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Clinical and radiological results of patients with femoral intertrochanteric fractures treated with proximal femoral nailing

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Abstract

The purpose of this study was to assess the long-term clinical, functional, and radiological results of the patients who underwent osteosynthesis of femoral intertrochanteric fractures using proximal femoral nails (PFNs). The study included forty patients who had PFN osteosynthesis of intertrochanteric fractures between May 2009 and October 2014 and were followed up on for at least 24 months. The average duration of follow-up was 52.6±5.4 months. The patients' clinical, functional, and radiological findings were reviewed retrospectively. The fracture types were determined using the Evans-Jensen classification, and the radiological evaluation was done using Fogagnolo's reduction quality criteria. Fifteen fractures (37.5%) were stable, while 25 (62.5%) were unstable. The most common complication was varus union (10 percent). In 90% of patients, good and acceptable reduction criteria were met. In functional evaluation, 31 patients (77.5%) received excellent or good HHSs. Because of its advantages such as low bleeding amount, short surgical duration, fast mobilization, and long-term satisfactory functional results, proximal femoral nailing should be considered in the first steps of the treatment algorithm for femoral intertrochanteric fractures.

Keywords: Femoral intertrochanteric fracture, Harris Hip Score, proximal femoral nail

Introduction

Low-energy trauma is the most common cause of peritrochanteric femur fractures in the elderly. Because comorbidities enhance the risk of fracture-related morbidity and mortality, early stabilization and mobilization are critical in patients with this type of fracture.

Intertrochanteric fractures are treated using extramedullary and intramedullary fixation techniques. Less surgical dissection, infection, and bleeding can be avoided with the proximal femoral nail (PFN), an intramedullary fixation device [1]. In recent years, the proximal femoral nail has become more popular, as most

studies have shown that it provides a more secure fixation than dynamic hip plates, especially in unstable fractures [2-6].

The goal of this study was to assess the long-term clinical, functional, and radiological outcomes of patients who had femoral intertrochanteric fractures treated with PFNs.

Materials and Methods

Ethical approval

The study protocol was approved by the Scientific Research Ethics Committee of Gaziantep University, Faculty of Medicine (Gaziantep University Noninterventional Clinical Studies Institutional Review Board, 14.09.2015, Ethical protocol number: 2015/249). A written informed consent was obtained from all patients.

Study design

The study included forty patients who underwent PFN

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osteosynthesis of intertrochanteric fractures in our clinic between May 2009 and October 2014 and were followed up on for at least 24 months. The patients' data were analyzed retrospectively. The average duration of follow-up was 52.65.4 months.

Among the numerous classifications described, we chose the Evans-Jensen classification because it is simpler to understand and covers a wide range of fracture types. *The Evans-Jensen classification used in intertrochanteric femur fractures defines Type 1 and 2 fractures as stable, while Type 3-5 and reverse oblique fractures are classified as unstable [7,8].* For surgical fixation, cannulated PFNs (ZimedMedikal, Gaziantep, Turkey), Talon DistalFix PFNs (Orthopedic Designs North America, Inc., Tampa, FL, USA), and PFN (DePuySynthes Companies, Warsaw, IN, USA) components were used. The patients' outcomes were evaluated clinically and radiologically, and their functional status was assessed using the Harris Hip Score (HHS) [9].

Age, gender, fracture type and mechanism, additional traumas, preoperative diseases, time until surgery, preoperative anesthesia risk (ASA score), surgery duration, bleeding amount, length of hospital stay, reduction quality, mechanical complication rates, and HHSs were all evaluated and compared in patients.

All patients received pharmacological deep vein thrombosis (DVT) prophylaxis with low-molecular-weight heparin (LMWH) from the time they were admitted to the hospital. The surgery was carried out as soon as the patient's general medical condition permitted. For infection prevention, all patients received a 1 g intravenous dose of cefazolin 30 minutes before surgery. Deep vein thrombosis prevention with LMWH was continued for one month following surgery.

Patients with postoperative medial cortex continuity were mobilized with a walker on the first postoperative day, with weight-bearing as tolerated. Quadriceps strengthening, as well as knee and hip muscle exercises, were begun. Patients with unstable intertrochanteric fractures who were unable to achieve adequate medial continuity or reduction were mobilized with partial weight-bearing with a walker for the first four weeks, and full weight-bearing as tolerated after the sixth week or with the development of callus. Patients were invited to return for follow-ups after the sixth week, third month, sixth month, and 12th month, as well as annually.

Complications such as screw/blade cut-out, implant failure, varus development, rotational or shortness deformity, acetabular penetration, acetabular protrusion, implant fracture, dislocation, peri-implant fracture, prosthesis loosening, avascular necrosis (AVN), lateral shift, Z effect, screw loosening, and screw migration were evaluated radiologically during follow-ups.

Evaluation of radiological and functional results

The postoperative reduction quality was evaluated based on Fogagnolo's criteria as good, acceptable, or poor (Table 1) [3,10]. Functional evaluations at the follow-ups were performed with HHS. According to the HHS system, 90-100 points are considered an 'excellent' result, 80-89 points as 'good', 70-79 points as 'fair', and <70 points as 'poor' [9].

Statistical analysis of the data was performed using the SPSS for Windows v.22.0 software. Spearman's rank correlation coefficient and the chi-square test (crosstabulation chi-square) were used in the analysis of the data. A p value of <0.05 was considered statistically significant.

Results

Of the patients included in the study, 19 were males and 21 were females. The mean age of the patients was 72.0±3.1 years. The etiology of the fracture was simple fall in 36 patients (90%), fall from height in two (5%), and in-vehicle traffic accident in two (5%). According to the Evans-Jensen classification, eight patients (20%) had Type 1, six (15%) had Type 2, one (2.5%) had Type 3, 12 had (30%) Type 4, and eight (20%) had Type 5 fractures, while five (12.5%) had reverse oblique fractures. Fifteen (37.5%) of the fractures were stable and 25 (62.5%) were unstable. Cannulated PFNs were applied to 20 patients, Talon Distal Fix PFNs to 16 patients, and PFN to four patients. The mean surgery duration was 50.6±5.7 minutes, while the mean amount of intraoperative bleeding was measured as 118.4±14.6 cc. Preoperative anesthesia risks were evaluated and recorded using the ASA scores (Table 2).

According to HHS, 20 patients (50%) had excellent results, 11 (27.5%) had good results, six (15%) had fair results, and three (7.5%) had poor results. According to Fogagnolo's criteria, postoperative reduction quality was good in 29 patients (72.5%), acceptable in seven (17.5%), and poor in four (10%). The reduction quality of the patients was compared to the fracture type. A statistically significant, positive correlation was found between the postoperative reduction quality and the long-term HHS (p=0.001) (Table 3).

Mechanical complications developed in six patients (15%). In addition, loss of reduction in one patient (2.5%), peri-implant fracture in one (2.5%), lateral shift in two (5%) and screw/blade cut-out in two (5%). Varus union developed in four patients (10%). Respectively, the first patient had to undergo partial hip prosthesis due to early loss of reduction, the second one underwent total hip arthroplasty (THA) due to AVN of the femoral head, while the last patient required revision osteosynthesis due to peri-implant fracture.

The relationship between the complication rates and age groups, fracture type, ASA score, reduction quality, and HHS were statistically evaluated. A statistically significant relationship was detected between the ASA score and complication rates (ASA2: 12.5%, ASA3: 47.5%, ASA3[ICU]: 17.5%, ASA4: 5%, ASA4[ICU]: 17.5%; p=0.023). A statistically significant relationship was also found between the reduction quality and complication rates (good reduction: 14.3%, acceptable reduction: 28.6%, poor reduction: 57.1%; p=0.001). Similarly, the relationship between HHSs and complication rates was significant (excellent: 0%, good: 42.9%, fair: 14.2%, poor: 42.9%; p=0.001). No statistically significant relationship was found between age groups and complication rates and between fracture type and complication rates (p=0.359 and p=0.671 respectively). Moreover, there was no significant relationship between fracture types and HHSs (p=0.363). However, a moderately significant, positive correlation was found between age groups and HHSs (p=0.001).

Table 1. Fogagnolo’s postoperative reduction quality criteria

Alignment	Normal femoral neck angle or mild valgus in the AP plane
	Less than 20 degrees of angulation in the lateral plane
Displacement of main fragments	At least 80% overlap
	At least 5 mm shortening
Reduction quality	
Good	Meets both criteria
Acceptable	Meets one criterion
Poor	Does not meet either criterion

Table 2. Preoperative ASA scores and their distribution among the patient groups

Preoperative ASA score, n (%)	
ASA 2	5 (12.5)
ASA 3	19 (47.5)
ASA 3 (ICU)	7(17.5)
ASA 4	2 (5.0)
ASA 4 (ICU)	7 (17.5)
Total	40 (100)

ASA: American Society of Anesthesiologists, ICU: intensive care unit

Table 3. Distribution of the reduction quality and Harris Hip Score outcomes among the patients

Reduction quality	Harris Hip Score				Total
	Excellent	Good	Fair	Poor	
Good	20	6	2	1	29
Acceptable	0	3	4	0	7
Poor	0	2	0	2	4
Total	20	11	6	3	40

Discussion

Intertrochanteric femur fractures are more common in the elderly population and have become more common as life expectancy has increased. Furthermore, the risks posed by the elderly population's additional diseases increase the risk of morbidity and mortality from fracture. As a result, early surgery and early mobilization of patients can reduce the incidence of complications such as DVT, pulmonary embolism, uremia, urinary tract infection, pressure sores, and death [11,12]. In our study, the average time until surgery was 3.13 days (range: 4 hours to 8 days).

Randomized controlled trials comparing extramedullary and intramedullary fixation systems have revealed that PFN achieves the best results in intertrochanteric femur fractures [13,14]. The findings from the literature are supported by the excellent and good results obtained by 77.5% of our cohort. Fracture reduction is an important predictor of complications. According to Fogagnolo et al., the quality of reduction is as important as the tip apex distance. According to Fogagnolo's reduction criteria, Sahin et al. achieved a good reduction in 75.6% of their patients, an acceptable reduction in 15.6% ,and a poor reduction in 8.9% of their patients [1]. In

our study, 72.5% of patients had a good reduction, 17.5% had an acceptable reduction, and 10% had a poor reduction, all of which were comparable to the results from the literature.

Both Fogagnolo's and Sahin's studies failed to show a statistically significant relationship between reduction quality and mechanical complications. In our study, however, the complication rates of 14.3% with good reduction, 28.6 % with acceptable reduction, and 57.1% with poor reduction revealed a statistically significant relationship between reduction quality and complication rates (p=0.001).

Mechanical complications with intramedullary nailing in proximal femur fractures have been reported at rates ranging from 4.6 to 23% [15-20]. Screw/blade cut-out has been reported to occur at a rate of 2.2-4.6% [18, 19]. In the study by Simmermacher et al., which included 191 patients, no femoral diaphysis fractures occurred, and 10 patients with poor reduction due to technical problems required a second surgery [21]. Banan et al. reported technical failure in five patients, femoral diaphysis fracture in two, and implant failure in one in their study of 60 patients, and added that 6.5% of the patients required a second surgery [22]. Mechanical complications were observed in six (15%) of the 40 patients in our study. Four of the six patients with complications had unstable fractures, while the other two had stable fractures. We observed reduction loss in one patient (2.5%), peri-implant fracture in one (2.5%), lateral shift in two (5%), and screw/blade cut-out in two (5%).

Wilson et al. emphasized the importance of reduction and nail position in the evaluation of 1,015 patients with intertrochanteric fractures treated with Jewett nails, reporting a 3.3% rate of resurgery due to mechanical complications in patients with good reduction and nail position, and a 28% rate in patients with poor reduction and nail position [23]. In our study, patients with good and acceptable reduction quality had a lower rate of resurgery due to mechanical complications than those with poor reduction quality.

De Bruijn et al. investigated the risk factors of screw/blade cut-out, one of the most serious complications, and reported on which markers can be used to predict the risk of screw/blade cut-out [24]. As a result, the authors proposed that greater tip-apex distance, inadequate fracture reduction, and fracture type were reliable predictors of screw/blade cut-out risk (with the least prevalence of screw/blade cut-out in A1 fractures and a higher prevalence in A3 fractures). Hsueh et al. reported that 61% of patients with screw/blade cut-out had unstable fractures, while 39% had stable fractures in a cohort of 937 patients [25]. One of the two patients with screw/blade cut-out in our study had Type 1 (stable) fracture and the other had Type 4 (unstable) fracture. Among these patients, one with a Type 1 fracture developed AVN and required THA. The patient with a Type 4 fracture had lateral shift and varus union. One of the two reoperated patients had a Type 4 fracture that required partial hip replacement due to loss of reduction. The other patient suffered a peri-implant fracture, which was treated with a long PFN and a cable plate. Lateral shift was also observed in this patient in the following period. The fractures in all four patients with varus union were unstable (two Type 4 and two Type 5).

In their study, Çakır et al. used HHS to evaluate hip functions in

48 patients with intertrochanteric femur fractures treated with PFN and reported that the results were excellent in 15 (31.3%), good in 14 (29.2%), fair in 15 (31.3%), and poor in four (8.3%) [26]. Zaimoğlu stated that he achieved successful results in 95.1% of his cohort, reporting excellent HHSs in 58.5% good scores in 26.8%, moderate scores in 9.8%, and poor scores in 4.9% of the patients [27]. In Korkmaz et al. study's of 90 patients treated with PFNs for trochanteric fractures, 26.6% had excellent, 34.4% good, 17.7% moderate, and 21.1% poor results, with an overall achievement in 78.8% of the cohort [28]. According to the HHSs in our study, 20 (50%) of our patients had excellent results, 11 (27.5%) had good results, six (15%) had moderate results, and three (7.5%) had poor results. In our study, we found a link between poor HHS and poor reduction. Furthermore, we discovered a statistically significant relationship between HHS and reduction quality ($p=0.001$).

The study's most significant limitation was its retrospective design and small number of patients. Another limitation of the study was the lack of a comparison group.

Conclusion

In conclusion, the statistically significant relationship between reduction quality and HHS and complication rates and HHS scores, the increase in the prevalence of mechanical complications due to poor reduction, and the higher rate of resurgery due to complications all suggest that more efforts should be made to achieve reduction quality. Because of its advantages, such as low bleeding amount, short surgical duration, fast mobilization, and long-term satisfactory functional results, proximal femoral nailing should be considered in the first steps of the treatment algorithm for femoral intertrochanteric fractures.

Conflict of interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical approval

The study protocol was approved by the Scientific Research Ethics Committee of Gaziantep University, Faculty of Medicine (Gaziantep University Noninterventional Clinical Studies Institutional Review Board, 14.09.2015, 2015/249).

References

- Sahin S, Erturker E, Ozturk I, et al. Radiographic and functional results of osteosynthesis using the proximal femoral nail antirotation (PFNA) in the treatment of unstable intertrochanteric femoral fractures. *Acta Orthop Traumatol Turc.* 2010;44:127-34.
- Zeng C, Wang YR, Wei J, et al. Treatment of trochanteric fractures with proximal femoral nail antirotation or dynamic hip screw systems: A meta-analysis. *J Int Med Res.* 2012;40:839-51.
- Haidukewych G, Israel A, Berry D. Reverse obliquity fractures of the intertrochanteric region of the femur. *J Bone Jt Surg Am.* 2001;38:643-50.
- Carulli C, Piacentini F, Paoli T, et al. A comparison of two fixation methods for femoral trochanteric fractures: A new generation intramedullary system vs. sliding hip screw. *Clin Cases Miner Bone Metab.* 2017;14:40-7.
- Curtis MJ, Jinnah RH, Wilson V, et al. Proximal femoral fractures: A biomechanical study to compare intramedullary and extramedullary fixation. *Injury.* 1994;25:99-104.
- Sevin HF, Cirpar M, Canbeyli ID, et al. Comparison of functional outcomes in patients fixed with dynamic hip screw and proximal femur nail-anti-rotation in A1 and A2 type intertrochanteric femur fractures. *Turkish Journal of Trauma and Emergency Surgery (TJTES).* 2020;26:811-7.
- Jensen JS. Classification of trochanteric fractures. *Acta Orthop Scand.* 1980;51:803-10.
- Aksu N, Iklar ZU. Hip Fractures. *TOTBİD.* 2008;7:8-19.
- Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am.* 1969;51:737-55.
- Fognanolo F, Kfuri M Jr, Paccola CA. Intramedullary fixation of pertrochanteric hip fractures with the short AO-ASIF proximal femoral nail. *Arch Orthop Trauma Surg.* 2004;124:31-7.
- Hinton RY, Lennox DN, Ebert FR, et al. Relative rates of fracture of the hip in the united states. Geographic, sex, and age variations. *J Bone Joint Surg Am.* 1995;77:695-702.
- Green S, Moore T. Bipolar prosthetic replacement for the management of unstable inter trochanteric hip fractures in the elderly. *Clin Orthop.* 1987;224:168-77.
- Sadowski C, Lübbecke A, Saudan M, et al. Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95 degrees screw-plate: a prospective, randomized study. *J Bone Joint Surg.* 2002;84:372-81.
- Saudan M, Lubbecke A, Sadowski C, et al. Pertrochanteric 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.* 2002;16:386-93.
- Bannister GC, Gibson AG, Ackroyd CE, et al. The fixation and prognosis of trochanteric fractures. A randomized prospective controlled trial. *Clin Orthop Relat Res.* 1990;254:242-46.
- Lenich A, Mayr E, Rüter A, et al. First results with the trochanter fixation nail (TFN): a report on 120 cases. *Arch Orthop Trauma Surg.* 2006;126:706-12.
- D'Arrigo C, Carcangiu A, Perugia D, et al. Intertrochanteric fractures: comparison between two different locking nails. *Int Orthop.* 2012;36:2545-51.
- Evans PD, Wilson C, Lyons K. Comparison of MRI with bone scanning for suspected hip fracture in elderly patients. *J Bone Joint Surg Br* 1994;76:158-59.
- Vélez M, Palacios-Barahona U, Arango-Posada MM, et al. Resultados funcionales y complicaciones del uso del clavo cefalomedular en el tratamiento de las fracturas de cadera [Functional results and complications of the use of the proximal femoral nail in the treatment of intertrochanteric hip fractures]. *Acta Ortop Mex.* 2018;32:126-30.
- Sevimli R, Bilal O. Applications of proximal femoral nail treatment for femoral neck fractures. *Van Med J.* 2013;20:207-11.
- Simmermacher RKJ, Bosch AM, Van der Werken C. The AO/ASIF-proximal femoral nail (PFN): a new device for the treatment of unstable proximal femoral fractures. *Injury.* 1999;30:327-32.
- Banan H, Al-Sabti A, Jimulia T, et al. The treatment of unstable, extracapsular hip fractures with the AO / ASIF proximal femoral nail (PFN) our first 60 cases. *Injury.* 2002;33:41-50.
- Wilson HJ, Rubin BD, Helbig FEJ, et al. Treatment of intertrochanteric fractures with the Jewett nail: Experience with 1015 cases. *Clin Orthop Relat Res.* 1980;148:186-91.
- De Bruijn K, den Hartog D, Tuinebreijer W, et al. Reliability of predictors for screw cutout in intertrochanteric hip fractures. *J Bone Joint Surg Am.* 2012;94:1266-72.
- Hsueh KK, Fang CK, Chen CM, et al. Risk factors in cutout of sliding hip screw in intertrochanteric fractures: an evaluation of 937 patients. *Int Orthop.* 2010;34:1273-6.

26. Çakır M. Our clinical results in intertrochanteric femoral fractures treated with proximal femoral nail. Ph.D. thesis. T.C. Ministry of Health Goztepe Training and Research Hospital ,Istanbul, 2009
27. Zaimoğlu MS. Our Surgical Results of Intramedullary Hip Nailing in Adult Femur Trochanteric Region Fractures. Ph.D. thesis. Cukurova University Sch Med, Adana, 2011
28. Korkmaz MF. Evaluation of surgical treatment results of femoral trochanteric region fractures with proximal femoral nail. Ph.D. thesis. Istanbul Bilim University, Istanbul, 2008