Section: Orthopaedics

Original Research Article

TO STUDY THE OUTCOME OF PROXIMAL FEMORAL NAILING WITH ADDITION OF SET SCREW IN INTERTROCHANTERIC FRACTURES

Iqbalpreet Singh Saggu[1], Amritpal Singh Kahlon[2], Nishant Minhas[3], Jantaj Singh[4]

[1]*Assistant Professor, GGSMC and H, Faridkot, Punjab, India*
[2]*Senior Resident, N.C. Medical College and Hospital, Israna, Panipat, India.*
[3]*Senior Resident, GGSMC&H, Faridkot, Punjab, India.*
[4]*International Surgical Training Fellow, Sandwell and West Birmingham NHS Trust, West Midlands, United Kingdom.*

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Corresponding Author:
Dr. Amritpal Singh Kahlon,
Senior Resident, N.C. Medical college and Hospital, Israna, Panipat, India.
Email: amritpalsinghkahlon434@gmail.com

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ABSTRACT

Background: Intertrochanteric fractures are common in the elderly and are associated with significant morbidity. The use of dynamic fixation methods has been standard; however, the role of statically locked proximal femoral nails with set screws remains underexplored. **Aim:** To evaluate the radiological and functional outcomes of intertrochanteric fractures managed with statically locked proximal femoral nailing using a set screw.
Materials and Methods: This quasi-experimental study included 30 patients with AO/OTA-classified intertrochanteric fractures managed with short proximal femoral nailing using a helical blade locked statically with a set screw. Patients aged ≥30 years without prior hip/femur surgeries were included. Standardized intraoperative and postoperative protocols were followed. Patients were assessed at 1- and 3-months using radiographs and the Harris Hip Score (HHS). Statistical analysis was conducted using SPSS version 20 with significance set at $p < 0.05$.
Results: The mean age was 70.5 years; 60% of patients were female. AO classification showed 50% A1, 40% A2, and 10% A3 fractures. At 3 months, union was observed in 91.3% of patients. HHS showed good-to-excellent outcomes in both stable and unstable groups. Average femoral neck length shortening in stable fracture was 1mm and in unstable fracture pattern was 2mm and both are statistically not significant. Horizontal femoral offset decreased significantly in both groups ($p = 0.024$ for stable; $p = 0.041$ for unstable). Limb length changes were minimal and not significant. Femoral neck-shaft angle increased significantly in both groups. Tip apex distance remained within acceptable limits in all cases.
Conclusion: Statically locked proximal femoral nails with helical blades can provide stable fixation in intertrochanteric fractures without compromising union rates. Proper fracture reduction with cortical contact is essential for optimal outcomes.
Keywords: Intertrochanteric fracture, Proximal femoral nail, Helical blade, Static locking, Set screw fixation.

INTRODUCTION

Trochanteric fractures are those occurring in the region extending from the extracapsular basilar neck region along the lesser trochanter proximal to the development of the medullary canal. These extracapsular hip fractures are mainly confined to the area of bone between the hip joint capsular attachments to a level of 5 cm distal to the lower border of lesser trochanter.[1] Extracapsular fractures can then be further divided into Trochanteric fractures and subtrochanteric fractures. Weight bearing stress is unequally distributed throughout this area.
The greater trochanter serves as an insertion site for the gluteus medius, gluteus minimus, obturator

internus, piriformis, and site of origin for the vastus lateralis. The lesser trochanter serves as an insertion site for the iliacus and psoas major, commonly referred to as the iliopsoas. The calcar femorale is the vertical wall of dense bone that extends from the posteromedial aspect of the femur shaft to the posterior portion of the femoral neck. This structure is important because it determines whether or not a fracture is stable. The vast metaphyseal region has a more abundant blood supply, contributing to a higher union rate and less osteonecrosis compared to femoral neck fractures.[3-4]

These fractures occur both in the elderly and the young, but they are more common in the elderly population with osteoporosis due to a low energy mechanism. The female to male ratio is between 2:1 and 8:1. These patients are also typically older than patients who suffer femoral neck fractures. In the younger population, these fractures typically result from a high-energy mechanism.[5]

Evans et al. made an important contribution to knowledge about stability of trochanteric fractures. According to them in stable fracture patterns the postero medial cortex remains intact or has minimal comminution making it possible to obtain stable reduction. Unstable fractures on the other hand are characterized by a greater comminution of posteromedial cortex, reverse obliquity fractures, greater trochanter fracture leading to lateral wall collapse, inability to obtain or maintain reduction intraoperatively.[6-7]

Intact lateral wall plays a key role in stabilization of unstable trochanteric fractures by providing a lateral buttress for proximal fragment, and the loss of lateral wall cause uncontrolled collapse with excessive medialization of femoral shaft. The consequences of femoral medialization are a reduced area of bone to bone contact, delayed fracture healing, an increased risk of fracture healing complications, and reduction in function from loss of femoral offset and moment arm. Intact lateral wall deficiency leads to excessive collapse and varus malpositioning.[8]

Many classification systems have come from last 6 decades, but none of them are found to be unanimously acceptable worldwide. Few classifications have focussed on stability and anatomical pattern (Evans; Ramadier; Decoulx; & Lavarde) while others on maintaining reduction of various types (Jensen's modification of Evan's, Ender; Tronzo, AO). an ideal classification should be simple, reproducible and easy to apply and should provide information on stability after reduction, secondary displacement, technique of fixation, postoperative mobilisation, outcome, and also data organisation for research. Various classifications proposed over years have described the fracture patterns, focusing on importance of posteromedial and lateral wall for stability. Tronzo classification is found to be less reliable and not useful in clinical practice. an AO/OTA group has good reliability; it is more useful in record keeping, deciding management and research.

MATERIALS AND METHODS

This quasi-experimental study was conducted in the Department of Orthopaedics at Sri Guru Ram Das Institute of Medical Sciences and Research (SGRDIMSAR), Amritsar. A total of 30 patients diagnosed with intertrochanteric fractures were included and managed surgically using a short proximal femoral nail with a helical blade, which was statically locked using a set screw. The study comprised a total of 30 patients, selected based on inclusion and exclusion criteria. Postoperative follow-up was conducted at 1 month and 3 months after discharge to assess radiological and functional outcomes.

Inclusion Criteria

- Patients with intertrochanteric femur fractures, classified according to the AO/OTA classification system.
- Age 30 years and above.

Exclusion Criteria

- Patients with a history of previous surgery on the ipsilateral hip or femur.
- Patients with abnormal hip anatomy or previous surgery on the contralateral hip.

Fractures were categorized into stable and unstable types based on AO/OTA classification and fracture morphology. Subsequent evaluations of radiological and functional outcomes were conducted accordingly. All patients underwent surgery on a radiolucent traction table. Closed reduction was attempted initially in all cases. If unsuccessful, mini-open or percutaneous reduction techniques were utilized. Provisional fixation was achieved using K-wires, which were retained until final nail insertion. The standard surgical technique for proximal femoral nailing with a statically locked helical blade was followed. Standardized radiographic imaging was employed at multiple time points: Preoperative X-rays, and Postoperative X-rays at 1 and 3 months, including anteroposterior (AP) view of the pelvis with both hips in 15° internal rotation. Proper positioning was confirmed by aligning the pubic symphysis and coccyx vertically, with a 1–3 cm gap between the superior edge of the pubic symphysis and the coccyx tip. The imaging parameters included a kVp of 80 (range 75–85) and a target-film distance of 102 cm (40 inches). At 3-month follow-up, long-standing scanograms of bilateral lower limbs were taken with the patellae facing forward or both feet in 15° internal rotation. A lateral X-ray view of the hip and thigh was also obtained. The Harris Hip Score (HHS) was used to assess functional recovery at the final 3-month follow-up. Scores were recorded and categorized as per standard guidelines.

Statistical Analysis

Data were compiled and analyzed using SPSS Statistics, version 20. Quantitative data were expressed as mean ± standard deviation (SD), and categorical data were presented as frequencies and percentages. The unpaired Student's t-test was used for comparing parametric data, while Chi-square tests were applied for categorical variables. A p-value < 0.05 was considered statistically significant, and p < 0.001 was considered highly significant.

RESULTS

Table 1 shows the demographic and fracture classification data of the study participants. The highest proportion of patients belonged to the 71–80 years age group, contributing 50% of the study population. The youngest patient was 36 years old, and the oldest was 86, with a mean age of 70.5 years. Among the 30 patients, 18 (60%) were female and 12 (40%) were male. Fractures were classified using the AO/OTA system, with 15 cases (50%) categorized as A1, 12 (40%) as A2, and 3 (10%) as A3. Based on this classification, 10 patients (43.48%) were categorized as having stable fractures, and 13 patients (56.52%) as having unstable fracture patterns.

Table 2 illustrates the functional outcomes based on the Harris Hip Score at the 3-month follow-up. Among patients with stable fractures, excellent outcomes were observed in 5 cases (21.74%), good in 4 (17.39%), and fair in 1 (4.35%). In contrast, among unstable fractures, 2 cases (8.70%) had excellent results, 10 (43.48%) were good, and 1 (4.35%) was fair. Overall, a majority of patients in both groups achieved good functional outcomes. The difference in distribution was statistically insignificant (p = 0.905).

Table 3 provides comparative data on femoral neck length and horizontal femoral offset at 1 and 3 months postoperatively.

For femoral neck length, in stable fractures, the average shortening on the operated side was less than 1 mm and statistically insignificant at 3 months (p = 0.972). In unstable fractures, the shortening was approximately 2 mm and also statistically insignificant (p = 0.625). Despite static locking of the helical blade, minimal collapse occurred in both groups without any medial or lateral migration. Tip apex distance (TAD) remained consistent from immediate postoperative to 3-month follow-up.

For horizontal femoral offset, the average decrease in stable fractures was approximately 6 mm, which was statistically significant (p = 0.024). In unstable fractures, the offset decreased by about 5 mm, also statistically significant (p = 0.041). Interestingly, the offset reduction was paradoxically greater in stable fractures, likely due to intraoperative valgus alignment from positive cortical reduction. While this valgus alignment was maintained in most stable cases, some unstable fractures showed minimal collapse into varus, leading to a relative increase in femoral offset from the intraoperative values.

Table 4 summarizes limb length and femoral neck-shaft angle changes at the 3-month follow-up. Regarding limb length, the stable group showed an average increase of 2 mm, while the unstable group showed a 1 mm increase, both statistically insignificant (p = 0.894 and p = 0.960 respectively). The slight increase in limb length can be attributed to the increased femoral neck-shaft angle in both groups, resulting from valgus alignment due to cortical reduction. In terms of femoral neck-shaft angle, stable fractures exhibited an average increase of 7 degrees and unstable fractures an increase of 5 degrees over 3 months. These changes were statistically significant (p = 0.011 for stable and p = 0.040 for unstable). The intentional valgus alignment contributed to this change in both groups, promoting favorable neck-shaft orientation during healing.

Table 5 highlights the assessment of tip apex distance (TAD) at the 3-month mark. In the stable fracture group, the mean TAD was 22.09 ± 3.13 mm, with 6 cases showing TAD < 25 mm and 4 with TAD > 25 mm (range: 21–28 mm). In the unstable group, the mean TAD was 23.00 ± 2.94 mm, with 11 cases having TAD < 25 mm and only 2 cases > 25 mm (range: 18–25 mm). Across all cases, TAD values remained consistent from immediate postoperative to the point of radiological union.

Radiological and clinical union was observed in all 21 evaluated cases by the 3-month follow-up. However, 2 cases showed delayed functional recovery as the patients were still using assistive devices at the end of 3 months, despite radiological evidence of union. Follow-up beyond this time point was unavailable for those two cases.

Table 1: Distribution of Patients by Age, Gender, AO Classification, and Fracture Stability (n = 30)

Parameter	**Category**	**No. of Cases**	**Percentage (%)**
Age (years)	30–40	1	3.33
	41–50	1	3.33
	51–60	4	13.33
	61–70	5	16.67
	71–80	15	50.00
	>80	4	13.33
	Total	**30**	**100.00**
Gender	Female	18	60.00
	Male	12	40.00
	Total	**30**	**100.00**
AO Classification	A1	15	50.00

	A2	12	40.00
	A3	3	10.00
	Total	**30**	**100.00**
Fracture Stability*	Stable	10	43.48
(Based on AO Classification)	Unstable	13	56.52
	Total	**23**	**100.00**

Table 2: Distribution of Patients on the Basis of Final Harris Hip Score

Harris Hip Score	**Fracture Pattern**					
	Stable		**Unstable**		**Total**	
	No.	**%age**	**No.**	**%age**	**No.**	**%age**
Excellent	5	21.74	2	8.70	7	30.43
Fair	1	4.35	1	4.35	2	8.70
Good	4	17.39	10	43.48	14	60.87
Total	10	43.48	13	56.52	23	100.00

X^2: 0.195; p=0.905

Table 3: Comparison of Femoral Neck Length and Horizontal Femoral Offset in Stable and Unstable Groups at 1-Month and 3-Month Follow-up

Parameter	**Time Point**	**Side**	**Stable (Mean ± SD)**	**Unstable (Mean ± SD)**	**p-value**
Femoral Neck Length (mm)	1 Month	Uninjured	47.60 ± 4.90	45.92 ± 5.36	—
		Operated	47.50 ± 5.01	44.84 ± 5.11	0.999 / 0.862
	3 Months	Uninjured	47.60 ± 4.90	45.92 ± 5.36	—
		Operated	47.10 ± 4.97	44.00 ± 5.33	0.972 / 0.625
Horizontal Femoral Offset (mm)	1 Month	Uninjured	38.90 ± 4.14	39.07 ± 4.66	—
		Operated	32.90 ± 5.06	33.76 ± 4.62	0.024 / 0.019
	3 Months	Uninjured	38.90 ± 4.14	39.07 ± 4.66	—
		Operated	32.90 ± 5.06	34.38 ± 4.89	0.024 / 0.041

Table 4: Comparison of Limb Length and Femoral Neck-Shaft Angle in Stable and Unstable Groups at 1-Month and 3-Month Follow-up

Parameter	**Time Point**	**Side**	**Stable (Mean ± SD)**	**Unstable (Mean ± SD)**	**p-value**
Limb Length (mm)	3 Months	Uninjured	712.40 ± 40.01	749.30 ± 42.82	—
		Operated	714.80 ± 39.54	750.15 ± 42.97	0.894 / 0.960
Femoral Neck-Shaft Angle (°)	1 Month	Uninjured	127.40 ± 5.03	126.38 ± 5.33	—
		Operated	134.60 ± 5.21	131.76 ± 4.56	0.011 / 0.021
	3 Months	Uninjured	127.40 ± 5.03	126.38 ± 5.33	—
		Operated	134.60 ± 5.21	131.23 ± 4.65	0.011 / 0.040

Table 5: Tip Apex Distance of Patients in Stable and Unstable Group

Tip apex distance (mm)	**Stable**		**Unstable**		**Total**	
	No.	**%age**	**No.**	**%age**	**No.**	**%age**
<25	6	26.09	11	47.83	17	73.91
>25	4	17.39	2	8.70	6	26.09
Total	10	43.48	13	56.52	23	100.00
Mean SD	22.90±3.13		23.00±2.94		22.90±2.90	

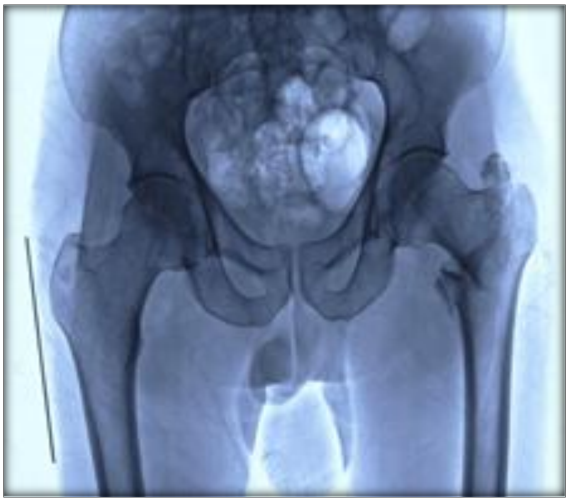

Figure 1: Preoperative x-ray with stable Intertrochanteric fracture left side

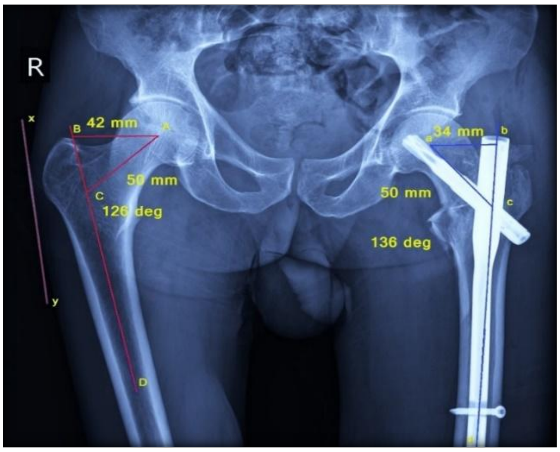

Figure 2: Postoperative xray at one month: Neck length remain constant. Horizontal femoral offset decreases by 8mm. Neck shaft angle increased by 10 degrees on operated side

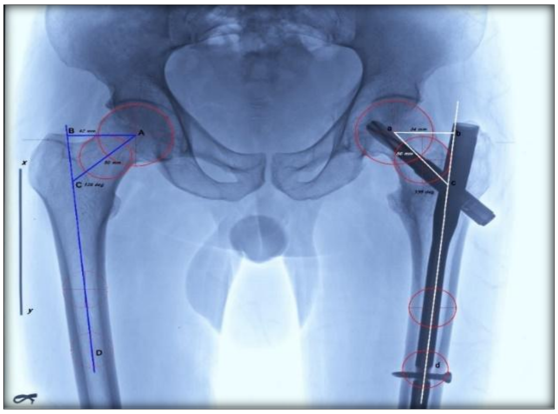

Figure 3: Postoperative x-ray at 3 months: Neck length, Neck shaft angle and horizontal femoral offset remains same at 3 months on operated side. Union at 3 months seen. X-y: 10 cm marker used for calibration

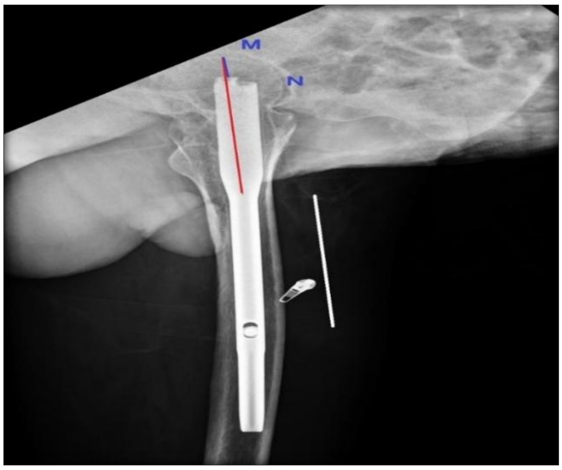

Figure 4: Postoperative X-ray at 3 months: Tip Apex distance (MN) calculated from both AP and Lateral plains-23 mm

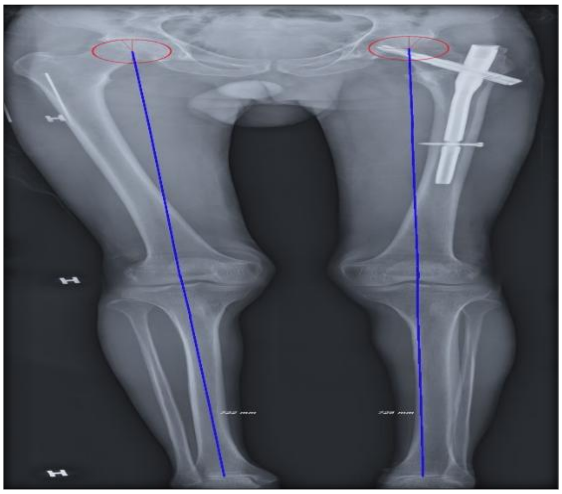

Figure 5: Scanogram Bilateral lower limb: Total Limb length of operated side increased by 3 mm

DISCUSSION

In the present study, the demographic profile showed that the majority of patients belonged to the elderly population, with a mean age of 70.5 years, ranging from 36 to 86 years. Female patients were predominant, accounting for 60% of the total cases. This demographic pattern is consistent with the literature, where intertrochanteric fractures are more commonly reported in older females due to osteoporosis and increased susceptibility to falls, as described by Swaroop et al. (2020),[9] and Li et al. (2014).[10] Based on AO classification, the most common fracture type observed was A1, followed by A2 and A3. When categorized into stability patterns, 10 fractures were classified as stable and 13 as unstable, forming a reliable foundation for comparative evaluation. At 3 months follow-up, radiological and clinical union was observed in 21 out of 23 patients (91.3%) who completed follow-up, demonstrating the effectiveness of intramedullary fixation with helical blade locking in achieving early union. These findings align with those of Barla et al. (2020),[11] who reported high union rates with controlled helical blade migration, even in elderly patients.

Evaluation of functional outcomes using the Harris Hip Score at the end of 3 months showed that patients with both stable and unstable fractures achieved largely satisfactory outcomes. Excellent scores were observed in 21.74% of stable fractures and 8.70% of unstable ones, while good scores predominated in both groups. These outcomes are similar to those reported by Zhang et al. (2021),[12] and Yoon et al. (2020),[13] who demonstrated that early mobilization and proper implant placement play critical roles in ensuring positive short-term function, even in unstable fracture configurations. However, due to the limited follow-up duration, long-term functional outcomes and implant performance could not be assessed beyond 3 months.

Radiological parameters showed minimal shortening of the femoral neck on the operated side in both groups. In stable fractures, the reduction in neck length was less than 1 mm and statistically insignificant, while in unstable fractures, the decrease was approximately 2 mm, also statistically insignificant. These observations suggest minor controlled collapse, a feature allowed by the design of the statically locked helical blade, which accommodates compressive forces without compromising stability. However, in a mechanical analysis conducted by DePuy Synthes Trauma (2015),[14] on the TFN-Advanced system, it was found that extreme loading conditions may still permit slippage, even with static locking. Our study observed no medial or lateral migration of the helical blade, and tip apex distance (TAD) remained constant from immediate postoperative to final follow-up, indicating stable implant positioning and successful load transfer.

The horizontal femoral offset showed a significant reduction in both stable and unstable fractures, with an average decrease of 6 mm and 5 mm respectively. Interestingly, the offset reduction was greater in stable fractures. This paradox can be explained by the positive cortical reduction technique used intraoperatively, which promotes valgus alignment and reduces offset. The offset reduction in stable fractures was pre-set during surgery and remained constant, whereas in some unstable cases, minor varus collapse occurred postoperatively, altering the offset values. Similar observations were reported by Chang et al. (2015),[15] who emphasized the importance of medial cortical support and valgus positioning in maintaining reduction and mechanical advantage. These findings also agree with Lee et al. (2014),[16] who documented the effects of varus collapse on femoral offset and implant behavior.

Limb length analysis at 3 months showed a slight increase in length on the operated side—about 2 mm in stable and 1 mm in unstable fractures. These changes were statistically insignificant. This length gain is likely due to the valgus realignment and increase in femoral neck-shaft angle, a planned intraoperative strategy to restore anatomy. In both groups, a significant increase in femoral neck-shaft angle was recorded: about 7 degrees in stable and 5 degrees in unstable fractures. These valgus changes, achieved through positive cortical contact, are known to enhance biomechanical load transfer and reduce varus collapse risk. The observed neck-shaft angle modifications correlate with findings by Chang et al. (2015),[15] and are considered an important predictor of long-term implant stability and alignment.

Tip apex distance (TAD), a known predictor for cut-out and implant failure, was carefully monitored in this study. The mean TAD values were approximately 23 mm in both groups, and remained within the recommended safety margin of 25 mm. The majority of cases showed no change in TAD throughout the follow-up period. These findings support the conclusion by Barla et al. (2020),[11] that when TAD is maintained within optimal range, the risk of mechanical failure is minimal. In our study, union was achieved in all followed-up patients by 3 months, with only two patients exhibiting delayed functional recovery, though radiological union was evident.

CONCLUSION

So, from current study of 23 cases operated by proximal femoral nailing with statically locked helical blade union was achieved in 91% of cases and no significant change in hip parameters from the changes that we observe that

- Changes in neck length in both stable and unstable fracture was insignificant.
- Femoral neck shaft angle, values was set intraoperatively by operating surgeon into valgus alignment in both stable and unstable fractures and was significant.
- Due to increased femoral neck shaft angle, there was significant decrease in horizontal femoral offset in both stable and unstable fracture.
- Changes in limb length in both stable and unstable was also insignificant.
- Tip apex distance values remain same as set intraoperatively in both stable and unstable fractures.

Current study recommends the use of proximal femoral nail with helical blade locked statically with set screw in intertrochanteric fractures over dynamic collapsible devices.

Current study did not find any decrease in union rate despite having statically locked the helical blade allowing no collapse at the fracture site, but pre-requisite for the use of statically locked device is minimal neutral or preferable positive cortical reduction in both planes views and no gap at the fracture site.

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