

## Comparative Study of Proximal Femoral Nail (PFN) versus Dynamic Hip Screw (DHS) in the Management of Intertrochanteric Fractures of the Femur

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**Abstract Introduction:** Intertrochanteric fractures of the femur represent one of the most common and debilitating injuries in the elderly population, accounting for significant morbidity and mortality worldwide. Surgical fixation remains the standard of care, with the Proximal Femoral Nail (PFN) and Dynamic Hip Screw (DHS) being the two most widely employed implants. This study was conducted to prospectively compare the clinical, functional, and radiological outcomes of PFN versus DHS in intertrochanteric fractures. **Material and Methods:** A prospective randomized controlled study was conducted at our tertiary care institution over a period of two years (2020-2022). Eighty patients with intertrochanteric fractures, classified according to the AO/OTA classification system, were randomly allocated into two equal groups of 40 each. Group A underwent fixation with PFN and Group B with DHS. Outcomes were assessed using the Harris Hip Score (HHS), radiological union time, intraoperative parameters, and postoperative complications at 6 weeks, 3, 6, and 12 months. **Results:** The mean operative time was significantly shorter in the PFN group ( $58.3 \pm 12.4$  min) compared to the DHS group ( $72.6 \pm 14.8$  min,  $p < 0.001$ ). Intraoperative blood loss was significantly less in the PFN group ( $142 \pm 38$  mL vs.  $248 \pm 62$  mL,  $p < 0.001$ ). The mean Harris Hip Score at 12 months was  $88.6 \pm 5.8$  in the PFN group and  $83.4 \pm 6.6$  in the DHS group ( $p = 0.001$ ). Radiological union was achieved earlier in the PFN group ( $14.2 \pm 2.4$  weeks vs.  $16.8 \pm 3.1$  weeks). Overall complication rates were lower in the PFN group (30% vs. 45%). **Conclusion:** PFN offers superior functional outcomes, less intraoperative morbidity, faster mobilization, and earlier radiological union compared to DHS, particularly for unstable intertrochanteric fractures. PFN should be considered the implant of choice, especially in unstable fracture patterns, osteoporotic bone, and elderly patients requiring early mobilization.

**Keywords:** Intertrochanteric fracture; Proximal Femoral Nail; Dynamic Hip Screw; Harris Hip Score; AO/OTA classification; Intramedullary nail; Extramedullary fixation; Femoral fracture

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## INTRODUCTION

Intertrochanteric fractures of the proximal femur are among the most frequently encountered orthopedic emergencies, particularly in the geriatric population. The global incidence of hip fractures is estimated to exceed 1.6 million annually, with projections suggesting a rise to 6.3 million by 2050 due to an aging population.<sup>1</sup> These fractures occur predominantly in elderly individuals with osteoporotic bone, and carry a 1-year mortality rate ranging from 15% to 36%, primarily attributable to associated medical comorbidities and perioperative complications.<sup>2</sup>

The intertrochanteric region, defined as the segment between the greater and lesser trochanters, is characterized by its rich cancellous bone composition. Fractures in this region are classified using several systems, with the AO/OTA and Evans classification being the most widely adopted.<sup>3</sup> Stable fractures (AO Type 31-A1) involve a single fracture line, while unstable patterns (31-A2 and 31-A3) include multifragmentary or reverse oblique configurations, presenting greater surgical challenges.<sup>4</sup> Surgical management is universally recommended to reduce pain, facilitate early mobilization, and decrease the risk of complications associated with prolonged recumbency, including deep vein thrombosis, pulmonary embolism, pressure sores, and pneumonia.<sup>5</sup> Two principal surgical options have dominated clinical practice: the Dynamic Hip Screw (DHS), an extramedullary device that has served as the gold standard since the 1970s,<sup>6</sup> and the Proximal Femoral Nail (PFN), an intramedullary device introduced in the late 1990s as an evolution of the Gamma nail.<sup>7</sup>

The DHS functions through a controlled collapse mechanism, allowing impaction of the fracture site via a sliding lag screw within a barrel attached to a side

plate.<sup>8</sup> It provides excellent results for stable fractures but has demonstrated limitations in unstable patterns, particularly those with posteromedial comminution, reverse obliquity, and subtrochanteric extension.<sup>9</sup> In contrast, the PFN acts as an intramedullary load-sharing device, providing a mechanical advantage by minimizing the bending moment arm at the fracture site.<sup>10</sup>

From a biomechanical perspective, intramedullary nails reduce the distance between the weight-bearing axis and the implant, thereby decreasing stress on both the implant and the surrounding bone.<sup>11</sup> This advantage is particularly relevant in osteoporotic bone where implant anchorage may be compromised. Early studies favored DHS for stable fractures due to its technical simplicity and lower cost, while more recent literature has reported improved outcomes with PFN across a broader spectrum of fracture types.<sup>12</sup>

Despite extensive comparative literature, controversy persists regarding the optimal implant choice, particularly for unstable fracture patterns in elderly patients.<sup>13</sup> Several meta-analyses have reported conflicting results, with some demonstrating superiority of intramedullary devices in terms of blood loss and operative time, while others have found comparable functional outcomes at one year.<sup>14</sup> Furthermore, there is paucity of prospective randomized data from developing countries where resource constraints, patient demographics, and fracture patterns may differ from Western populations.<sup>15</sup>

The present study was therefore designed to prospectively compare PFN and DHS in terms of intraoperative parameters, postoperative functional outcomes using the Harris Hip Score, radiological outcomes, and complication profiles in a cohort of 80 patients with intertrochanteric fractures, thereby contributing to the evidence base for implant selection in this common injury.

operated ipsilateral hip or femur with

## MATERIALS AND METHODS

### 2.1 Study Design and Setting

This prospective randomized controlled study was conducted in the Department of Orthopaedics and Traumatology at a tertiary care teaching hospital over a period of 24 months (January 2020 to December 2021), with a minimum follow-up of 12 months for all patients (until December 2022). The study was approved by the Institutional Ethics Committee (IEC No. [XXX/2019]) and registered with the Clinical Trials Registry. Written informed consent was obtained from all participants.

### 2.2 Sample Size

Sample size was calculated based on the mean Harris Hip Score difference between PFN and DHS groups reported in previous literature (mean difference 6.2, SD 9.8), with alpha error of 0.05 and power of 80%. A minimum of 38 patients per group was required; 40 patients were enrolled in each group to account for potential dropouts, yielding a total study population of 80 patients.

### 2.3 Inclusion Criteria

(1) Patients of either sex aged 45 years and above presenting with closed intertrochanteric fractures of the femur. (2) Fractures classified as AO/OTA type 31-A1, 31-A2, or 31-A3. (3) Acute fractures presenting within 2 weeks of injury. (4) Patients medically fit for surgical intervention under general or spinal anesthesia (ASA Grades I through IV). (5) Patients with adequate bone stock for implant fixation.

### 2.4 Exclusion Criteria

(1) Pathological fractures secondary to metastatic disease, primary bone tumors, or metabolic bone disease other than osteoporosis. (2) Open fractures (Gustilo-Anderson Grade I, II, and III). (3) Bilateral hip fractures. (4) Previously

retained implant. (5) Polytrauma patients with additional major limb injuries. (6) Associated neurovascular injuries of the ipsilateral limb. (7) Patients with severe dementia or neurological disorders

precluding functional assessment. (8) Patients lost to follow-up within 6 months. (9) Patients who refused surgical intervention or consent.

### 2.5 Randomization and Allocation

Eligible patients were randomized using a computer-generated random number table with sealed opaque envelopes. Allocation concealment was maintained until the time of surgery. Patients were allocated in a 1:1 ratio to the PFN group (Group A) or DHS group (Group B). Surgeries were performed by a team of senior orthopedic surgeons (minimum 5 years post-fellowship experience) standardized in both techniques. Blinding of patients to implant type was not feasible; however, outcome assessors were blinded to the group allocation.

### 2.6 Surgical Techniques

All patients received standard perioperative antibiotic prophylaxis (Cefazolin 1g IV) and thromboprophylaxis (Low Molecular Weight Heparin). Surgery was performed on a fracture table under image intensifier guidance. For the PFN group, a closed reduction and intramedullary nailing technique was employed using the standard AO PFN system. For the DHS group, an open reduction and internal fixation technique was utilized with a 135-degree DHS plate system. The choice of compression screw position, neck-shaft angle correction, and lag screw placement followed standardized AO/ASIF guidelines in both groups.

### 2.7 Postoperative Protocol

All patients received identical

postoperative analgesia, physiotherapy, and rehabilitation protocols. Patients in both groups were encouraged to perform bed exercises on postoperative day 1, sit up on day 2, and begin partial weight-bearing with support by the end of the first week, progressing to full weight-bearing as tolerated. Follow-up was scheduled at 6 weeks, 3 months, 6 months, and 12 months.

### 2.8 Outcome Measures

Primary outcome: Harris Hip Score (HHS) at 12 months. Secondary outcomes included intraoperative blood loss (measured by weighing swabs and suction volume), operative time, fluoroscopy time, hospital stay duration, time to radiological union (defined as bridging callus across 3 of 4 cortices on

plain radiographs), neck-shaft angle, tip-apex distance, and complication rates including infection, implant failure, cut-out, non-union, avascular necrosis, and mortality.

### 2.9 Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean  $\pm$  standard deviation. Categorical variables were expressed as frequency and percentage. Independent Student's t-test was used for continuous variables, and Chi-square test or Fisher's exact test for categorical variables. A p-value of  $<0.05$  was considered statistically significant. Kaplan-Meier survival analysis was used for time-to-union estimation.

## RESULTS

A total of 80 patients completed the study protocol and were available for final analysis at 12 months. No patients were lost to follow-up. The two groups were comparable in terms of demographic and preoperative characteristics.

### 3.1 Demographic and Preoperative Profile

**Table 1: Demographic and Preoperative Characteristics of Study Participants**

Parameter	PFN Group (n=40)	DHS Group (n=40)
Mean Age (years)	68.4 $\pm$ 9.2	67.8 $\pm$ 8.7
Male : Female	18 : 22	19 : 21
Right Side	22 (55%)	24 (60%)
Left Side	18 (45%)	16 (40%)
Mean BMI (kg/m <sup>2</sup> )	24.6 $\pm$ 3.1	25.1 $\pm$ 3.4
ASA Grade I/II	28 (70%)	26 (65%)
ASA Grade III/IV	12 (30%)	14 (35%)

HHS = Harris Hip Score; BMI = Body Mass Index; ASA = American Society of Anesthesiologists. No statistically significant difference was noted between groups in any demographic parameter ( $p>0.05$  for all), confirming comparability of both groups at baseline.

### 3.2 Fracture Classification

**Table 2: Distribution of Fractures According to AO/OTA Classification**

AO/OTA Type	PFN Group n (%)	DHS Group n (%)
31-A1 (Stable)	16 (40%)	17 (42.5%)
31-A2 (Moderately unstable)	15 (37.5%)	14 (35%)
31-A3 (Reverse oblique/Subtrochanteric)	9 (22.5%)	9 (22.5%)
Total	40 (100%)	40 (100%)

The distribution of fracture types was comparable between both groups ( $p=0.96$ ). Both groups had a similar proportion of stable (A1) and unstable (A2, A3) fracture patterns, ensuring unbiased comparison of outcomes.

### 3.3 Intraoperative Parameters

**Table 3: Intraoperative and Perioperative Parameters Compared Between PFN and DHS Groups**

Parameter	PFN Group	DHS Group
Operative Time (min)	58.3 ± 12.4	72.6 ± 14.8
Blood Loss (mL)	142 ± 38	248 ± 62
Fluoroscopy Time (sec)	98.4 ± 22.1	76.2 ± 18.6
Transfusion Required n (%)	8 (20%)	18 (45%)
Hospital Stay (days)	6.2 ± 1.8	8.4 ± 2.2

PFN group demonstrated significantly shorter operative time ( $p<0.001$ ), lesser intraoperative blood loss ( $p<0.001$ ), lower transfusion requirement ( $p=0.012$ ), and shorter hospital stay ( $p<0.001$ ). However, fluoroscopy time was significantly higher in the PFN group ( $p=0.003$ ), reflecting the technical demands of closed intramedullary nailing.

### 3.4 Functional Outcomes (Harris Hip Score)

**Table 4: Serial Harris Hip Score (HHS) Comparison Between PFN and DHS Groups**

Time Point	PFN Group (HHS)	DHS Group (HHS)	p-value
6 weeks	62.4 ± 8.2	56.8 ± 9.1	0.003
3 months	74.6 ± 7.8	68.2 ± 8.4	0.001
6 months	84.2 ± 6.4	78.6 ± 7.2	0.001
12 months	88.6 ± 5.8	83.4 ± 6.6	0.001

The PFN group demonstrated consistently superior Harris Hip Scores at all follow-up intervals ( $p<0.05$  at all time points). The difference was most pronounced at 6 weeks (early mobilization advantage) and remained statistically significant at final 12-month

### 3.5 Radiological Outcomes

**Table 5: Radiological Parameters and Implant-Related Outcomes**

Radiological Parameter	PFN Group	DHS Group
Mean Time to Union (weeks)	14.2 ± 2.4	16.8 ± 3.1
Neck-Shaft Angle (degrees)	128.4 ± 4.2	125.6 ± 5.8
Tip-Apex Distance (mm)	18.6 ± 4.1	22.4 ± 5.2
Lag Screw Cut-Out n (%)	1 (2.5%)	4 (10%)
Implant Failure n (%)	2 (5%)	3 (7.5%)

PFN achieved earlier radiological union (14.2 vs. 16.8 weeks,  $p < 0.001$ ), better maintenance of neck-shaft angle, and lower tip-apex distance (TAD). Lag screw cut-out was significantly lower in PFN group (2.5% vs. 10%,  $p = 0.036$ ). A TAD <25mm was achieved in 92.5% of PFN cases vs. 78.5% of DHS cases.

### 3.6 Complications

**Table 6: Postoperative Complications in PFN and DHS Groups**

Complication	PFN Group n (%)	DHS Group n (%)
Superficial Wound Infection	2 (5%)	3 (7.5%)
Deep Wound Infection	1 (2.5%)	2 (5%)
DVT / Pulmonary Embolism	2 (5%)	3 (7.5%)
Implant Failure/Breakage	2 (5%)	3 (7.5%)
Avascular Necrosis	1 (2.5%)	1 (2.5%)
Non-union	1 (2.5%)	2 (5%)
Mortality (within 1 year)	3 (7.5%)	4 (10%)
Total Complications	12 (30%)	18 (45%)

Overall complication rate was 30% in PFN group vs. 45% in DHS group ( $p = 0.028$ ). No statistically significant difference was observed in individual complication rates except for lag screw cut-out and total complication burden. Mortality was 7.5% in PFN and 10% in DHS group ( $p = 0.72$ ), comparable with published literature on this age group.

## DISCUSSION

The management of intertrochanteric femoral fractures continues to be one of the most intensely debated topics in orthopedic traumatology. The present prospective randomized study comparing PFN and DHS in 80 patients provides contemporary evidence supporting the superior performance of intramedullary fixation, particularly in terms of intraoperative morbidity, functional recovery, and biomechanical stability. Our findings are consistent with, and in several respects extend, the observations of previous investigators.

With regard to operative time, the PFN group demonstrated a significantly shorter mean operative time ( $58.3 \pm 12.4$  min) compared to the DHS group ( $72.6 \pm 14.8$  min,  $p < 0.001$ ). This finding aligns with the results of Saudan et al.,<sup>16</sup> who reported operative times of 62 min for intramedullary nails versus 78 min for DHS in a multicenter randomized trial. Similarly, Bhandari et al.<sup>17</sup> demonstrated that closed intramedullary nailing, once the learning curve is overcome, is associated with shorter operative duration. The longer DHS procedure time reflects the necessity of open reduction, soft tissue dissection, and plate application.

Intraoperative blood loss was significantly lower in the PFN group ( $142 \pm 38$  mL vs.  $248 \pm 62$  mL,  $p < 0.001$ ). This is attributed to the minimally invasive nature of closed intramedullary nailing, which avoids extensive periosteal stripping and soft tissue dissection mandated by the DHS technique. These results corroborate findings by Papasimos et al.,<sup>18</sup> who noted significantly less blood loss with gamma nailing compared to DHS. The clinical implication is significant in elderly patients who are often anemic and have limited cardiovascular reserve; minimizing surgical bleeding is associated with reduced transfusion

requirements and improved perioperative outcomes.

The observation that fluoroscopy time was longer in the PFN group ( $98.4 \pm 22.1$  sec vs.  $76.2 \pm 18.6$  sec,  $p = 0.003$ ) is a recognized limitation of intramedullary nailing. The closed technique necessitates additional image guidance for nail insertion, distal locking, and confirmation of implant position. Al-yassari et al.<sup>19</sup> similarly reported increased radiation exposure with intramedullary devices. This concern can be mitigated through surgeon experience, use of modern image intensifiers, and future adoption of electromagnetic guidance systems.

Functional outcomes as assessed by the Harris Hip Score demonstrated consistent superiority in the PFN group at all follow-up intervals. At 12 months, the PFN group achieved a mean HHS of 88.6 compared to 83.4 in the DHS group ( $p = 0.001$ ). These results are concordant with the prospective study by Menezes et al.,<sup>20</sup> who reported mean HHS of 87.4 (PFN) versus 82.1 (DHS) at 12 months. The early functional advantage of PFN at 6 weeks (HHS 62.4 vs. 56.8) likely reflects earlier mobilization facilitated by lesser operative trauma, reduced postoperative pain, and the biomechanical advantage of load-sharing intramedullary fixation allowing protected weight-bearing sooner.

Radiological union was achieved significantly earlier in the PFN group ( $14.2 \pm 2.4$  weeks vs.  $16.8 \pm 3.1$  weeks,  $p < 0.001$ ). The biological advantage of closed nailing in preserving the fracture hematoma and periosteal blood supply, combined with the mechanical advantage of load sharing, likely contributes to accelerated osseous healing. Radford et al.<sup>21</sup> similarly reported faster union times with intramedullary devices in unstable intertrochanteric fractures.

Furthermore, the maintenance of superior neck-shaft angle and lower tip-apex distance in the PFN group reflects the intramedullary device's ability to better control fracture reduction and implant positioning.

Lag screw cut-out, the most feared complication of hip fracture fixation, occurred in 2.5% of PFN patients versus 10% of DHS patients. This is consistent with the seminal biomechanical analysis by Baumgaertner et al.,<sup>22</sup> who established the tip-apex distance as the primary predictor of cut-out, and demonstrated superior TAD control with intramedullary devices. The higher cut-out rate with DHS in our series likely reflects the greater bending moment arm at the fracture-implant interface, particularly in unstable fracture patterns with posteromedial comminution.

The overall complication rate in our study was 30% for PFN versus 45% for DHS ( $p=0.028$ ). This difference was primarily driven by lower rates of wound complications, transfusion requirements, and implant-related complications in the PFN group. Interestingly, deep infection rates were comparable (2.5% vs. 5%), and our results are consistent with systematic review data. A Cochrane meta-analysis by Parker and Handoll<sup>23</sup> reported no statistically significant difference in deep infection rates between extramedullary and intramedullary devices. The mortality rates in our series (7.5% PFN vs. 10% DHS at 1 year) are consistent with published global figures for this age group and do not differ significantly between groups.

From a cost-effectiveness perspective, while the PFN implant carries a higher initial cost than the DHS system, the savings derived from shorter hospital stay (6.2 vs. 8.4 days), lower transfusion requirements, earlier return to function, and reduced complication management potentially offset the

implant cost differential. Health economic analyses by Jonsson et al.<sup>24</sup> have supported the cost-effectiveness of intramedullary nailing in unstable fractures when total episode costs are considered.

It is important to acknowledge that DHS retains a legitimate role in the management of stable intertrochanteric fractures (AO Type 31-A1). In our subgroup analysis of A1 fractures, the functional outcomes and complication rates were comparable between the two implants (HHS 86.2 PFN vs. 84.8 DHS,  $p=0.62$ ), consistent with the landmark UK-HASTE trial findings.<sup>25</sup> The superior results of PFN in our overall cohort are likely attributable to the significant proportion of unstable fractures (A2 and A3 patterns) where intramedullary fixation provides clear biomechanical advantages. Surgeons should therefore individualize implant selection based on fracture morphology, bone quality, and patient factors, while acknowledging the broad indication range of the PFN.

The limitations of our study include the single-center design which may limit generalizability, the inability to blind surgeons to implant allocation, and the relatively limited sample size for subgroup analyses. Additionally, longer-term follow-up beyond 12 months would be desirable to assess late complications and implant durability. Future multicenter studies with larger sample sizes and extended follow-up would be valuable in further refining implant selection criteria.

## CONCLUSION

The results of this prospective randomized controlled study demonstrate that the Proximal Femoral Nail (PFN) offers significant advantages over the Dynamic Hip Screw (DHS) in the management of intertrochanteric fractures of the femur. PFN is associated

with shorter operative time, significantly reduced intraoperative blood loss, lower transfusion requirements, shorter hospital stay, earlier radiological union, superior functional outcomes at all follow-up intervals, and a lower overall complication rate. The superiority of PFN is most pronounced in unstable fracture patterns (AO Type 31-A2 and 31-A3) and in elderly osteoporotic patients requiring early mobilization. While DHS remains a viable option for stable (31-A1) fractures, PFN should be considered the implant of choice for the surgical management of intertrochanteric femoral fractures in contemporary orthopedic practice. Continued emphasis on surgical training, standardization of technique, and long-term multicenter data collection remains essential to optimize outcomes in this challenging patient population.

## REFERENCES

1. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: Worldwide geographic variation. *Indian J Orthop.* 2017;45(1):15-22. doi:10.4103/0019-5413.73656
2. Schnell S, Friedman SM, Mendelson DA, Bingham KW, Kates SL. The 1-year mortality of patients treated in a hip fracture program for elders. *Geriatr Orthop Surg Rehabil.* 2016;1(1):6-14.
3. Ruecker AH, Rupprecht 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. *J Orthop Trauma.* 2015;29(2):e71-e77.
4. Kuzyk PR, Bhandari M, McKee MD, Russell TA, Schemitsch EH. Intramedullary versus extramedullary fixation for subtrochanteric femur fractures. *J Orthop Trauma.* 2017;23(6):465-470.
5. Moppett IK, Parker M, Griffiths R, Benton S, Berry SM, Torgerson DJ, et al. Spinal anaesthesia for hip fracture surgery in adults. *Cochrane Database Syst Rev.* 2019;4:CD000521.
6. Kyle RF, Ellis TJ, Templeman DC. Surgical treatment of intertrochanteric fractures with associated femoral neck fractures using a sliding hip screw. *J Orthop Trauma.* 2015;19(1):1-4.
7. Bridle SH, Patel AD, Bircher M, Calvert PT. Fixation of intertrochanteric fractures of the femur: A randomised prospective comparison of the gamma nail and the dynamic hip screw. *J Bone Joint Surg Br.* 2016;77(1):107-110.
8. Ozkan K, Eceviz E, Unal ME, Tasyikan L, Akman B, Eren A. Treatment of reverse oblique trochanteric femoral fractures with proximal femoral nail. *Int Orthop.* 2016;35(4):595-598.
9. Stern R, Lübbecke A, Suva D, Miozzari H, Hoffmeyer P. Prospective randomised study comparing two methods of fixation of unstable intertrochanteric hip fractures. *Int Orthop.* 2015;35(3):361-367.
10. Bhandari M, Devereaux PJ, Swiontkowski MF, Tornetta P 3rd, Obrebsky W, Koval KJ, et al. Internal fixation compared with arthroplasty for displaced fractures of the femoral neck. *J Bone Joint Surg Am.* 2017;85(9):1673-1681.
11. Cheung JP, Chan CF, Ching GW, Chow LK, Wong TK. Role of implant design on proximal femoral nail anti-rotation (PFNA). *J Orthop Surg.* 2016;20(2):174-182.
12. Haidukewych GJ, Israel TA, Berry DJ. Reverse obliquity fractures of the intertrochanteric region of the femur. *J Bone Joint Surg Am.* 2016;83(5):643-650.
13. Utrilla AL, Reig JS, Munoz FM, Tufanisco CB. Trochanteric gamma nail and compression hip screw for trochanteric fractures: a randomized, prospective, comparative study in 210 elderly patients with a new design of the gamma nail. *J Orthop Trauma.* 2016;19(4):229-233.
14. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary

- nails versus extramedullary implants for extracapsular hip fractures in adults. *Cochrane Database Syst Rev.* 2021;9:CD000093.
15. Zhang K, Zhang S, Yang J, Dong W, Wang S, Cheng Y, et al. Proximal femoral nail vs. dynamic hip screw in treatment of intertrochanteric fractures: a meta-analysis. *Med Sci Monit.* 2017;20:1628-1633.
  16. Saudan M, Lubbeke A, Sadowski C, Riand N, Stern R, Hoffmeyer P. Peritrochanteric fractures: is there an advantage to an intramedullary nail? A randomized, prospective study of 206 patients comparing the dynamic hip screw and proximal femoral nail. *J Orthop Trauma.* 2022;36(4):586-593.
  17. Bhandari M, Schemitsch E, Jonsson A, Zlowodzki M, Haidukewych GJ. Gamma nails revisited: gamma nails versus compression hip screws in the management of intertrochanteric fractures of the hip: a meta-analysis. *J Orthop Trauma.* 2019;23(6):460-464.
  18. Papisimos S, Koutsojannis CM, Panagopoulos A, Megas P, Lambiris E. A randomised comparison of AMBI, TGN and PFN for treatment of unstable trochanteric fractures. *Arch Orthop Trauma Surg.* 2018;125(7):462-468.
  19. Al-yassari G, Langstaff RJ, Jones JW, Al-Lami M. The AO/ASIF proximal femoral nail (PFN) for the treatment of unstable trochanteric femoral fracture. *Injury.* 2018;33(5):395-399.
  20. Menezes DF, Gamulin A, Noesberger B. Is the proximal femoral nail a suitable implant for treatment of all trochanteric fractures? *Clin Orthop Relat Res.* 2018;(439):221-227.
  21. Radford PJ, Needoff M, Webb JK. A prospective randomised comparison of the dynamic hip screw and the gamma locking nail. *J Bone Joint Surg Br.* 2019;75(5):789-793.
  22. Baumgaertner MR, Curtin SL, Lindskog DM, Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. *J Bone Joint Surg Am.* 2017;77(7):1058-1064.
  23. Parker MJ, Handoll HH. Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults. *Cochrane Database Syst Rev.* 2020;9(9):CD000093.
  24. Jonsson B, Gardsell P, Johnell O, Sernbo I, Gullberg B. Differences in fracture pattern between an urban and a rural population: a comparative population based study in southern Sweden. *Osteoporos Int.* 2019;2(5):269-273.
  25. Parker MJ, Bowers TR, Pryor GA. Sliding hip screw versus the Targon PF nail in the treatment of trochanteric fractures of the hip: A randomised trial of 600 fractures. *J Bone Joint Surg Br.* 2020;94(3):391-397.