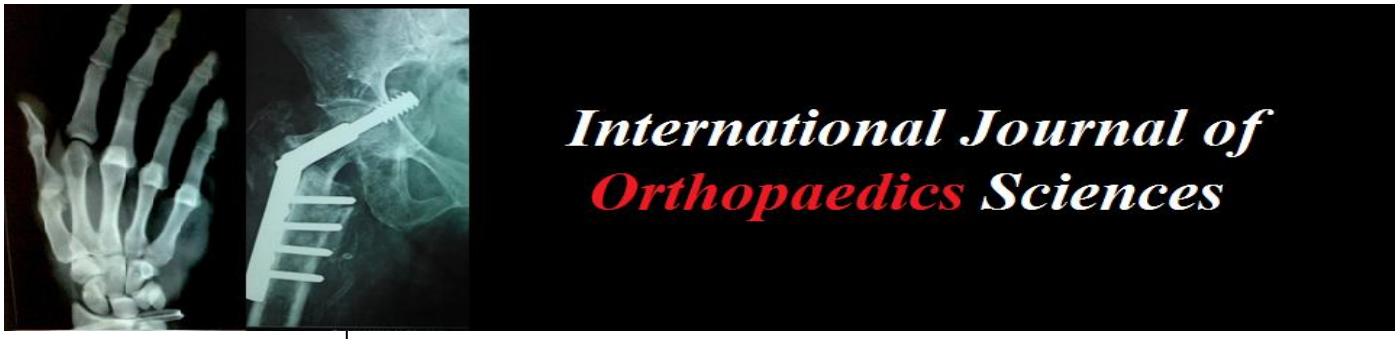

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A prospective study of functional outcomes and complications of trochanteric femoral nail in intertrochanteric fractures

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Abstract
Background: The incidence of fractures of the peri trochanteric fractures is increasing since the general life expectancy of the population and related osteoporosis has increased significantly during the past few decades. They are second most common fractures related to osteoporosis, by the year 2050, intertrochanteric fractures will be ones taking a major share of them. The mechanism of action of TFN is controlled collapse at the fracture site on weight bearing leading to compression at the fracture. It has been noticed complications such as implant failure, screw back-out, protrusion of implant over the tip of the greater trochanter causing impingement, the z effect involves lateral migration of inferior head screw and medial migration of superior head screw and opposite is reverse z effect. We have hereby conducted the study to evaluate the functional outcomes and complications of trochanteric femoral nail in intertrochanteric femur fractures based on clinical and radiological findings.
Materials and Methods: A prospective, single blinded, randomized control trial with 43 cases, out of which 24 were males and 19 were females was conducted. The postoperative evaluation was done both clinically and radiologically. Out of the 43 cases, follow up at outpatient level at regular intervals at 6wks, 3months, and 6months for serial clinical and radiological evaluation was done. At each follow up, patients were evaluated clinically using the Modified Harris Hip Score and radiologically with appropriate X-rays. The intraoperative blood loss, duration of surgery, intra operative complications, post-operative complication, duration of hospital stay were studied.
Results: Results were evaluated by modified Harris hip score in our series we had 30.2% excellent, 48.8% good, 16.3 % fair and 4.7% poor results. The nail protrusion height was >5 in 74.4% of the patient.
Conclusion: Trochanteric femoral nail can be considered the most judicious and rational method of treating intertrochanteric fractures, but it we recommend a modification to the Trochanteric femoral nail that would further shorten the proximal nail end 5–10 mm for the Indian population, so as to avoid soft tissue irritation on lateral trochanter.

Keywords: Intertrochanteric fractures, trochanteric femoral nail, nail protrusion height

Introduction
A trivial fall account for 90% of intertrochanteric fractures of femur in elderly occurs commonly because of osteoporotic bone [1, 2]. Where as in young individuals it may be a result of high energy injury such as motor vehicle accident or fall from height [2]. The incidence of fractures of the proximal femur is increasing since the general life expectancy of the population and related osteoporosis has increased significantly during the past few decades. They are second most common fractures related to osteoporosis, next only to spine. There were an estimated 1.66 million hip fractures worldwide in 1990 and this world wide annual number is expected to reach 6.26 million by the year 2050, intertrochanteric ones taking a major share of them. Cummings *et al.* [3] noted that neither age related osteoporosis, nor the increasing incidence of falls with age sufficiently explains the exponential increase in the incidence of hip fracture with aging. Intertrochanteric fractures in elderly people are usually comminuted and unstable because of indirect forces which include pull of the iliopsoas muscle on the lesser trochanter and pull of the abductor muscle on the greater trochanter. Hence they are associated with high rates of morbidity and mortality if they are not treated surgically, intertrochanteric fractures are associated with complications like pressure sores, pulmonary

infection, DVT, atelectasis, malunion etc and hence surgery (Trochanteric Femoral Nail) is aimed at early rehabilitation and mobilization [4]. The dynamic hip score has been considered the device of choice because it is time tested implant in fracture union. The drawback of sliding hip screw is loss hip offset and shortening of leg.

The goal of treatment in treating intertrochanteric fracture is to achieve stable anatomical reduction, rigid fixation, and early mobilization. The mechanism of action of TFN is controlled collapse at the fracture site on weight bearing leading to compression at the fracture. The distal screws lock the nail and help in control of rotation and telescoping of the fracture fragments. Management options available for intertrochanteric fractures at this time.

1. Conservative
2. Close Reduction and internal fixation with D.H.S.
3. Close Reduction & internal fixation with TFN
4. Hemiarthroplasty
5. Total HIP Arthroplasty
6. Ender's Nail
7. External fixation

It had been noticed complications such as implant failure, screw back-out, protrusion of implant over the tip of the greater trochanter causing impingement, the z effect involves lateral migration of inferior head screw and medial migration of superior head screw and opposite is reverse z effect. We have hereby conducted the study to evaluate the functional outcomes and complications of trochanteric femoral nail in intertrochanteric femur fractures based on clinical and radiological findings.

Materials and Methods

Study design: Prospective observational study.

Study location: Department of Orthopedics, Shri B M Patil Medical College, Vijayapura, Karnataka, India.

Study period:

Sampling size: Consecutive sampling method was used.

The study involved 43 confirmed cases of intertrochan-teric fractures.

Study population

In the study confirmed cases of intertrochanteric fractures of either sex were treated with intramedullary fixation "Trochanteric femoral nail" was used.

Following inclusion and exclusion criteria were used.

Inclusion criteria

1. Patient aged 40 years and above.
2. Intertrochanteric fractures of femur (stable and unstable).
3. Age of the fractures less than 2 weeks.
4. Patients willing for treatment and giving informed and written consent.

Exclusion criteria

1. Pathological fractures.
2. Associated neurovascular injury.
3. Patients medically unfit for surgery.
4. Non-union or mal union.
5. Open fracture of intertrochanteric fracture.

Methodology

Patients admitted with Intertrochanteric fracture were examined and investigated with X-ray pelvis with both hips AP and Lateral view. Skin traction was applied to all cases. X-ray were reviewed again and classified with using Orthopaedic Trauma Association (OTA) classification. All fractures were treated using a Trochanteric femoral nail were followed up at 6 weeks, 3months, and 6 months. During the follow up period the intraoperative blood loss, duration of surgery, intra operative complications, postoperative complication were studied. Functional outcome was assessed based on modified Harris hip score [5] and visual analogue score for the assessment of pain at greater trochanter on abduction. Radiological evaluation was done with help of x-rays of hip joint ap and lateral views. The tip apex distance on AP view of both Compression screw and anti-rotation screw were measured according to Baumgaertner MR *et al.* [6] and also the measurement of nail protrusion height over the greater trochanter of the femur was measured according to Chang S *et al.* [7] and on lateral view we have measured the tip apex distance of compression screw. Also on AP view the head–neck interface line (L1) is a connecting line between the two curving points where the convexity of the femur head contour turns into femur neck concavity. The centre neck line (L2) is a line perpendicular to the head– neck interface line in its mid-length. The apex is the point where the centre neck line crosses the femur head cortex. D1 = the length of the head–neck interface line. D2 = the distance to the centre of lag screw. D3 = the distance to the upper part of the anti-rotation screw according to the study conducted by Amir Herman *et al.* [8] (figure given below) with the help of software Digimizer and keeping the compression screw width constant as 8mm.

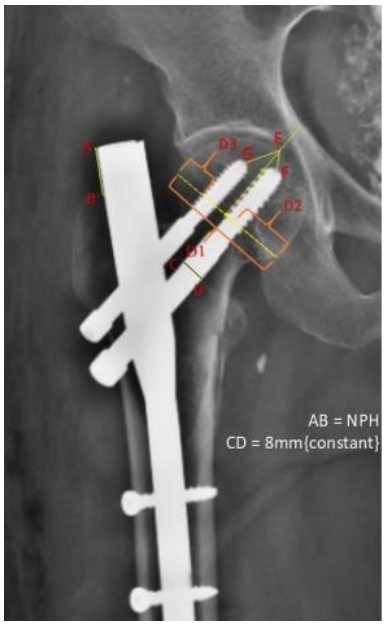


Fig 1: Radiological Measurements by using Digimizer software keeping CD = 8mm (width of the compression screw) AB = Nail Protrusion Height EF = TAD of compression screw EG = TAD of antirotation screw

Results

The study involved 43 confirmed cases of Intertrochanteric fractures of either sex from June 2018- March 2020. All the cases were treated with Intramedullary fixation "Trochanteric femoral nail". The analysis of the patient data, intraoperative data & postoperative outcome is as follows:

The study involved patients above 40 years of age. The age distribution was from 40 and above. The average age was 65

years and the largest group of patients being from 60 to 80 years. There were 24 males and 19 females in the study. In the study out of 43 patients 14 had domestic fall, 28 patients had road traffic accident and others 1 patient. 19 patients were of left side and 24 of right side intertrochanteric fracture. All the fractures were classified as per Orthopaedic Trauma Association (OTA) classification. In which 31A1 (15 cases) were considered stable fractures. 31A2 (19 cases) and 31A3 (9cases) were unstable fractures. Eight patients (18.6%) were suffering from Hypertension, nine patients (6.7) suffering from Diabetes mellitus and three patients (10%) were having both Diabetes mellitus and Hypertension. The average operating time was 55 mins from the incision to closure. Results were evaluated by modified Harris hip score in our series we had 30.2% excellent, 48.8% good, 16.3 % fair and 4.7% poor results. The nail protrusion height was >5 in 74.4% of the patient.

Table 1: Distribution of Cases according to NPH

NPH	N	%
<5	11	25.6
>5	32	74.4
Total	43	100

Table 2: Mean NPH according to NPH categories

Parameters	NPH<5		NPH>5		p value
	Mean	SD	Mean	SD	
NPH	2.0	1.1	6.2	1.1	<0.001*

Note: * significant at 5% level of significance (p<0.05)

Table 3: Mean Study parameters according to NPH categories

Parameters	NPH<5		NPH>5		p value
	Mean	SD	Mean	SD	
D1	42.0	3.8	40.6	4.9	0.392
D2	16.2	3.0	15.6	2.4	0.542
D3	10.2	2.1	9.3	2.7	0.362
TADC(AP)	9.9	1.8	10.6	2.2	0.353
TADA(AP)	16.9	3.9	15.6	4.5	0.385
TADC(LAT)	11.5	1.8	10.4	1.5	0.036*

Note: * significant at 5% level of significance (p<0.05)

Table 4: Distribution of Result according to NPH categories

Result	NPH<5		NPH>5		p value
	N	%	N	%	
Excellent	9	81.8%	4	12.5%	<0.001*
Good	2	18.2%	19	59.4%	
Fair	0	0.0%	7	21.9%	
Poor	0	0.0%	2	6.3%	
Total	11	100.0%	32	100.0%	

Case 1

Pre op X-ray

Post op X-ray

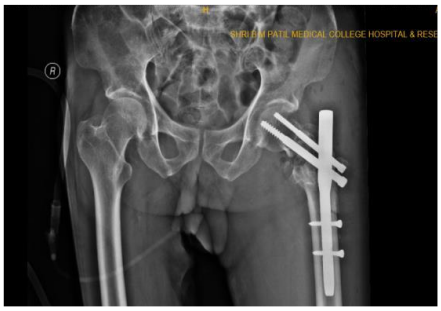
Three months follow up

Six months follow up

Case 2

Pre op X-ray

Squatting



Post op X-ray

6 weeks follow up

Active flexion

Case 3

Pre op X-ray

Squatting

Post op X-ray

Active abduction

Follow up X-ray

Active flexion

Complications

Shortening of 2mm is seen in 4 patients. Also in 4 patients superficial infection was seen. No cases of Rotation deformity, deep infection, bed sores, or mortality were seen. In 1 case the 'Z'- effect of implant failure was seen. There were no cases of non-union in my study. Two patients had varus Mal union in my study.

Discussion

The successful treatment of Intertrochanteric fractures depends on many factors like [9]:

- Age of the patient
- Patients general health
- Time from fracture to treatment
- The adequacy of treatment

- Concurrent medical illness
- Stability of the fixation

At present it is generally believed that all Intertrochanteric fractures should be internally fixed to reduce the morbidity and the mortality of the patient. But the appropriate method and the ideal implant by which to fix the Intertrochanteric fracture is still in a debate. Because each method having its own advantages and the disadvantages.

In the present study 43 patients of Intertrochanteric fractures were studied.

In our study the average age was 64 years which was comparable to Indian as well as western authors with similar study.

We had an 24 male patients and 19 female patients, this resembles many Indian studies. The most common mode of injury in our study was road traffic accident which was 65.1%.

In our study 34.9% were stable fracture pattern and 65.1% were unstable.

Osteoporosis was measured by the Singh's index. More osteoporosis was present in the older patient and post-menopausal females. In our study 39.5% had a grade – III osteoporosis whereas grade IV was 44.2%.

The average intra operative blood loss was minimal. The average was 100ml and it was more in patients who required a limited open reduction. Radiation exposure was calculated in seconds, it was 599.11 seconds by the C-arm. Stable fractures required less exposure than the unstable fractures. This is far below the toxic levels of the radiation.

The average operating time was 55 mins from the incision to closure.

There was no case of non-union. Infection was present in 9.3% of the patient it was superficial which was treated with antibiotics and dressing in the ward, none required debridement or revision and healed well.

Results were evaluated by modified harris hip score in our series we had 30.2% excellent, 48.8% good, 16.3 % fair and 4.7% poor results. It was similar to W.M.Gadegone *et al*. [10] & pavelka *et al*. [11] that the use of TFN may have a positive effect on the speed at which walking is restored.

In the series of 295 patients with trochanteric fractures treated with TFN by Domingo *et al*. [12] the average age of the patient was 80 years, which possibly accounted for 27% of the patients developed complications in the immediate postoperative period. The success of Trochanter femoral nail depended on good surgical technique, proper instrumentation and good C-arm visualization. All the patients were operated on fracture table. We found following advantages

- Reduction with traction is easier.
- Less assistance is required.
- Manipulation of the patient is reduced to minimum.
- Trauma to patient is decreased.
- Better use of C-arm with better visibility.

Placement of the patient on the fracture table is important, for better access to the greater trochanter the upper body is abducted away 10-15°. Position of the C-arm should be such that proximal femur is seen properly in AP and lateral view.

The anatomical reduction and secure fixation of the patient on the operating table are absolutely vital for easy handling and good surgical result. If reduction was not achieved by traction and manipulation then nail reduction was done, in which nail was introduced in the proximal fragment and reduction was tried by rotational movements and compression by the nail. If still reduction was a problem, then it was achieved by limited open reduction at the fracture site. The entry point of the nail was taken on the tip or the lateral part of the greater trochanter. As the nail has 6° of valgus angle medial entry point cause more distraction of the fracture.

The hip pin is inserted 5mm away from the subchondral bone in the lower half in the AP view and center on the neck in the lateral view. The cervical pin is placed parallel to the hip pin in AP view and overlapping it in the lateral view. It should be 10mm shorter than the hip pin from the subchondral bone. This ensures that the cervical screw will not take the weight load but only fulfill the anti-rotational function. The position of the compression screw and antiroation screw were measured which was comparable to the study of Amir Herman *et al*. [8] Distal locking was done with the interlocking bolt and both static and dynamic holes were locked in all the nails in our study.

Dynamic hip screw introduced by claws on in 1964 remains the implant of choice due to its favourable results and low rate of complications. It provides control compression at the fracture site. Its use has been supported by its biomechanical properties which have been assumed to improve the healing of the fracture [13].

But Dynamic hip screw requires a relatively larger exposure, more tissue trauma and anatomical reduction. All these increase the morbidity, probability of infection and significant blood loss. It also causes varus collapse leading to shortening and inability of the implant to survive until the fracture union.

The plate and screw device will weaken the bone mechanically. The common causes of fixation failure are instability of the fractures, osteoporosis, lack of anatomical reduction, failure of fixation device and incorrect placement of the screw [14].

We found Trochanteric femoral nail to be more useful in unstable and reverse oblique patterns due to the fact that it has better axial telescoping and rotational stability. It has shown to be more biomechanically stronger because they can withstand higher static and several fold higher cyclical loading than dynamic hip screw. So the fracture heals without the primary restoration of the medial support. The implant compensates for the function of the medial column [11].

Despite the wide use of trochanteric femoral nail and satisfactory outcomes with low major complication rates, lateral cortex impingement in Indian patients has been reported.

We speculated that the long standing lateral hip pain may be a result of soft tissue irritation caused by nail protrusion over the greater trochanter, which is a cause for the greater trochanter pain syndrome.

In this study, protrusions >5 mm occurred in 74.4% of cases; the mean protrusion height was 5.70 mm, and 70% patients had lateral trochanter pain after an average of 15 months follow up which is comparable to the study done by Sun-Jun Hu *et al*. [7] In this study even though there is proper placement of the screws in neck as well as head of the femur there is nail protrusion over the greater trochanter which causes pain on abduction in Indian population.

As both the length of the proximal segment and the screw angles were fixed, several factors may have influenced the extent of the nail protrusion such as ethnicity, position of the screws and fracture freduction quality. In our practice, anatomic or slightly valgus reduction is preferred, and both the screws are consistently placed in correct position in both the AP and the lateral view.

Conclusion

According to our study and use of Trochanteric femoral nail in Intertrochanteric fractures we can say that Trochanteric Femoral Nail can be considered the most judicious and rational method of treating intertrochanteric fractures, especially the unstable type due to:

- It can be used in all configurations of proximal femoral fractures.
- It is a closed method thus preserves the fracture hematoma and yields early healing and early union.
- It is a quick procedure with a small incision and with significantly less amount of blood loss.
- Post-operatively early mobilization can be begun as the fixation is rigid and because of the implant design.
- Also we have observed the nail protrusion height over 5 mm will cause greater trochanteric pain on abduction in Indian population.

Thus we can conclude that the Trochanteric Femoral Nail is after proper training and technique a safe and easy implant option for treatment of intertrochanteric fractures, but it we recommend a modification to the Trochanteric femoral nail that would further shorten the proximal nail end 5–10 mm for the Indian population, so as to avoid soft tissue irritation on lateral trochanter.

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