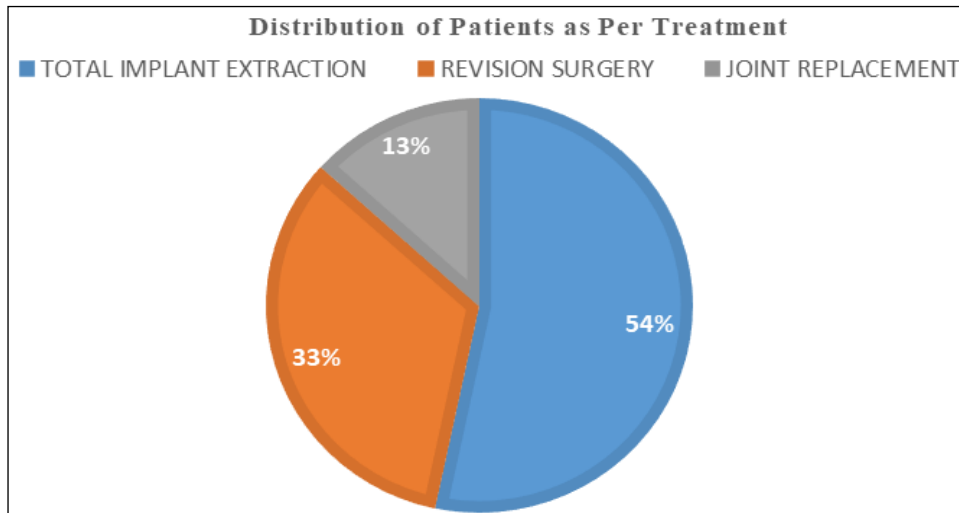


Fig 19: Distribution of patients as per treatment

Follow up post treatment

Table 11: Movements at Hip Joint (n=30)

Percentage loss (movement at hip joint)	Flexion	Extension	ER	IR	Adduction	Abduction
<25%	10	9	12	9	11	13
25-50%	14	16	12	13	10	10
>50%	6	5	6	9	9	7

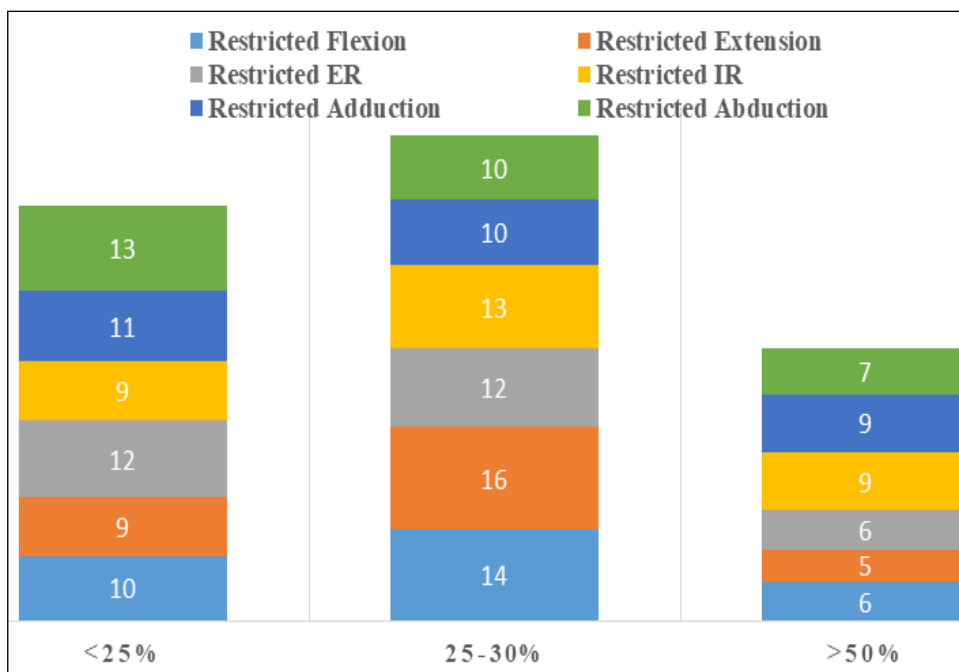


Fig 20: Movements at HIP joint (n= 30)

Table 12: Squatting

Squatting	No. of Patients (n=30)	Percentage (%)
With Ease	8	27
With difficulty	16	53
Unable	6	20
Total	30	100

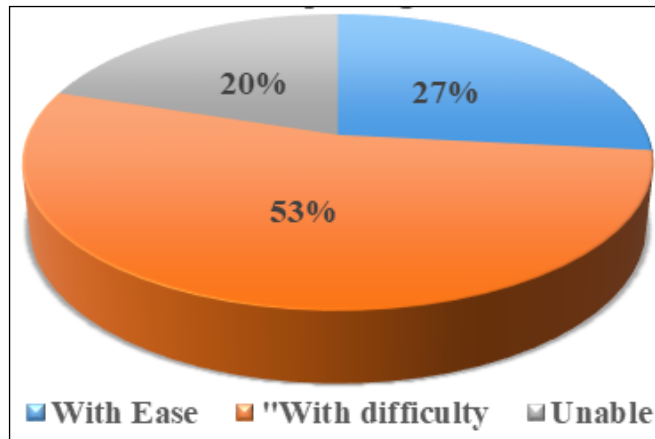


Fig 21: Squatting

Table 13: Sitting Cross Legged

Sitting Cross Legged	No. of Patients (n=30)	Percentage (%)
With Ease	8	27
With difficulty	16	53
Unable	6	20
Total	30	100

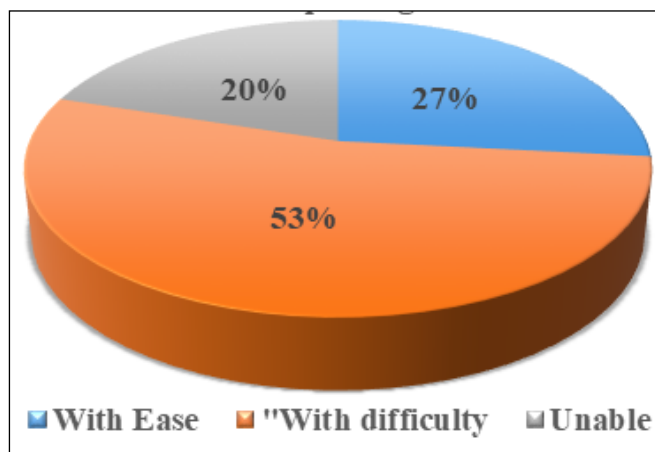


Fig 22: Squatting

Table 14: Results Based on "Modified Harris Hip Score at Final Follow Up

Outcome	Score	No. of Patients	Percentage (%)
Excellent	(90-100)	4	13
Good	(80-89)	4	13
Fair	(70-79)	6	20
Poor	(<70)	16	54

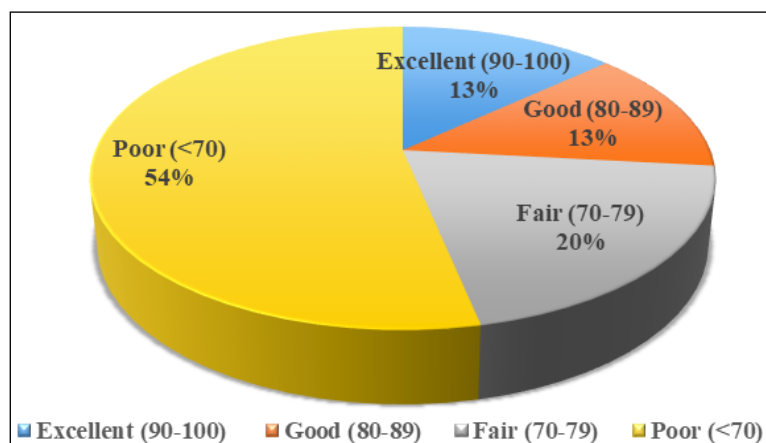


Fig 23: Result based on modified harris HIP score

Discussion

In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra- and subtrochanteric femoral fractures. A retrospective multicentre trial (4) of 8930 patients with proximal femur fractures over 60 years of age found out that 19% patients had post-operative medical complications. No complications were reported in 81% patients after fracture union. Non-union was reported in only 1% patients of elder age which was usually treated by Total hip replacement. In the younger patients; osteotomy, bone grafting & revision implant surgery were preferred mode of treatment following PFN failure. Implant malfunctions accounts for 5% of cases ending in failure which includes implant fatigue failure, shaft fixation with broken or bent screws, femoral head medial penetration & screw cut out.

The results of our study as compared to the above study done by Domingo L:-

- We had a prospective single centered study of 36 patients with failure of Proximal Femoral Nail fixation.
- The age group in our study was above 20 years with average age of 64 years.
- Non-union was reported in only 3% cases in elderly age which was treated post PFN failure with Total Hip Replacement.
- In young age group of 20-40 years, Failure of PFN fixation had been treated with Total implant extraction after average follow up of 4 months which gave good outcome (assessed by MHHS).
- Implant malfunctions accounts for 25% of cases ending in failure which includes implant fatigue failure seen in 3% cases with screw cut out seen in 22% of cases.
- In a prospective study of 55 patients (5) having proximal femoral fractures treated with the PFN from 1997 to 2000, 34 patients achieved what was close to anatomic reduction of the main fracture fragments. Immediate full weight bearing was permitted in 49 patients. During the follow-up period of 15 months, complications occurred in 12 patients. 2 patients had a cut-out of the implant because they used too short proximal gliding screws. In 5 patients, closed fracture reduction could not be done and open fracture reduction with use of cerclage became necessary. Author suggested that careful surgical technique and modification of the PFN can reduce the high complication rate.

The results of our study as compared to the study done by Boldin, Christian:-

- We had a prospective single centered study of 36 patients with failure of Proximal Femoral Nail fixation.
- 28 patients achieved what was close to anatomic reduction i.e. valgus reduction (n=14) & posteromedial contact reduction (n=14).
- Full weight bearing was permitted after minimum interval of 45 days post PFN fixation.
- During follow up period of 12 months, out of 36 patients enrolled in our study, Type of failure occurred were 9 patients with migrating interlocking head screws (Z & Reverse Z effect), 9 patients with varus collapse, 8 patients with screw cut out, 1 patient with peri-implant fracture, 1 patient with non-union & 8 patients with shortening.
- A study done by Ruecker *et al.* [6] reported outcome of PFN with integrated cephalocervical screws and linear compression in 100 consecutive patients. In this elderly

population, 48 patients were available for the 1-year follow-up examination (mean time 18.7 ± 4.5 months, range 12-27 months). These 48 fractures consisted of 11 stable, 29 unstable, and 8 reverse obliquity fractures. Within the follow-up period, 2 fractures treated early in the series had collapsed into varus, with resultant protrusion of the implant into the acetabulum requiring hip arthroplasty. An initial, acceptable closed reduction was not achieved in either case, and subsequent screw position was suboptimal (anterior– superior quadrant placement of the screws) in both. The remaining 46 fractures healed without any shift into varus (96%). There were no instances of nail or screw fatigue (bending) or failure (fracture) in this series (0%). No patient complained clinically of leg length discrepancy or lateral hip pain. The mean pre-fracture Harris hip score (75.1 ± 13.4) was significantly reduced at the time of follow-up (70.3 ± 14.5, P = 0.003); 58% of the patients recovered their pre-fracture status.

The results of our study as compared to the above study done by Ruecker [6]:

- We had a prospective single centered study of 36 patients with failure of Proximal Femoral Nail fixation with follow period of 1 year.
- These 36 cases were divided on the basis of 6 stable, 20 unstable comminuted & 10 reverse oblique comminuted fractures. (Assessed by Boyd-Griffin Classification).
- 28 patients achieved what was close to anatomic reduction i.e. valgus reduction (n=14) & posteromedial contact reduction (n=14).
- Implant malfunctions accounts for 25% of cases ending in failure which includes implant fatigue failure seen in 3% cases with screw cut out seen in 22% of cases.
- 16 patients complained clinically of limb length discrepancy or lateral hip pain.
- 13% of the patients recovered their pre-fracture status while 54% patients had poor results as assessed by MHHS.

Conclusion

- Patients with age >60 years had poor outcome as compared to age group of 20-60 years.
- Patients with age group 20-40 had the excellent outcome.
- Patients with Type II fractures & type III (Boyd & Griffin Classification) had poor outcome as compared to other types described in this classification.
- Type I (Boyd & Griffin Classification) fractures showed excellent outcome.
- Patients with Grade IV trabecular pattern had poor outcome as compared to other grading as trabecular pattern affected with increasing age.
- Patients with age >60 years had poor outcome as compared to age group of 20-60 years.
- Patients with varus reduction and valgus reduction had poor outcome in contrast to posteromedial contact reduction.
- Patients with proximal femoral screws directing centro-posterior & centro-central had excellent outcome in-contrast to patients with supero-central & supero-posterior.
- Out of 36 patients enrolled in our study 6 patients were lost to follow up, with Remaining 30 patients with proximal femoral nail fixation failure during follow up period 16 patients (54%) were treated with Implant

extraction, 10 patients (33%) patients were treated with Revision surgery, 4 patients (13%) were treated with joint replacement surgery. No patients were kept under conservative management post PFN fixation failure.

At the final follow up, we had 30 patients with Post PFN Failure management with following characteristics:

- Restriction of movements >50% was seen in around 30% of patients.
- 16 patients (53%) had difficulty in squatting and sitting cross legged.
- At final follow up, 54% patients had poor results as assessed by Modified Harris Hip Score.
- In older age group of patients outcome was better with Total hip replacement as compared to revision surgery, while patients who underwent only a total implant extraction had a poor outcome (on the basis of Modified Harris Hip score).
- In young age group of 20-40 years patients with PFN fixation failure had good outcome (on the basis of Modified Harris Hip score) post total implant extraction & were able to return to activity of daily living without any limp/pain. No revision surgery or joint replacement needed.

References

1. Sonawane DV. Classifications of intertrochanteric fractures and their clinical importance. *Trauma Int.* 2015;1(1):7-11.
2. Cooper A. *A Treatise on Dislocations and Fractures of the Joints.* Blanchard and Lea; c1851.
3. Bartoniček J. Early history of operative treatment of fractures. *Archives of orthopaedic and trauma surgery.* 2010 Nov;130(11):1385-96.
4. Bartoniček J. Early history of operative treatment of fractures. *Archives of orthopaedic and trauma surgery.* 2010 Nov;130(11):1385-96.
5. Domingo L, Cecilia D, Herrera A, Resines C. Trochanteric fractures treated with a proximal femoral nail. *International orthopaedics.* 2001 Oct;25(5):298-301.
6. Boldin Christian, Seibert Franz J, Fankhauser Florian, Peicha Gerolf, Grechenig Wolfgang, Szyszkowitz Rudolf. The proximal femoral nail (PFN)-a minimal invasive treatment of unstable proximal femoral fractures: A prospective study of 55 patients with a follow-up of 15 months. *Acta Orthopaedica.* 2003;74(1):53-58. Doi:10.1080/00016470310013662
7. Ruecker AH, Rupperecht M, Gruber M, Gebauer M, Barvencik F, Briem D, *et al.* The treatment of intertrochanteric fractures: results using an intramedullary nail with integrated cephalocervical screws and linear compression. *Journal of orthopaedic trauma.* 2009 Jan;23(1):22-30.
8. Boyd HB, Griffin LL. Classification and treatment of intertrochanteric fractures. *Arch Surg.* 1949;58:853-66.

How to Cite This Article

Ashish AD, Viswanath HC, Tejas DL, Yamik ND, Akhilesh KR, Abhishek BS. A study of patients with failure of proximal femoral nail fixation. *International Journal of Orthopaedics Sciences* 2023; 9(1): 380-391.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.