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Periprosthetic Distal Femur Fractures: A Single-Center Retrospective Epidemiological Analysis

ABSTRACT

Background and Aims: Distal femur fractures (DFFs) are relatively rare but clinically significant injuries associated with high morbidity and mortality. With the rising prevalence of total knee arthroplasty (TKA), the proportion of periprosthetic distal femur fractures (PPDFFs) has been increasing. The incidence, classification, and clinical characteristics of DFFs, with a particular focus on PPDFFs, were aimed to be evaluated in this study.

Methods: Patients admitted to our tertiary care trauma center between January 2020 and 2025 with a diagnosis of distal femur fracture were included in this retrospective descriptive study. Demographic data, mechanism of injury, fracture classification, treatment preference, surgical approach, recorded complications, and comorbidities were analyzed.

Results: A total of 56 patients were evaluated, including 46 (82.1%) with native DFFs and 10 (17.9%) with PPDFFs following TKA or Total hip arthroplasty (THA) . Female predominance was significantly higher in the PPDFF group compared to native fractures (100% vs. 63%, p=0.023). All PPDFFs resulted from simple falls (100%), whereas the native group had a more diverse trauma profile (p=0.036). Fracture type, Charlson Comorbidity Index and postoperative complication rates were similar between groups (p=0.702, p=0.170, p=0.639, respectively).

Conclusion: PPDFFs constituted 17.9% of all DFFs in our series, aligning with reports from tertiary referral centers. These injuries predominantly affect elderly women and are strongly associated with low-energy falls. The findings underscore the need for preventive strategies such as osteoporosis management and fall prevention, as well as for timely surgical intervention and updated epidemiological data to optimize treatment planning and improve outcomes.

Keywords: Distal femur fracture; periprosthetic fracture; total knee arthroplasty; epidemiology; AO/OTA classification; Rorabeck classification; Vancouver classification

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Introduction

Distal femur fractures (DFFs) exhibit a bimodal distribution, typically occurring due to low-energy trauma in elderly patients and high-energy mechanisms in younger individuals (1). Such injuries, particularly those involving complex intra-articular extension, pose significant management challenges and are associated with elevated morbidity and mortality rates (2). The challenge is further compounded by the complex anatomy of the distal femur and the presence of high-energy deforming forces (3). To facilitate precise classification and improved treatment planning, the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification system categorizes these fractures into three distinct types based on the extent of articular involvement: Type A (extra-articular), Type B (partial articular), and Type C (complete articular) (4). Historically, locking plates and intramedullary nails have been the most prevalent fixation methods preferred. However, in recent years, the combined use of both implants has gained popularity due to their potential biomechanical advantages and improved clinical outcomes (5,6).

With the increasing frequency of total joint arthroplasty procedures, the prevalence of periprosthetic distal femur fractures (PPDFFs) has also increased. (7,8). The classification of PPDFFs, particularly those occurring in the setting of total knee arthroplasty, is typically performed using both the AO/OTA and Lewis–Rorabeck classification systems. (9). The Lewis–Rorabeck classification was utilized for the categorization of fractures following total knee arthroplasty, distinguishing between non-displaced fractures with stable implants (Type I), displaced fractures with stable implants (Type II), and fractures associated with a loose or failing prosthesis (Type III).The classification is predicated on two principal factors: the stability of the prosthesis and the displacement of the fracture. It is noteworthy that the majority of PPDFFs following total knee arthroplasty have been categorized as Rorabeck Type II in the literature, signifying displaced fractures with a stable implant (11). As demonstrated in the extant literature, the treatment principles for PPDFFs are analogous to those utilized in the management of native DFFs. The treatment of PPDFFs typically involves the use of locking plates or intramedullary nailing (10).

Despite the growing awareness of distal femoral injuries, there is a paucity of data regarding the proportion of periprosthetic fractures among all DFFs in clinical practice. In light of the aging population and the increasing prevalence of arthroplasty operations, updated epidemiological data are imperative in order to inform treatment strategies.To address this research gap, the incidence and distribution of DFFs in a tertiary care trauma center between 2020 and 2025 were analyzed. The study focuses in particular on the proportion, classification and clinical characteristics of periprosthetic cases.

Methods

Study population and data collection

This retrospective descriptive study was conducted in the Department of Orthopaedics and Traumatology at ** Hospital. Patients diagnosed and treated for DFFs between January 2020 and 2025 were included in the present evaluation. All patients with DFFs who underwent treatment and subsequent follow-up at our clinic were included in the study, irrespective of the treatment method applied.Patients with pathological fractures, patients younger than 18 years, and those with incomplete clinical or radiological data were excluded from the study. A total of 56 patients were identified, of whom 46 presented with native DFFs and 10 sustained PPDFFs following total knee or hip arthroplasty.

The present study was conducted in accordance with the principles of the Declaration of Helsinki, with ethical approval obtained from the local institutional review board (Approval No: E1-22-2905) and informed consent waived due to the retrospective design.

Evaluation of the Patients

Patients were identified retrospectively through a systematic review of the hospital's electronic medical records and clinical archives. The collected data comprised demographic characteristics (age, gender, side of fracture), mechanism of injury, comorbidities, fixation methods, preferred surgical approach, and postoperative complications.

The classification of fractures was conducted in accordance with the AO/OTA system, which was utilized for the categorization of DFFs. In the periprosthetic subgroup, additional classification systems were applied depending on the primary implant. The Lewis–Rorabeck classification was utilized for the categorization of fractures following TKA. The Vancouver classification was utilized for fractures following total hip arthroplasty, wherein DFFs are categorized as Type C—fractures occurring well distal to the femoral stem—with subsequent subcategorization (Types C1–C3) based on implant stability and the quality of the surrounding bone stock. The mechanism of injury (simple fall, high-energy fall, traffic accident, gunshot wound) was documented for each case.

The evaluation of comorbidity was conducted utilizing the Charlson Comorbidity Index (CCI), a system of validation that predicts a 10-year mortality risk based on the presence and severity of chronic diseases. These diseases include, but are not limited to, diabetes, cardiovascular, pulmonary, renal, hepatic, and malignant conditions. Higher CCI scores have been demonstrated to be a reliable indicator of a greater comorbidity burden and poorer survival.

A comprehensive set of surgical data was meticulously documented, encompassing the fixation methods employed (e.g., plate-screw fixation, intramedullary nailing, cannulated screws, or external fixation) and the surgical approaches utilized (e.g., anterolateral, midline, posteromedial, percutaneous, or combined). In the periprosthetic subgroup, the time from fracture to surgery (in days) and the duration of follow-up (in months) were also documented.

All postoperative local and systemic complications were systematically evaluated and categorized as wound problems, implant failures, peri-implant fractures, and pulmonary thromboembolism (PTE). Mortality was also considered a complication for patients who died during the early postoperative period .

Statistical analysis

SPSS version 25.0 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses. Categorical variables were represented by frequencies and percentages, while continuous variables were represented by median and minimum-maximum values. The Kolmogorov–Smirnov test was used to determine whether the continuous data's distribution was normal or skewed. For group comparisons, as all continuous data were skewedly distributed, the Mann–Whitney U test was utilized. The Chi-square Test and the Fisher's Exact Test (when the Chi-square assumption was not met) were used to assess categorical data (gender, side, injury mechanism, fixation method, surgical approach, classification, and complications). P-values less than 0.05 were regarded as statistically significant.

Results

A total of 56 patients were included in the study, consisting of 46 native DFFs (82.1%) and 10 PPDFFs (17.9%). The mean age was 69.5 years (18–88) in the native group and 74.5 years (56–

94) in the periprosthetic group, with no statistically significant difference (p=0.235). Female predominance was noted in both groups; however, all periprosthetic fractures occurred in women (100%), compared with 63% in the native group (p=0.023). The mechanism of injury differed significantly between groups: while all PPDFFs (100%) resulted from low-energy simple falls, native DFFs demonstrated a more heterogeneous trauma profile, including simple falls (60.9%), high-energy falls (19.6%), traffic accidents (13%), and gunshot wounds (6.5%) (p = 0.036). Detailed distribution of the demographic and surgical variables is shown in Table 1.

Within the PPDFFs, 80% of fractures occurred following TKA and 20% after THA. TKA-related fractures were most frequently classified as Lewis–Rorabeck type II (62.5%), followed by type I (25%) and type III (12.5%). The two THA-related fractures were categorized as Vancouver C2 (50%) and C3 (50%) (Table 2).

In terms of surgical treatment, the majority of patients in both groups underwent plate-screw fixation (87% in the native group vs. 80% in the periprosthetic group, p=0.276). No patient with PPDFF underwent revision arthroplasty operation. The anterolateral approach was the most frequently used surgical approach in both groups (82.6% in native vs. 60% in periprosthetic), followed by the midline incision (10.9% vs. 20%), with other approaches being rarely used; no significant difference was detected (p=0.119) (Table 1).

Postoperative complications showed a different profile between groups. The periprosthetic group demonstrated wound complications in 30% of patients but no implant failure, peri-implant fracture, or mortality were recorded during the follow-up. Overall complication rates were not statistically different between the two groups (p=0.639).

Discussion

Although distal femur fractures account for less than 1% of all fractures, they are of considerable clinical importance due to the significant morbidity and mortality (12). Martinet et al. initially reported this rarity, and Elsoe et al. later confirmed the low overall incidence in a large population-based study, while also emphasizing the considerable clinical burden associated with these injuries (13). The proportion of periprosthetic fractures among DFFs is steadily increasing (14). In light of the aging population and the increasing prevalence of arthroplasty operations, updated epidemiological data are imperative. The significance of our study lies in reporting the 5-year results of our tertiary trauma center, while also highlighting the epidemiological differences between PPDFF and native fractures. In the present study, periprosthetic fractures constituted 17.9% of all DFFs. The most striking finding of the study was the significantly higher prevalence of PPDFFs in the female population, with these cases almost always observed following simple falls.

PPDFFs accounted for 17.9% of all DFFs in this series, which is lower than 28.7% that was reported in the population-based Danish study by Elsoe et al. (13). Several factors may explain this discrepancy, including differences in study design (single-center vs. population-based), demographic characteristics, regional prevalence of total knee arthroplasty, and data collection periods. It is also possible that local variations in implant longevity and revision rates have influenced the observed proportion of periprosthetic cases. In line with this, Direder et al. reported that the incidence of PPDFFs ranges from 0.3% to 2.5% after primary TKA and increases up to 38% following revision procedures, highlighting the influence of study design and case variations on reported proportions (15).

In the light of an aging population and the rising incidence of high-energy trauma among younger individuals, DFFs have garnered increasing attention in the orthopedic literature. Khan et al., in their five-year epidemiological analysis from a central London major trauma center, highlighted this characteristic bimodal distribution, with high-energy trauma predominating in younger patients and low-energy falls in the elderly (16). The present study provided updated epidemiological data on distal femur fractures and demonstrated the contribution of DFFs within the context of this increasing trend. A marked female predominance was noted in the PPDFF group (100%) compared to the native DFF group (63%), (p=0.023). This finding is consistent with previous reports highlighting that elderly women are at increased risk for PPDFFs, likely due to the combined effects of osteoporosis, lower bone mineral density, and the higher incidence of primary TKA in this population (17). Recent evidence further supports this association: Park et al. demonstrated that osteoporosis significantly increases the risk of PPDFFs after TKA, particularly in elderly women with untreated bone fragility (18). Similarly, Houel et al. reported that patients sustaining periprosthetic femoral fractures are typically older adults with a high prevalence of osteoporosis (19). In addition, Mazur et al. found that nearly 90% of PPDFF cases in their series occurred in women, underscoring the combined influence of sex-specific bone quality and implant-related factors (20). The strong female predominance is also in line with the fact that low-energy trauma was the exclusive mechanism of injury in the PPDFF group, further supporting the role of fragility and implant-related factors in fracture pathogenesis. Furthermore, all periprosthetic cases in this study resulted from low-energy falls, whereas high-energy trauma, including falls from height, traffic accidents, and gunshot wounds, occurred exclusively in the native group. This distribution aligns with the bimodal injury pattern described in previous epidemiological studies (13,16), in which native fractures occur both after low-energy falls in the elderly and high-energy trauma in younger patients. Moreover, these findings are consistent with Al-Jabri et al., who reported that the vast majority of PPDFFs around total knee replacements result from low-energy mechanisms, with high-energy trauma being relatively uncommon (21).

The management of DFFs requires advanced surgical expertise and the application of sound biomechanical principles. As emphasized by Nauth et al., DFFs demand meticulous surgical technique and adherence to biomechanical principles to optimize fixation stability and reduce complication rates (22). Moreover, Quinzi et al. emphasized that surgical management—most commonly locking plate fixation, retrograde intramedullary nailing, or distal femoral replacement—provides more reliable outcomes than conservative treatment, which is associated with high rates of nonunion, malunion, and reoperation (23). In our series, plate-screw fixation was the predominant surgical method, both in native (87%) and PPDFFs (80%). This trend reflects the widespread adoption of locked plating systems in elderly, osteoporotic patients and in the presence of knee or hip prostheses, where intramedullary nailing may be technically challenging (24). Nevertheless, intramedullary nailing remains a valuable alternative in selected cases. A recent systematic review by Shah et al. demonstrated equivalent union rates between intramedullary nails and locked plate fixation for PPDFFs, emphasizing that implant choice should be individualized according to fracture pattern, bone quality, and prosthesis design (25).

Periprosthetic fractures tended to occur in older patients and required a greater variety of surgical approaches compared to native fractures, reflecting the influence of prior prosthetic surgery and soft tissue scarring on surgical exposure. Interestingly, implant failure was observed only in native fractures, while wound-related complications predominated in the periprosthetic group, suggesting that the complication profile differs between these entities. Furthermore, the relatively high proportion of 33B2 fractures in the periprosthetic cohort (8.7% vs. 30%) emphasizes the susceptibility of the metaphyseal region adjacent to prosthetic implants. Wound complications were more frequent in PPDFFs (30%) compared to native cases (17.4%). This observation is consistent with recent reports indicating higher rates of wound-related problems in periprosthetic fractures, attributed to advanced patient age, multiple comorbidities, and compromised soft tissue integrity following prior arthroplasty (15,26).

Several limitations should be acknowledged. The retrospective design of the study may have resulted in the creation of selection bias, thereby hindering the establishment of causal relationships. The relatively limited sample size of the periprosthetic group is a particular concern, as it restricts the statistical power and generalizability of the findings. The single-center nature of the study may limit its ability to generalize the findings to other institutions. The evaluation of functional outcomes and patient-reported measures was not conducted, and the shorter follow-up period may have resulted in an underestimation of late complications, such as nonunion or implant failure. In order to enhance the generalizability of the findings, prospective multicenter studies involving larger patient cohorts are required in order to validate the results. It is recommended that future research endeavors focus on the identification of independent risk factors for PPDFFs. This finding has the potential to inform the development of targeted prevention strategies and optimized management protocols.

CONCLUSION

PPDFFs are a distinct fracture group that should be considered separately from native DFFs. In the present series, they accounted for 17.9% of all DFFs, a significantly higher incidence of which has been observed in women and which occurs following almost always low-energy trauma associated with fragility. The high incidence of wound complications in this group, although not statistically significant, underscores the challenges associated with treatment and the importance of meticulous soft tissue management.

Conflicts of interest: The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

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Ethical approval: This study was reviewed and approved by the Bilkent City Hospital, Non-Pharmaceuticals and Non-Medical Devices Research Ethics Committee (Approval No: E1-22-2905).

Consent to Participate: Informed consent was not required because of the retrospective design of the study.

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Tables

Table 1: Comparing demographics of native and periprosthetic distal femur fractures

		Native (n=46)	**Periprosthetic** (n=10)	**P**
Age (years)		69.5 (18-88)	74.5 (56-94)	0.235
Gender	**Female**	29 (63%)	10 (100%)	***0.023***
	Male	17 (37%)	0	
Side	**Right**	33 (71.7%)	9 (90%)	0.423
	Left	13 (28.3%)	1 (10%)	
Injury Mechanism	**Simple Fall**	28 (60.9%)	10 (100%)	***0.036***
	High-Energy Fall	9 (19.6%)	0	
	Traffic Accident	6 (13%)	0	
	Gunshot Wound	3 (6.5%)	0	
Fixation Technique	**Plate-Screw Fixation**	40 (87%)	8 (80%)	0.276
	Cannulated Screws	4 (8.7%)	1 (10%)	
	External Fixator	2 (4.3%)	0	
	Intramedullary Nail	0	1 (10%)	
Surgical Approach	**Anterolateral**	38 (82.6%)	6 (60%)	0.119
	Midline	5 (10.9%)	2 (20%)	
	Medial/Posteromedial	1 (2.2%)	1 (10%)	
	Percutaneous	2 (4.3%)	0	
	Combined	0	1 (10%)	
AO Classification	**33A1**	2 (4.3%)	1 (10%)	0.702
	33A2	13 (28.3%)	2 (20%)	
	33A3	10 (21.7%)	1 (10%)	
	33B1	2 (4.3%)	0	
	33B2	4 (8.7%)	3 (30%)	
	33B3	3 (6.5%)	0	
	33C1	3 (6.5%)	1 (10%)	
	33C2	4 (8.7%)	1 (10%)	
	33C3	5 (10.9%)	1 (10%)	
Complications	**None**	24 (52.2%)	7 (70%)	0.639
	Wound Problem	8 (17.4%)	3 (30%)	
	Implant Failure	5 (10.9%)	0	
	Exitus	7 (15.2%)	0	
	Periimplantic Fracture	1 (2.2%)	0	
	PTE	1 (2.2%)	0	
Charlson Comorbidity Index		4 (0-7)	4 (0-7)	0.170

n: number of patients, PTE: pulmoner thromboembolism

Table 2: Detailed demographic profile of the periprosthetic distal femur fractures

		Number of Patients (%) (N=10)
Age (years)		74.5 (56-94)
Gender	**Female**	10 (100%)
	Male	0
Side	**Right**	9 (90%)
	Left	1 (10%)
Injury Mechanism	**Simple Fall**	10 (100%)
Primary Implant	**Total Knee Arthroplasty**	8 (80%)
	Total Hip Arthroplasty	2 (20%)
Fracture Type – Primary Total Knee Arthroplasty (n=8)	**Lewis-Rorabeck Type 1**	2 (25%)
	Lewis-Rorabeck Type 2	5 (62.5%)
	Lewis-Rorabeck Type 3	1 (12.5%)
Fracture Type – Primary Total Hip Arthroplasty (n=2)	**Vancouver Type C2**	1 (50%)
	Vancouver Type C3	1 (50%)
Fixation Technique	**Plate-Screw Fixation**	8 (80%)
	Cannulated Screws	1 (10%)
	Intramedullary Nail	1 (10%)
Surgical Approach	**Anterolateral**	6 (60%)
	Midline	2 (20%)
	Medial/Posteromedial	1 (10%)
	Combined	1 (10%)
Follow-up (months)		6 (6-17)
Duration between Fracture to Surgery (days)		5 (0-21)
Complications	**None**	7 (70%)
	Wound Problem	3 (30%)

n: number of patients

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