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Trochanter-shaft, mis-alignments, angulation, rotation, varus/valgus deformity

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Optimizing Entry Point for Femoral Nailing: Role of Trochanter-Shaft Angle in Reducing Complications

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ABSTRACT

To evaluate the role of Trochanter-Shaft Angle in Selection of Entry Site for Femoral Nail Insertion and reducing complications. Observational study. Postgraduate Institute of Medical Education and Research. A total of 70 cases. were evaluated in this. study, divided into two groups of 35 each. Group A in which 35 cases entry was in accordance to the basis of Trochanter-shaft angle and Group B in which 35 cases not following the basis of trochanter-shaft angle. Group A has 22 males and 13 females, group B has 25 males and 10 females. Results were made separately for each of the mis-alignments i.e. displacement, angulation, rotation, varus/valgus deformity, comminution based on their incidence in each of the categories. Group A experienced fewer complications, with only 6 cases, where comminution was the most common issue. In contrast, Group B had 22 cases of complications, with displacement being the most prevalent. The independent T-test analysis showed Group B had a statistically significant higher complication rate compared to Group A ($p=0.012$). Moreover, the prevalence of complications in Group B (26 cases) was notably higher than in Group A (6 cases), with significant differences in displacement and varus/valgus deformities ($p=0.41$ and $p=0.10$, respectively). Findings of this study indicate that using TSA to guide the entry hole for the insertion of femoral nail results in a lower complication rate, emphasizing the benefit of incorporating TSA in clinical practice for improved surgical outcomes.

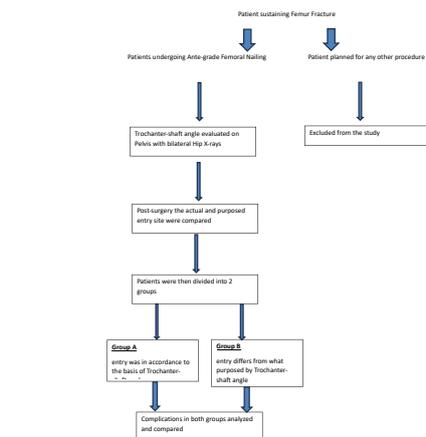
INTRODUCTION

Femur fractures are a significant cause of morbidity, with an annual global incidence of 1.0-2.9 million, primarily affecting the elderly but increasingly seen in younger populations. Effective management is crucial for maintaining quality of life, as these fractures often require surgical intervention^[1,2]. Various treatment methods exist, with intramedullary nailing (IMN) currently preferred for femoral shaft and proximal fractures^[1]. The entry point for IMN, traditionally the piriformis fossa, has been associated with complications such as improper fracture reduction, new stress point on femoral neck and potential vascular damage^[3,4]. Also making an entry through the piriformis fossa has shown many complications such as intra capsular infection^[5,6]. Alternative entry points, such as the greater trochanter, may reduce these risks but can introduce new challenges^[7]. Recent designs, like the Proximal Femoral Nail with a lateral bend for trochanteric insertion, aim to mitigate complications while maintaining effective outcomes^[8,9]. The piriform fossa and the trochanter has been regularly designated as main initial points for antegrade nailing of femur^[7]. For effective nailing technique a comprehensive information of the structural features is required. Of chief attention is the choice of the right entry hole which has more marked effect than the size of the entry hole drilled^[3]. So, many additional entry holes like tip of trochanter, lateral to the tip oftrochanter and medial to greater trochantertiphave also been defined^[10]. Research on femur fractures emphasizes the importance of individualized treatment approaches, particularly regarding the selection of entry points for intramedullary nailing (IMN). Ghouri *et al.* (2021) highlight that traumatic femur fractures are prevalent, especially among young males due to road traffic accidents, with delays in IMN linked to worse trauma outcomes^[11]. Gausepohl *et al.* (2002) found that the ideal entry point is often medial to the greater trochanter, though anatomical variations exist^[12]. Ricci *et al.* (2006) reported comparable outcomes between using the greater trochanter and piriformis fossa as entry points^[8]. Lakhwani *et al.* (2012) stressed the significance of careful entry point selection to avoid complications^[10] while Winquist *et al.* (1984) demonstrated a high union rate using the piriformis fossa^[13] and Streubel *et al.* (2011) emphasized the variability of optimal entry points among patients^[14]. Linke *et al.* (2008) cautioned against lateral entry points due to fracture risks^[15]. Overall, these findings underscore the need for tailored surgical strategies to

enhance patient outcomes in femur fracture management. Follow-up after hip fracture treatment varies globally and may be limited due to financial constraints. We hence know little about there sult of patients today^[16] and the ideal entry hole for ante grade intra medullary nailing of femur fractures remains debatable^[17], highlighting the need for further study, such as the one focusing on the "Trochanter-Shaft Angle" for nail insertion.

MATERIALS AND METHODS

This study aims to evaluate the impact of using the Trochanter-shaft angle for determining the entry site for Antegrade femoral nailing in 70 patients with femur fractures. The participants were randomly divided into two groups of 35: Group A, which used the Trochanter-shaft angle as a guide for the entry site and Group B, which followed standard surgical practices without this criterion. Patients were selected from both outpatient and inpatient departments, ensuring a diverse sample and the study was conducted in compliance with Good Clinical Practice (GCP) guidelines, receiving approval from the hospital's medical research committee. Participation in the study was entirely voluntary and no financial incentives were provided. Pre-operative evaluations included obtaining radiographs to measure the Trochanter-shaft angle on the unaffected limb, which was critical in determining the appropriate entry site for the Antegrade femoral nail. The surgical procedures employed standard nailing techniques, tailored to the specific conditions of each fracture as assessed by the operating surgeon. Post-operatively, patients were kept under observation to monitor for any complications and the site of entry was assessed against the initially calculated site based on the Trochanter-shaft angle. Follow-up assessments included post-operative radiographs, which were taken to evaluate potential alignment issues, such as displacement, angulation, rotation, varus/valgus deformity and comminution. These findings were compared with the normal limb to assess the effectiveness of the entry site determination. The correlation between the Trochanter-shaft angle and the entry site of the femoral nail was analyzed to understand its influence on surgical outcomes. Angles were measured using the Angle Meter app (Android version 1.2.4), ensuring accuracy in data collection. This comprehensive approach seeks to enhance the understanding of optimal entry site determination for femoral nailing, potentially leading to improved patient outcomes in femur fracture management.



Flow Chart



Fig. 1: Representation of Trochanter Shaft Angle^[10]

- The trochanter-shaft angle (R-Angle) plays a significant role in determining the appropriate entry point during procedures such as intramedullary nailing of the femur. When the R-Angle ranges from 0-6 degrees, the entry point is typically located in the trochanteric region, closer to the lateral side of the femur. As the R-Angle increases to between 6 and 12 degrees, the entry point shifts medially towards the medial border of the trochanter, improving alignment with the femoral shaft. When the R-Angle further increases to between 12 and 17 degrees, the entry point moves even more medially, aligning closer to the center of the greater trochanter. This progression helps ensure that the nail is properly aligned with the medullary canal, thereby minimizing the risk of misalignment^[15].

RESULTS AND DISCUSSIONS

The observational study revealed distinct outcomes when comparing the two groups based on the entry site for femoral nail insertion. Group A, which utilized the Trochanter-shaft angle for determining the entry site, demonstrated a significantly lower complication rate with only six incidents, predominantly comminution. Conversely, Group B, which did not rely on the Trochanter-shaft angle, experienced a higher complication rate with 22 cases, primarily displacement. The statistical analysis underscored

significant difference in complications between the groups, suggesting that the use of the Trochanter-shaft angle as a guide for entry point selection may enhance surgical outcomes. These results highlight the importance of precise entry site selection in minimizing post-operative complications and improving patient recovery in femoral nailing procedures.

Statistical Analysis: The statistical analysis of the study was conducted using SPSS version 20, employing descriptive analysis, Karl Pearson correlation test and the Independent T test to evaluate the differences between the two groups. A significant positive correlation was found between the Trochanter-shaft angle and the entry point for Group A ($p=0.004$), indicating a strong association with reduced complications. Conversely, Group B exhibited a significant negative correlation ($p=0.036$), suggesting a misalignment in entry point selection and higher incidence of complications. While the correlation between the point of entry and complication score was not significant for either group, the Independent T test revealed that Group B had significantly more complications than Group A ($p=0.012$). This statistical evidence underscores the efficacy of using the Trochanter-shaft angle as a reliable guide for selecting the entry site, potentially minimizing surgical complications in femoral nailing procedures.

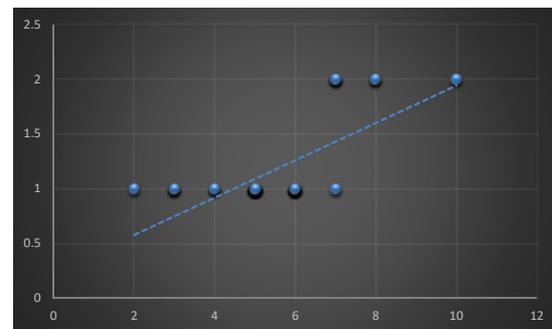


Fig. 2: Trochanter Shaft Angle Vs Entry Site Group A

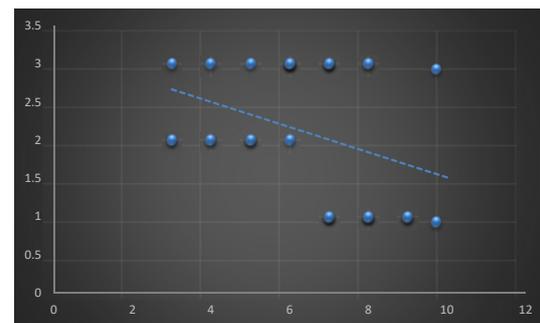


Fig. 3: Trochanter Shaft Angle VS Entry Site Group B

Table 1: Correlation TSA VS Entry Point

	r	p
Group A	.695	0.000*
Group B	-.356	0.036*

Table 2: Entry Point VS Complication Score

	r	p
Group A	-.154	0.377
Group B	-.287	0.094

Table 3: TSA VS Complication Score

	r	p
Group A	.113	0.517
Group B	.028	0.871

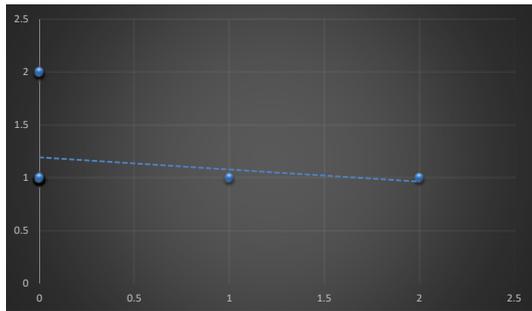


Fig. 4: Complication Score VS Entry Site Group A

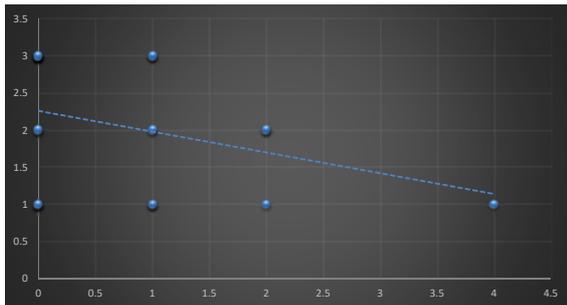


Fig. 5: Complication Score VS Entry Site Group B

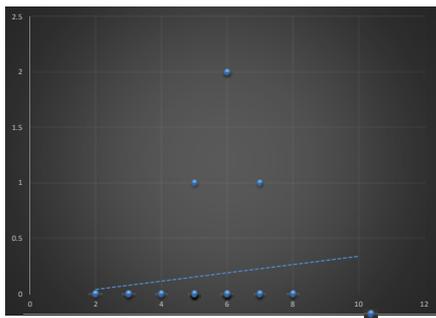


Fig. 6: Trochanter Shaft Angle VS Complication Score Group A

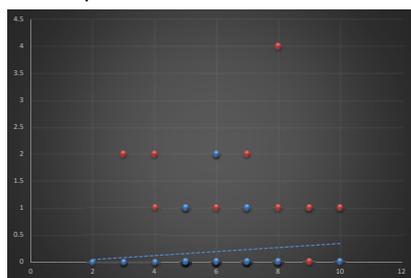


Fig. 7: Trochanter Shaft Angle VS Complication Score Group B

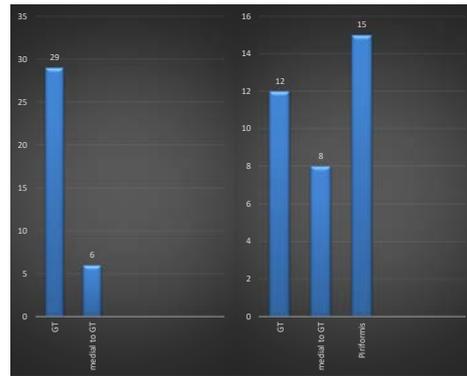


Fig. 8: Group Entry Point and Group B Entry Point

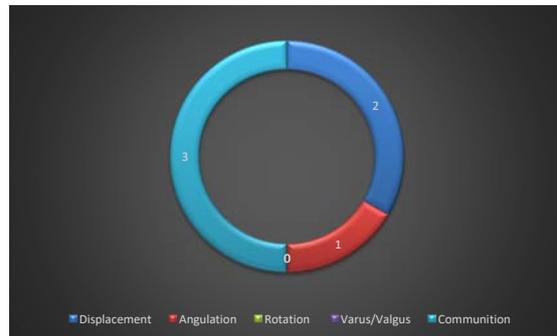


Fig. 9: Distribution Of Complications Group A

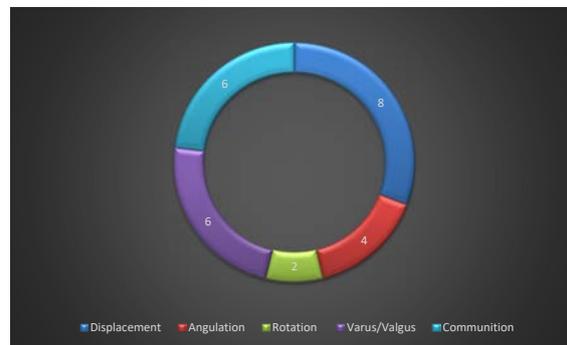


Fig. 10: Distribution of Complication Group B

Table 4: Comparison of Mean Complication Score

	Mean±SD	t	p
Group A	0.1714±0.6286		
Group B	0.6286±0.9102	-2.588	0.012

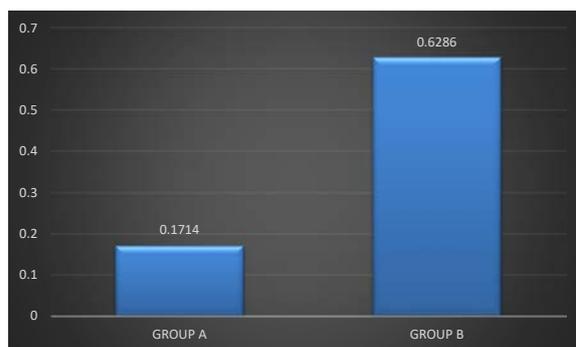


Fig. 11: Mean Complication Score Group A VS Group B

Table 5: Comparison of Complications Between the Groups

Complications	Mean±SD		t	p
	Group A	Group B		
Displacement	.0571±.23550	.2286±.42604	-2.083	.041
Angulation	.2286±.16903	.1143±.32280	-1.392	.169
Rotation	0.0±0.0	.0571±.23550	-1.435	.156
Varus/Valgus	0.0±0.0	.1714±.38239	-2.652	.010
Communication	.0857±.28403	.1714±.38239	-1.065	.291

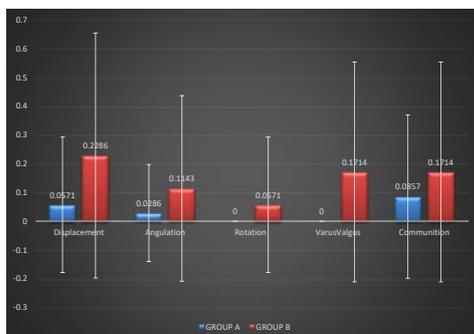


Fig 12: Comparison of Complications Between Groups

The study's findings underscore the critical role of the Trochanter-shaft angle in the election of entry sites for femoral nail insertion, significantly impacting surgical outcomes. Group A, utilizing this angle, experienced notably fewer complications, with only six incidents primarily involving comminution, suggesting a more stable alignment. Conversely, the higher complication rate in Group B, with 22 cases primarily of displacement, highlights the risks associated with neglecting the Trochanter-shaft angle in surgical planning. These discrepancies affirm the importance of precise entry point determination to mitigate misalignments such as displacement and angulation, ultimately enhancing patient recovery. The discussion emphasizes the necessity for orthopedic surgeons to adopt the Trochanter-shaft angle methodology, as evidenced by the statistical significance of reduced complications in Group A, indicating its efficacy in optimizing surgical precision and outcomes in femoral nailing procedures.

CONCLUSION

The evaluation of the Trochanter-shaft angle (TSA) in selecting the entry site for femoral nail insertion revealed notable correlations influencing surgical outcomes. A significant positive correlation was identified between the TSA and the entry point in Group A, indicating that using the Greater Trochanter as the entry site correlated with fewer complications ($p=0.004$). Conversely, in Group B, where the Piriformis entry point was utilized, a significant negative correlation was observed ($p=0.036$), highlighting a misalignment that resulted in a higher incidence of complications. This correlation analysis underscores the efficacy of the Greater Trochanter entry site in minimizing misalignments such as displacement and

angulation, crucial for improving post-operative recovery. The findings emphasize the importance of precise entry site selection, guided by the TSA, in optimizing surgical outcomes and reducing the risk of complications associated with femoral nailing procedures.

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