Joint Diseases and Related Surgery

Jt Dis Relat Surg
2025;36(1):137-141

ORIGINAL ARTICLE

Effectiveness of the Dorr index in predicting implant failure before proximal femoral nail application

Mehmet Cenk Turgut, MD[1], Resul Bircan, MD[2], Muhammed Çağatay Engin, MD[1], Alperen Zeynel, MD[3], Coşkun Ulucaköy, MD[2]

[1]Department of Orthopedics and Traumatology, Atatürk University Faculty of Medicine, Erzurum, Türkiye
[2]Department of Orthopedics and Traumatology, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Türkiye
[3]Department of Orthopedics and Traumatology, Avcılar Murat Kölük State Hospital, İstanbul, Türkiye

ABSTRACT

Objectives: This study aimed to investigate the importance of the Dorr index in the preoperative evaluation of implant failure in patients who underwent proximal femoral nail (PFN).

Patients and methods: This retrospective study examined 312 patients who underwent PFN for intertrochanteric fractures between January 2016 and January 2020. Patients with unstable fractures according to the AO/OTA (AO Foundation/Orthopaedic Trauma Association) classification, those over 65 years of age, with at least one year of regular follow-up, a tip-apex distance <25 mm, and a caput-collum-diaphyseal angle between 125° and 135°, were included. Seventy patients (19 males, 51 females; mean age: 72±3.8 years; range, 65 to 88 years) who met the inclusion criteria were included in the study. According to the Dorr index, patients were type A if the ratio was <0.5, type B if the ratio was between 0.50 and 0.75, and type C if the ratio was >0.75.

Results: The mean follow-up period was 46.2±4.4 months. As indicated by the Dorr index, the failure rates were 0%, 17%, and 63% for Dorr types A, B, and C, respectively. The comparison of failure rates between Dorr types A and B (p=0.02), B and C (p=0.016), and A and C (p=0.001) yielded statistically significant results. Patients with Dorr types B and C exhibited significantly inferior outcomes compared to those with type A. The mean time to failure was 27±3 days after surgery.

Conclusion: Dorr index is an important parameter that can be easily checked and used on preoperative radiographs to predict implant failure. The high probability of failure in the early period should be taken into account, particularly if PFN is planned in Dorr type C.

Keywords: Cut-out, Dorr index, implant failure, proximal femoral nail, trochanteric fracture.

The incidence of trochanteric fractures has increased in parallel with the growth of the geriatric population. Percutaneous fixation of these fractures using proximal femoral nail (PFN) has become the standard method due to its stronger and more rigid biomechanics and superior ability to prevent varus collapse compared to extramedullary devices.[1,2]

Although PFN is the optimal treatment for these fractures, it is not without complications. In the geriatric population, implant failure remains a significant concern, with a notable impact on morbidity and mortality.[3-5] The most prevalent cause of implant failure is the cut-out of lag screws.[6,7] The success of fixation is contingent upon multiple factors, including bone quality, fracture geometry, reduction, implant design, and implant placement.[8] In the existing literature, a number of different markers have been employed to determine the risk of failure, including the tip-apex distance (TAD), calcar-referenced TAD, and Parker's ratio.

Received: June 22, 2024
Accepted: November 03, 2024
Published online: December 14, 2024

Correspondence: Coşkun Ulucaköy, MD. Dr. Abdurrahman Yurtaslan Ankara Onkoloji Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, 06200 Yenimahalle, Ankara, Türkiye.

E-mail: coskunulucakoy@gmail.com

Doi: 10.52312/jdrs.2025.1861

Citation: Turgut MC, Bircan R, Engin MÇ, Zeynel A, Ulucaköy C. Effectiveness of the Dorr index in predicting implant failure before proximal femoral nail application. Jt Dis Relat Surg 2025;36(1):137-141. doi: 10.52312/jdrs.2025.1861.

In their article published in 1993, Dorr et al.[9] classified the proximal femur according to bone quality and morphology. They concluded that wider femoral canal types might be the cause of more advanced osteoporosis and, thus, more complications. The present study aimed to investigate the effectiveness of the Dorr index in predicting implant failure in patients who underwent PFN for proximal femoral fractures. There are studies in the literature on postoperative failure prediction.[6,7] In contrast to the majority of studies in the literature, this study sough to underscore the preoperative assessment of failure prediction.

PATIENTS AND METHODS

A total of 312 patients who underwent PFN antirotation performed by the same surgical team for intertrochanteric fractures at the Erzurum Regional Training and Research Hospital Department of Orthopedics and Traumatology between January 2016 and January 2020 were retrospectively examined. Patients with unstable fractures according to the AO/OTA (AO Foundation/Orthopaedic Trauma Association) classification,[10] those over 65 years old, with at least one year of regular follow-up, TAD <25 mm, and caput-collum-diaphyseal (CCD) angle between 125° and 135°, were included in the study. The clinical and radiographic outcomes of these patients before and after surgery were examined. The mean cutoff time after surgery was evaluated. Exclusion criteria were as follows: patients with pathological or open fractures, those who underwent open reduction, those with cognitive disorders, those without regular follow-up, those who could not walk due to neuromuscular diseases, patients who died during follow-up, and those with bilateral fractures. After applying the exclusion criteria, a total of 70 eligible patients (19 males, 51 females; mean age: 72±3.8 years; range, 65 to 88 years) were included in the study. The study protocol was approved by the Erzurum Regional Training and Research Hospital Clinical Research Ethics Committee (date: 03.01.2022, no: 2021/23-290). All patients provided written informed consent. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The preoperative evaluation of our patients included the following: age, sex, injury types, fracture classification according to AO/OTA, preoperative mobility, and comorbid conditions. In addition, the operation was performed by consulting the relevant clinics for any additional diseases and comorbid conditions.

The surgical procedure was conducted in the lateral decubitus position. Prior to the surgical procedure, all patients received a dose of 2 g of cefazolin. The surgical approach involved a closed reduction, with an incision made approximately 5 cm proximal to the greater trochanter tip. This allowed for the passage of tissues. A guidewire was then inserted. Following this, the proximal reaming process was conducted, after which the nail and lag screw were placed in the appropriate position (center-center or inferior-center).[11] Fluoroscopy was performed at all stages.

The patients' preoperative and postoperative radiographic evaluations were conducted by an expert radiologist and an orthopedist who was not responsible for the case. This approach was adopted to minimize potential bias in the initial postoperative period, which included the first week, first month, third month, sixth month, and final controls, during which no additional complications occurred. The preoperative film was used to evaluate the fracture type and Dorr stage. The neck-shaft angle, TAD ratio, screw placement, and reduction quality were evaluated on the initial postoperative radiograph. The correct position was accepted if the head-neck angle was within the range of 125° to 135°.

The Dorr index was calculated by dividing the width of the medullary canal at the level of the lesser trochanter by the width of the medullary canal at the level of the isthmus, located 10 cm distal to the lesser trochanter (Figure 1). If the ratio was <0.5, it was classified as type A; if the ratio was between 0.50 and 0.75, it was classified as

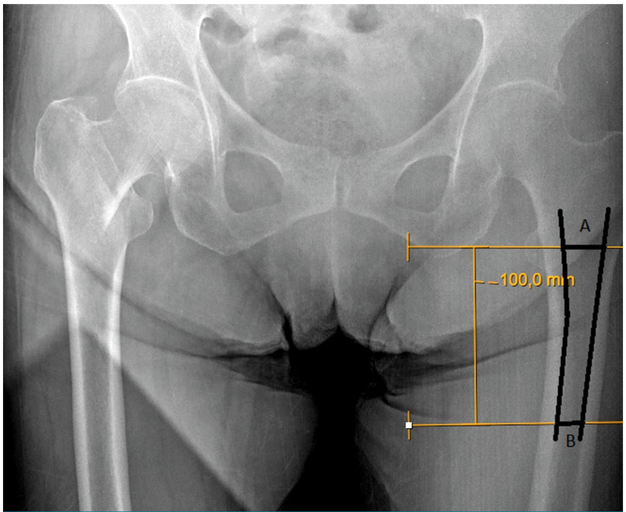

FIGURE 1. Dorr index=A/B.

TABLE I
Distribution of patients by Dorr types

	Dorr A				Dorr B				Dorr C				
	n	%	Median	Min-Max	n	%	Median	Min-Max	n	%	Median	Min-Max	*p*
Age (year)			74	65-85			76	65-84			74	67-88	0.9
Sex													0.08
Male	12	33			7	30							
Female	24	67			16	70			11	100			
Femoral neck angle			131°	125°-135°			128°	25°-135°			129°	125°-135°	0.09
TAD (mm)			22	17-25			20	16-25			22	18-25	0.08
Failure	0				4				7				<0.01

TAD: Tip-apex distance.

type B; and if the ratio was >0.75, it was classified as type C.[3] The contralateral hip was used on standard anteroposterior radiographs with a distance of 180 cm to the cassette to measure the Dorr index.

The TAD distance was defined as the sum of distances in millimeters between the tip of the lag screw and the apex of the femoral head on anteroposterior and lateral radiographs. The TAD was categorized as either <25 mm or >25 mm. The CCD angle was measured on the first postoperative film and the last follow-up radiograph available. The CCD angle was defined as the angle between the femoral neck axis and the femoral shaft axis on anteroposterior radiographs. Complications such as cut-out, infection, and nerve damage were examined. Patients who underwent revision surgery due to loss of reduction were classified as having implant failure.

Due to the instability of the fractures at the outset, the patients were mobilized with partial weight bearing for a period of two weeks, with the assistance of a walker or crutches, irrespective of the stability of the fixation. The rehabilitation program was initiated with the physiotherapist on the first postoperative day. Low-molecular-weight heparin prophylaxis (0.4 mL, once daily) was applied to all patients to mitigate the risk of deep vein thrombosis. After two weeks, the sutures were removed, and the use of crutches was discontinued.

Statistical analysis

Statistical analyses and calculations were performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA) and Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA). The chi-square test and Fisher exact test were applied for nominal values. The Kolmogorov-Smirnov test was used to examine whether the groups were normally distributed. The Kruskal-Wallis test, a nonparametric test, was used for the ordinal values of the nonnormally distributed groups. A p-value <0.01 was considered statistically significant.

RESULTS

Table I displays the demographic data of the patients by groups. The mean follow-up period was 46.2±4.4 months. Forty-one patients were operated on the left hip, and 29 were operated on the right hip.

There were no failures in patients with Dorr type A. There were 17% failures in type B and 63% failures in type C. A comparison of the ratios between the groups revealed that the p-value between Dorr types A and B was 0.02, the p-value between Dorr types B and C was 0.016, and the p-value between Dorr types A and C was 0.001. Patients with Dorr types B and C exhibited significantly inferior outcomes compared to those with type A.

Superficial infection developed in two patients. Neurological deficit was not observed in any of our patients. The mean cut-out duration was 27±4 days. The lowest failure period was 20 days, and the highest was 58 days. The PFN was revised in 11 patients with implant failure. Nine patients underwent revision hemiarthroplasty. Two patients were converted to PFN.

DISCUSSION

This study found the implant failure risk to be significantly higher in Dorr type C compared to the other groups. Numerous studies have been based on postoperative evaluation parameters to determine this risk of failure.[6,7] The advantage of our study was the importance of Dorr classification in terms of preoperative failure prediction. The main finding of this study was that as the Dorr index increases (approaching type C), implant failure increases, and poor clinical outcomes occur.

With the increasing proportion of the elderly population, there has been a corresponding rise in the incidence of trochanteric fractures. Given the significant increase in morbidity and mortality rates associated with fixation failures, particularly in elderly patients, numerous studies have been conducted on this topic. The majority of these studies commence with an investigation into the underlying causes of implant failure and the potential strategies for its prevention.[3-7] In their study on implant failure, Çepni et al.[12] concluded that peroperative anatomical reduction could be used as a predictor factor. Siddiqui et al.[13] published a study on ways to reduce fixation failure in trochanteric fractures. Pires et al.[14] published their study on why complications such as the Z-effect and the reverse Z-effect could develop. Shetty et al.[15] emphasized the importance of avoiding fixation failure. As Dorr proximal femoral types progress to type C, they are associated with more severe osteoporosis and a higher risk of intraoperative fractures.[9] Although the causes of this complication are still not fully known, many different factors such as age, sex, and TAD are held responsible in the literature.[3-7] In our study, we hypothesized that one of the factors affecting implant failure would be preoperative bone quality, and the findings revealed that poor preoperative bone quality led to unsuccessful clinical results.

Due to the complications of implant failure, it is essential to achieve successful fixation in this patient group. Revision surgery is morbid and mortal due to the poor general condition of the patients. The way to minimize the risk of implant failure is through successful fixation.[16] A review of the literature revealed that the incidence of implant failure following PFN ranges from 1 to 8%.[17] Kulakoğlu et al.[18] found this rate to be 7.2% in their study, while Morvan et al.[19] found this rate to be 5.7% in their meta-analysis in 2018. In their meta-analysis, Li et al.[20] identified many factors that determine the implant failure risk. In this study, we identified patients whose TAD, CCD angle, and lag screw positions were compatible with the literature. However, 15% of our patients developed implant failure. The higher rate in our study compared to the literature was attributed to the long follow-up period, and the exclusion of patients who underwent open reduction. This rate was found to be statistically significantly higher in Dorr type C than in the other groups.

Dorr type C femurs are structurally deformed and are candidates for implant incompatibility.[9] Nash and Harris[21] considered routine preoperative template of the contralateral femur before surgery as a way to predict risks and difficulties and guide the choice of fixation method. Similarly, our study demonstrated that the preoperative Dorr index was effective in predicting postoperative outcomes.

This study had some limitations. Although we tried to correct for variables that could affect the results, since these variables can have a very wide range, we may have missed situations. In addition, all the problems in retrospective studies were also valid for our study. The small number of patients in the groups can be considered as another limitation.

In conclusion, contrary to numerous studies in the literature, the Dorr index was a parameter that can be simply checked and used in preoperative radiographs to predict implant failure. The high probability of failure in the early period should be taken into account, particularly if PFN is planned in patients with Dorr type C. We believe awareness on this issue can reduce patient and physician distress.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea and writing the article: M.C.T.; Design and analysis: R.B.; Data collection and materials: M.Ç.E.; References and writing the article: A.Z.; Literatür review and critical review: C.U.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Janardhana Aithala P, Rao S. Proximal femoral nailing: technical difficulties and results in trochanteric fractures. Open Journal of Orthopedics. 2013;3:234.
2. Kassem E, Younan R, Abaskhron M, Abo-Elsoud M. Functional and radiological outcomes of dynamic hip screw with trochanteric stabilizing plate versus short proximal femoral nail in management of unstable trochanteric fractures: A randomized-controlled trial. Jt Dis Relat Surg 2022;33:531-7. doi: 10.52312/jdrs.2022.800.
3. van Balen R, Steyerberg EW, Polder JJ, Ribbers TL, Habbema JD, Cools HJ. Hip fracture in elderly patients: Outcomes for

function, quality of life, and type of residence. Clin Orthop Relat Res 2001;:232-43.
4. Liu F, Su P, Zhang L, Zhang Y, Zhu J, Zhang R. Preoperative computed tomography morphological characteristics of displaced femoral neck fractures. Jt Dis Relat Surg 2023;34:253-64. doi: 10.52312/jdrs.2023.1003.
5. Jin Z, Chen L, Wang D, Ye Y, Fu J, Yang Z, et al. A prediction model for osteonecrosis of femoral head after internal fixation with multiple cannulated compression screws for adult femoral neck fractures. Jt Dis Relat Surg 2024;35:20-6. doi: 10.52312/jdrs.2024.975.
6. Baumgaertner MR, Solberg BD. Awareness of tip-apex distance reduces failure of fixation of trochanteric fractures of the hip. J Bone Joint Surg [Br] 1997;79:969-71. doi: 10.1302/0301-620x.79b6.7949.
7. Verettas DA, Ifantidis P, Chatzipapas CN, Drosos GI, Xarchas KC, Chloropoulou P, et al. Systematic effects of surgical treatment of hip fractures: Gliding screw-plating vs intramedullary nailing. Injury 2010;41:279-84. doi: 10.1016/j.injury.2009.09.012.
8. Biber R, Berger J, Bail HJ. The art of trochanteric fracture reduction. Injury 2016;47 Suppl 7:S3-6. doi: 10.1016/S0020-1383(16)30845-2.
9. Dorr LD, Faugere MC, Mackel AM, Gruen TA, Bognar B, Malluche HH. Structural and cellular assessment of bone quality of proximal femur. Bone 1993;14:231-42. doi: 10.1016/8756-3282(93)90146-2.
10. Lindskog DM, Baumgaertner MR. Unstable intertrochanteric hip fractures in the elderly. J Am Acad Orthop Surg 2004;12:179-90. doi: 10.5435/00124635-200405000-00006.
11. Angelini AJ, Livani B, Flierl MA, Morgan SJ, Belangero WD. Less invasive percutaneous wave plating of simple femur shaft fractures: A prospective series. Injury 2010;41:624-8. doi: 10.1016/j.injury.2010.01.101.
12. Çepni SK, Şişman A, Batar S. A simple minimally invasive technique providing anterior and medial reduction in intertrochanteric femur fractures: A case-control study. Ulus Travma Acil Cerrahi Derg 2022;28:1328-34. doi: 10.14744/tjtes.2022.46706.
13. Siddiqui YS, Mohd J, Abbas M, Gupta K, Khan MJ, Istiyak M. Technical difficulties and mechanical failure of Distal Femoral Locking Compression Plate (DFLCP) in management of unstable distal femoral fractures. Int J Burns Trauma 2021;11:9-19.
14. Pires RE, Santana EO Jr, Santos LE, Giordano V, Balbachevsky D, Dos Reis FB. Failure of fixation of trochanteric femur fractures: Clinical recommendations for avoiding Z-effect and reverse Z-effect type complications. Patient Saf Surg 2011;5:17. doi: 10.1186/1754-9493-5-17.
15. Shetty A, Ballal A, Sadasivan AK, Hegde A. Dynamic hip screw with trochanteric stablization plate fixation of unstable inter-trochanteric fractures: A prospective study of functional and radiological outcomes. J Clin Diagn Res 2016;10:RC06-8. doi: 10.7860/JCDR/2016/20275.8415.
16. Sharma A, Mahajan A, John B. A comparison of the clinico-radiological outcomes with Proximal Femoral Nail (PFN) and Proximal Femoral Nail Antirotation (PFNA) in fixation of unstable intertrochanteric fractures. J Clin Diagn Res 2017;11:RC05-9. doi: 10.7860/JCDR/2017/28492.10181.
17. Hohendorff B, Meyer P, Menezes D, Meier L, Elke R. Treatment results and complications after PFN osteosynthesis. Unfallchirurg. 2005;108:938. doi: 10.1007/s00113-005-0962-8.
18. Kulakoglu B, Ozdemir G, Bingol O, Karlidag T, Keskin OH, Durgal A. A new scoring system for predicting cut-out risk in patients with intertrochanteric femur fractures treated with proximal femoral nail anti-rotation. Acta Orthop Traumatol Turc 2023;57:258-66. doi: 10.5152/j.aott.2023.23018.
19. Morvan A, Boddaert J, Cohen-Bittan J, Picard H, Pascal-Mousselard H, Khiami F. Risk factors for cut-out after internal fixation of trochanteric fractures in elderly subjects. Orthop Traumatol Surg Res 2018;104:1183-7. doi: 10.1016/j.otsr.2018.06.021.
20. Li S, Chang SM, Niu WX, Ma H. Comparison of tip apex distance and cut-out complications between helical blades and lag screws in intertrochanteric fractures among the elderly: A meta-analysis. J Orthop Sci 2015;20:1062-9. doi: 10.1007/s00776-015-0770-0.
21. Nash W, Harris A. The Dorr type and cortical thickness index of the proximal femur for predicting peri-operative complications during hemiarthroplasty. J Orthop Surg (Hong Kong) 2014;22:92-5. doi: 10.1177/230949901402200123.