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## Trochanteric entry VS piriformis entry in case of antegrade nailing of femoral shaft fracture treatment: A prospective randomised comparative study

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### Abstract

**Background:** Intramedullary nailing is the best modality for femoral shaft fractures as it is biological fixation with good apposition with minimal tissue damage and fixation is bio mechanically superior to plates and fixators with immediate rehabilitation and fewer complications. The optimal entry point for antegrade intramedullary nailing of femoral shaft fractures remains controversial. Since the study by Ricci *et al*, there have been a number of randomized, controlled trials (RCTs) and cohort studies comparing the efficacy of the 2 entry points on various patient-and procedure-related outcomes. As per our knowledge, there has been very less systematic review of the literature on optimal entry point during antegrade nailing of femoral shaft fracture.

### Aims and Objectives

**Aims:** To compare the operative and fluoroscopic time required for IM nail fixation, time taken for taking entry, the amount of blood loss, and other complication in the form of iatrogenic neck femur fracture in surgery of femoral shaft fractures using the GT (greater trochanter) versus PF (Piriformis fossa) entry point. A secondary objective was to determine whether there were any differences in complications (delayed and non union), fracture alignment and healing and functional outcomes in the form of thorenson score, and HHS (harris hip score) between the 2 entry points.

**Materials and Methods:** The present pilot project was conducted in a time span of 2 year and 4 months. The patients admitted with femoral diaphyseal fractures were alternately selected for antegrade nailing through PF group and greater trochanter entry (GTE group) approach. Total number of patient in each group was 30 ( $n = 30$ ).

**Results:** Complications of nailing: PE group - 6.7% infection, 20% malunion, 20% delayed union, 20% restriction of hip ROM, 6.7% restriction of knee ROM, 13.3% limb length discrepancy, 13.3% hardware prominence. Intra-op neck femur fracture 10%, Isolated Greater trochanter fracture -0%, Femoral head osteonecrosis-6.67%

GTE group -3.3% infection 13.3% malunion, 13.3% delayed union, 33.3% restriction of hip ROM, 6.7% restriction of knee ROM, 20% limb length discrepancy, 20% hardware prominence. Intra-op neck femur fracture 0%, Isolated Greater trochanter fracture -3.35%, Femoral head osteonecrosis-0%

**Conclusion:** An antegrade femoral nail for trochanteric insertion resulted in equally high union rates, equally low complication rates, and functional results similar to conventional antegrade femoral nailing through the piriformis fossa. The greater trochanter entry portal represents a rational alternative for antegrade femoral nailing with the benefit of decreased fluoroscopy time and decreased operative time in normal patients and benefits are more marked in those who are obese.

**Keywords:** Trochanteric entry, piriformis entry, case, antegrade nailing, femoral shaft fracture

### Introduction

Hip and Knee joint are the two major weight bearing joints in the lower extremity. The femur is the longest, strongest, largest and heaviest tubular bone in the human body and is the principal weight bearing bone of lower extremity fracture of which leads to considerable morbidity and mortality [1-5]. Femoral shaft fracture results from high energy trauma which may be associated with multisystem injury and considerable soft tissue injury [2,3]. Fractures of the shaft in elderly people are frequently associated with low energy trauma (e.g., falls from standing height), the main predisposing factor of which is osteoporosis [4,5].

Early fixation prevents some grave complications of femoral shaft fractures like fat embolism

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and acute respiratory distress syndrome. It also allows for early active mobilization, which prevents hip and knee stiffness as well as quadriceps and hamstring wasting.

Intramedullary nail provides predictable restoration of shaft length and alignment and allowed early load bearing. Intramedullary nails have a center of movement close to the center of bone, thus are subjected to lesser load, and hence less likely to undergo fatigue failure. Fractures are stabilized with cortical contact of major proximal and distal fragments so that the fractured bone shares the load along with the nail. Relative stability of the construct allows micromotion at the fracture site leading to union by callus formation [1-7].

Osteosynthesis of the femur using an intramedullary nail is considered to be the gold standard for treating diaphyseal fractures of the femur. This is considered to be superior to extramedullary fixation using plates and external fixators, from both the biomechanical and the clinical points of view [8].

To be successful when using the antegrade intramedullary nail technique for the treatment of femur fractures, besides having a good understanding of the anatomy of the proximal femur, one must know how to choose the proper entry point to introduce the nail. The main objective of defining the entry point is to obtain anatomic alignment of the bone fragments. There are different opinions in the literature about the best location for the point of entry into the proximal end of the femur. Some authors prefer the tip of the greater trochanter [9-11]. Others prefer the piriform fossa, as they believe that this location would be the axis between the trochanter and femoral diaphysis [12-15]. Regions of the anterior third and posterior two thirds of the tip of the greater trochanter have also been described [16, 17].

Thus, the piriformis fossa (PF) and the tip of the greater trochanter both have been commonly described as entry portals for antegrade femoral nailing. Both forms of nails have an anterior bowing simulating the bowing of the femur shaft in sagittal plane. But the main structural difference is that the piriform entry nails are devoid of any coronal plane angulation as the piriform fossa is collinear with the long axis of femoral shaft, whereas the trochanteric entry nails have a lateral bending of 4°-5° [5, 6].

The piriform fossa and the tip of the greater trochanter, both the entry points have their own merits and demerits. The clinical outcomes after nail insertion through which entry point is superior with lesser complications is yet to be established firmly [5, 6]. The purpose of this study was to compare results of femoral shaft fracture treatment with nailing through the greater trochanter to nailing through the PF with nails specifically designed for each starting point.

## Methodology

### Material and Methods

The present Comparative randomised prospective study was conducted in S.V.N Govt. Medical College for a time span of two years and four months from August 2016 to November 2018 after taking clearance from the institutional ethics committee and informed consent of the subjects: The patients admitted with femoral diaphyseal fractures at OPD or emergency department of this institution were randomly selected for antegrade nailing through piriformis entry (PE group) and greater trochanter entry (GT group) approach.

Sixty six patients treated for a femoral shaft fracture with antegrade nailing between were included. Two patients who expired early in the postoperative period and 4 with insufficient follow-up were excluded from analysis. At final

follow up only, only 60 patients were present, making total number of patient in each group as 30 each

The criteria used intraoperatively were total operative time and fluoroscopy time, time taken in taking entry, reamer used and nail diameter, blood loss, complications like iatrogenic fracture and malignment. On follow up, functional outcome based on thorensen score, Harris hip score, abductor power, fracture healing and late complications including AVN were analysed.

**Type of study:** Comparative randomised prospective study

### Inclusion criteria

1. Close fracture shaft of femur.
2. Type 1st & type 2nd compound fracture shaft femur (gustillo-anderson).
3. Skeletally mature patient. (>20 years of age)
4. Patient giving consent for the study.

### Exclusion criteria

1. Type 3rd compound fracture shaft femur (gustillo-anderson).
2. With vascular injury.
3. Pathological fractures.
4. Fractures >3 weeks old.
5. 5.Segmental femoral fractures.
6. Below 20 years and above 60
7. Bilateral shaft femur
8. 8.Patients with head injury
9. Medically or anaesthetically unfit patients.
10. Patient not giving written consent for the study

60 patients of shaft femur fracture were randomly assigned into two groups i.e one having taken entry from piriformis fossa and other from greater trochanter and were treated in parallel series and the outcome of the treatment were evaluated both clinically and radiologically using criteria by Harris Hip scoring and Thorenson scoring system periodically.

Routine investigations were done followed by preanesthetic check-up. Distance from the tip of the greater trochanter to the intra articular space of the knee (lateral joint line) on the patient's uninjured side was measured and 20-30 mm was subtracted. Nails of this size along with the next shorter and longer length were kept ready before the operation.

### Implant

All nails were cannulated, closed section, interlocking. The nails used for the GT group, was identical to those used for the PF group, with exception nail has a 4-degree proximal lateral bend to accommodate trochanteric entry. Two proximal holes for locking in head through neck, one proximal dynamic hole

### Patient positioning

Patient can be positioned either supine or lateral on the fracture table. Supine position is better tolerated in patients with associated pulmonary injury or preexisting pulmonary disease while use of lateral decubitus position facilitates location of the piriform fossa. Injured extremity was adducted, and hip flexed to 15°. The contralateral lower extremity was placed adjacent but either inferior to the injured extremity (scissors position) or hip and knee flexed hip abducted (banana position). Patient's trunk was adducted away from the operative table to facilitate access to the entry

point and nail insertion. Correct rotational alignment was established using an image intensifier.

### Operative details

An oblique skin incision was placed just proximal to the greater trochanter and extended proximally and posteriorly for 4 cm. Further dissection depended on intended entry portal.

**For piriform fossa entry:** The fascia of gluteus maximus was bluntly dissected. PF was palpated posterior to the fibers of gluteus medius. Entry point was made in the middle of the piriform fossa in line with the femoral shaft on both sagittal and coronal planes. Entry point was created with a curved awl, entry was confirmed with a 3.2 mm guide pin.

**For trochanteric tip Entry:** The fascia of gluteus medius was incised. The muscle was split in the middle of the belly to access the trochanteric tip. The entry point was in the center of the trochanter and shaft in lateral view and directed medially toward the medullary canal anteroposterior (AP) view under C- arm guidance. Entry point was made using a curved awl or guide pin and canal cutter.

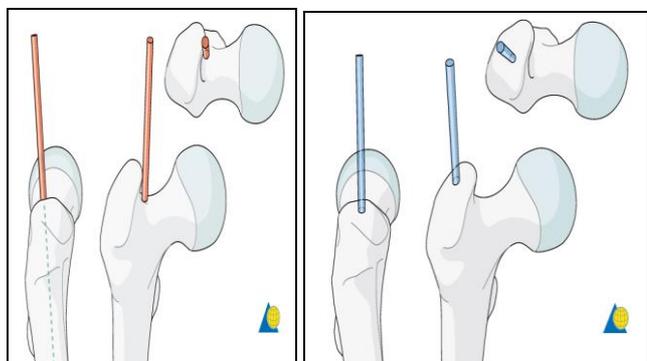


Fig 1: Entry points for interlocking nail in femur

Second generation antegrade intramedullary interlocking nail Indian nail. It is a hollow tubular nail with a circular cross section. Proximal 10 cm is expanded to 12 mm to give additional strength for proximal screw fixation. It has position slots to lock the jig. Its 2 mm wall thickness gives the nail a certain flexibility on bending. Proximal end has got threads on the inner side that provides secure fixation of the threaded conical bolt for attachment of jig/extractor. Nail has a curvature to the average anatomic curvature of the femur.

For locking, there are 2 holes on either side, at the proximal and distal ends of the nail. Circular holes for static locking measure 5 mm. Nails are available in diameter of 9, 10 and 11 with the length from 340 to 440 mm with increments of 20 mm. Locking bolts are self-tapping, 4.5 mm available from 25 to 95 mm in 5 mm increments.

A ball tipped guidewire with slightly bent tip attached to a T-handle chuck was placed down the femoral canal to the fracture site and the containment of the guide wire in the femoral canal was confirmed with AP and lateral views. The fracture was reduced under C-arm guidance, and the guidewire was advanced across the fracture site into the distal fragment.

It is important to center the guide wire in the canal by confirming its position under C-arm in both AP and lateral views. Proper nail length was determined preoperatively and confirmed by either using 2 guide wires of equal length or by a radiolucent ruler. The femur was serially reamed by a cannulated flexible reamer over the guide wire in 0.5 mm

increments starting from 8.0 mm until the desired canal diameter was achieved. Usually, the canal was over reamed by 1–1.5 mm than the desired nail size to prevent jamming of nail. The ball tipped guide wire was replaced by a straight tip guide wire using medullary exchange tube to facilitate the reduction.

Selected nail was mounted to an insertion jig in such a fashion that the nail had anterior bow simulating femoral bow and proximal locking guide of the jig should point laterally. It is important to verify that the proximal targeting jig aligns with the proximal nail holes by “free fall” technique before insertion of the nail. The nail was then advanced down the canal over the guide wire. Insertion handle was used to control the rotation and when no longer manual insertion was possible nail was driven by a hammer – assembly.

As the nail was advanced one assistant verified the rotation. Once the nail was fully seated, and its position verified, proximal locking screw was inserted through the insertion jig from lateral to medial. For distal locking, the C-arm was placed in such a way, that the X-ray beams were parallel to the distal holes and necessary adjustments were done so that the distal locking holes can be seen “perfectly circular”.

Distal locking was done by “free hand” technique. A second distal locking screw was inserted in an identical manner.

In cases of transverse or short oblique fractures, after doing distal locking, necessary back-hammer can be done after loosening the traction if there is a distraction at the fracture site noted. Proximal locking was done using trochar drill sleeves. Length of the screw was determined by graduated drill bit. Length was measured once the drill bit contacted the medial cortex, and then 5 mm was added to determine proximal screw length. Screw placement was avoided in the inferior femoral neck as this might act as a stress raiser. Before closing the wound, reduction, nail position and bolt sizes were verified. Wound was closed in a single layer.

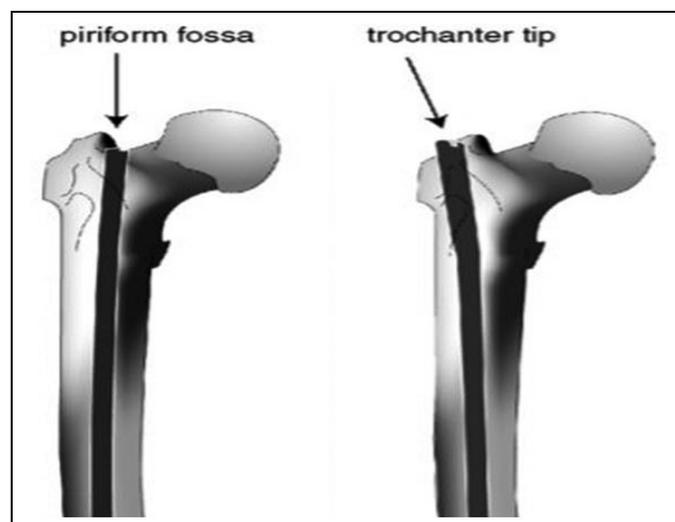


Fig 2: Entry points of a cephalomedullary femoral nail

### Rehabilitation

Emphasis was placed postoperatively on muscle strengthening of the thigh as well as on the range of motion (ROM) of the knee. Active hip and knee ROM exercises were started as soon as pain subsided, usually 24–48 h after operation. Patients were ambulated within 24–48 h after surgery using toe-touching bilateral axillary crutches in cases of stable fracture and satisfactory stable fixation. Suture removal was done after 2 weeks of surgery, on the first postoperative visit. Guarded weight bearing was allowed as soon as bridging

callus was seen in X-ray, usually after 4–6 weeks. Full weight bearing was started when the fracture site was completely bridged by callus and fracture site clinically became nontender. Patients were then examined at 6 weekly intervals until absolute fracture union was obtained clinic-radiographically. Patients were followed up at 6 months and 1-year. Patients who did not show normal periosteal bridging callus at end of 3 months after injury were followed up seen at 4–6 week intervals. If delayed or absent healing was noted at 4–5 months after injury, consideration was given to convert a statically locked nail to a dynamic mode by removing dynamic bolt or both the bolts from the longer fragment of the bone to encourage union (dynamization). Patients were evaluated both clinically and radiologically using criteria by Harris Hip scoring and Thorenson scoring system periodically.

**Observation and results**

About 6.7% Patients were within 20 years of age, 20% were in the age group of 21–30 years, 33.3% were in the age group of 31–40 years, 26.7% were in the age group of 41–50 years, 13.3% were in the age group of 51–60 years. 23.3% were males and 76.7% females.

Road traffic accident was the commonest mode of injury (70%) of cases followed by fall from height in 16.7% of cases. Right femur was injured in 66.6% of cases. All cases were operated within 3 weeks of surgery.

Type of fracture in the two groups were as follows: Group PE A1 6.7%, A2 10%, A3 20%, B1 10%, B3 3.3% and Group GTE A1 10%, A2 23.3%, A3 33.3%, B1 20%, B2 6.6%, B3 6.6%.

**Operative and fluoroscopy time**

The mean operative time for the PF group was 112. 7 minutes; for the GT group it was 90.7 minutes. The mean fluoroscopy time for entry portal in the PF group was 10.08 seconds (range 2–18) and number of C-arm shots for the entry point was around 12, While for the GT group the mean fluoroscopy time for entry portal was 5.88 seconds and number of C-arm shots taken for the entry point was around 8. This increase in fluoroscopy and operating time for the PF group was significant.

These differences were magnified in patients who were obese (body mass index >30) where the operative time (PE= 130.8, GT=100.6) and the fluoroscopy time was higher (PE=16, GT=8.33) in the PF group.

**Healing**

Full Weight bearing time in PE group was 2–3 days in 20%, 2–3 weeks in 53.3%, 2–3 months in 26.7%, and 2–3 days in 13.3%, 2–3 weeks in 46.7%, 2–3 months in 33.3%, >3 months in 6.7% in GTE group.

Radiological union time in PE was 12–15 weeks in 5 patients, 16–19 weeks in 8 patients, 20–23 weeks in 1 and > 24 weeks in 1 patient. Radiological union time in GTE was 12–15 weeks in 4 patients, 16–19 weeks in 9 patients, 20–23 weeks in 2 patients.

Need for dynamization was 20% in the PE group and 13.3% in GTE group.

Radiological union in follow up at 6wks, 8 wks, 12wks and 18wks show no significant difference and took almost similar time in both the groups, and there were no new mal-alignments observed. All fractures were united by 6 months.

**Functional status estimation**

Patients from both groups had a similar initial decline and subsequent improvement in function over time (P > 0.05). Harris hip score at 4 months was GT 73.37 (+/-) 8.25 and PE was 68.67 (+/-) 8.04 with p value<0.002. So the results show that GT has better functional outcome than PF group in terms of Harris-Hip Score but at 6 months follow up, differences were insignificant.

There were no significant differences in Range of motion of knee and hip joint as compared to unaffected side.

**Complications**

No Hip abduction loss developed in 80% of the PE group and in 66.7% in GTE group. No Limb length discrepancy (LLD) was seen in 86.7% in the PE group and in 80% in GTE group. PE group - 6.7% infection, 20% malunion, 20% delayed union, 20% restriction of hip ROM, 6.7% restriction of knee ROM, 13.3% limb length discrepancy, 13.3% hardware prominence. Intra-op neck femur fracture 10%, Isolated Greater trochanter fracture -0%, Femoral head osteonecrosis-6.67%

GTE group -3.3% infection 13.3% malunion, 13.3% delayed union, 33.3% restriction of hip ROM, 6.7% restriction of knee ROM, 20% limb length discrepancy, 20% hardware prominence. Intra-op neck femur fracture 0%, Isolated Greater trochanter fracture -3.35%, Femoral head osteonecrosis-0%

**Table 1:** fluoroscopy timing and number of C-arm shots taken in taking entry

	GT group	PE group	PE group	Significance
fluoroscopy timing	5.88 seconds (range 2–9)	10.08 seconds (range 2–18)	<0.001	Significant
number of C-arm shots	8 (range 6-10)	12 (range 10-14)	<0.001	Significant

**Table 2:** Total operative timing

GT group	PE group	PE group	Significance
90.7 minutes (range 80-102 min)	112. 7 minutes (range 100–124 min)	<0.001	Significant

**Table 3:** comparison of intra op blood loss (no. of Mops used)

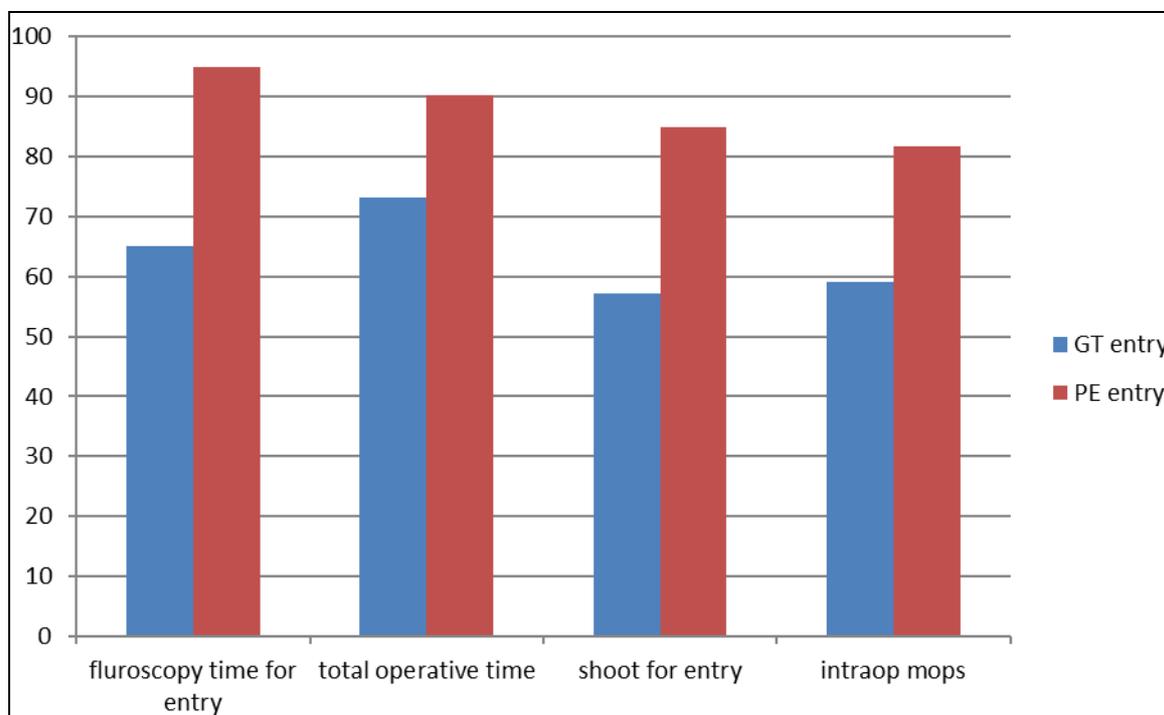
GT group	PE group	PE group	Significance
Mean+/- 1SD 3.25	Mean+/- 1SD 4.5	<0.001	Significant

**Table 4:** Complications

Complication	Number of patients		percentage	
	GT	PE	GT	PE
Hardware prominace	6	4	20	13.35
Malunion	4	6	13.35	20
Delayed union	4	6	13.35	20
Non union	0	0	0	0
Intra-op NOF fracture	0	3	0	10
Isolated GT fracture	1	0	3.35	0
Femoral head AVN	0	2	0	6.67

**Table 5:** Functional status estimation by Thoresen's scoring system at the end of one year

Result	Number of patients		percentage		P value
	GT	PE	GT	PE	
Excellent	24	24	80	80	.68 Not significant
Good	4	6	13.35	20	
Fair	2	0	6.7	0	
Poor	0	0	0	0	
Total	30	30	100	100	

**Fig 3:** Comparative bar chart of different significant parameters

## Discussion

In our comparative study evaluating the optimal entry point (GT vs PF) for antegrade nailing of femoral shaft fractures we found the following:

1. using the GT entry point leads to significantly reduced operative times compared with the PF entry point;
2. fluoroscopy time for entry and number of C arm shoots taken for entry is significantly less when using the GT entry point compared with the PF entry point; and
3. Intra-Op blood loss using GT entry point is significantly less compared with the PF entry point thus reducing chances of post-op infections;
4. nonunion and delayed union rates are not significantly different among patients undergoing antegrade nailing via the GT and PF entry points suggesting that the biological healing process is not influenced by entry point.
5. Bone healing time and functional recovery (at the end of one year) are not significantly different among patients undergoing antegrade nailing via the GT and PF entry points.

The antegrade intramedullary nail is a standard procedure for diaphyseal fractures of the femur in both exposed and closed fractures [18, 19]. Many authors point out the great importance of a proper entry point with the antegrade intramedullary nail [9, 20, 21]; the wrong location can cause several intraoperative complications such as angular deformities postoperatively [13, 20, 21]. Information on the correct location of the entry point are rarely found in the literature, and are controversial and

confusing [10, 17].

Kuntscher originally popularized the technique of closed, antegrade, intramedullary nailing using an open section, straight, cloverleaf nail for fractures of the femoral shaft. He suggested the lateral decubitus position and the use of the tip of the greater trochanter as the preferred entry portal to minimize risks such as intracapsular infection, avascular necrosis of femoral head, and iatrogenic femoral neck fracture [22, 23].

The entry portal was further refined by Bohler, who in 1948 stated: "the awl is placed on the greater trochanter at the junction of the middle and posterior third" [24].

The piriformis fossa starting point became the standard for antegrade nailing since Winqvist, *et al.* indicated they "strongly preferred" this starting point with the patient in the lateral decubitus position [13]. Although no specific data were presented, they described eccentric reaming of the medial cortex of the proximal fragment and comminution of the fracture site, especially in the more proximal fractures or varus malalignment when the lateral starting point that Kuntscher had advised was used.

The main advantage of a PF starting point is its collinear alignment with the long axis of the femoral shaft. This reduces the risk of iatrogenic fracture comminution and varus malalignment compared to off-axis entry points such as trochanteric entry points [6, 7]. Disadvantages of this entry point include relative technical difficulty obtaining the proper entry site, especially in obese patients [2, 3]. This difficulty also reflected in comparatively higher operative time and fluoroscopy shots required in this entry portal. This entry

point is also very sensitive to anterior-posterior translation, with anterior positioning being associated with extreme hoop stresses increased risk of iatrogenic bursting of the proximal segment [6, 7].

In our study, the mean operative time of piriformis entry nailing and trochanteric entry nailing was 112.7 min. and 90.7 min. respectively. This difference in operative time was statistically significant. The average number of C-arm shots to perform the entry point in piriform fossa is significantly higher as compared to trochanter (mean is 12 and 8 respectively). This result corroborates with study of Ricci *et al.* [6] where one-hundred and eight patients were treated with either nailing through a greater trochanter starting point with the trigen TAN nail (GT group) ( $n = 38$ ) or through a PF starting point with the trigen FAN nail (PF group) ( $n = 53$ ). These differences were magnified in patients who were obese (body mass index. 30) where the operative time was 30% greater and the fluoroscopy time was 73% higher in the PF group.

Michael Archdeacon *et al.*; in his study showed that the mean operative time averaged 84 minutes and the average blood loss was 219 cc [25]. In our study, blood loss were kept to as low as 110-155cc. J. Starr *et al.*; in 2006 concluded that the two groups did not differ with regard to blood loss, incisional length and the duration of surgery or intra-op complication [26]. Our study concludes positively the benefits of the GTE entry technique.

About 93.3% patients of piriform entry group and 100% patients of trochanteric entry showed union after index procedure. There was no statistically significant difference in union rates between two study groups. Majority of piriform entry (85.7%) and trochanteric entry (80%) patients showed radiological union before 20 weeks

In the present study, majority of cases of PE group and GTE group could be allowed for full weight bearing between 16–19 weeks (42.8%) and 20–23 weeks (40%) respectively. ROM of hip and knee joint in the study subjects were almost within normal limits. However, abduction loss within 10–20 degree range is slightly higher among the GTE group (13.3%) than the PE group but it was statistically insignificant ( $P = 0.47$ ). Four patient in the PE group and six patients in GTE group had limb length discrepancies (0.69) but all limb shortenings were within an acceptable range ( $\leq 2$  cm). Four patients in PE group and six patients in GTE group had hardware prominences at entry sites but this difference had no statistical significance. However, these hardware prominences had not severe enough to warrant implant removal.

Although fracture union, alignment of the limb, and lack of intraoperative complications are important goals of femoral nailing, alteration of hip function is of great concern. The relative effect on hip function of piriformis compared to trochanteric nailing remains unclear. In a cadaver study, Dora *et al.* found that the PF entry portal was associated with significant damage to the external rotators and medial circumflex artery when compared with the GT entry portal [27]. Ansari Moein *et al.* reported similar findings in their study of cadavers, noting that nailing through the GT would limit any surgical injury to the tendinous aspect of the hip abductor complex [28]. However, in another cadaver study by McConnell *et al.*, the GT entry point was reported to cause an average of 27% damage to the gluteus medius tendon insertion [29]. In our study, no Hip abduction loss developed in 80% of the PE group and in 66.7% in GTE group. Abductor strength significance difference noted intergroup in initial 2 follow ups but at 6 month follow up it was insignificant Hip

abductors showed time dependant improvement in both groups with the GT group improving faster as compared to PF group.

Functional status assessment was done using Thoresens Scoring System. Excellent functional status was seen more in the PE group (85.7%) than the GTE group (80%) but this had no statistical significance.

Two patients in PF entry showed AVN changes at 6 months follow up which can attributed to more medial entry in piriformis and hampering the vascularity in femoral neck. Hence GT entry may avoid damaging blood supply to the femoral head and resultant AVN, femoral neck fractures and septic arthritis.

## Conclusion

Our study concludes that use of the GT entry point during antegrade IM nailing is associated with decreased operative and fluoroscopy times, with no difference in nonunion and delayed union rates when compared with the PF entry point. Healing rates, complication rates, and functional results were similar to those found with antegrade nailing through the piriformis fossa.

Based on these we conclude that antegrade femoral nailing through the greater trochanter should be considered a rational alternative to femoral nailing through the piriformis fossa with the benefit of reduced requirement for fluoroscopy and decreased operative time in patients who are obese with requirement of the nail specifically designed for such entry insertion only. Further research is required to determine the effect of each entry point on the surrounding soft tissue structures and functional outcomes.

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