Original article
https://doi.org/10.17816/2311-2905-17763

Beyond Mechanism: Comparable Complication Rates in High- and Low-Energy Distal Femoral Fractures Suggest Complex Risk Interplay

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Abstract

Background. Distal femoral fractures traditionally present in two distinct populations: young males with high-energy trauma and elderly females with low-energy injuries. Despite inherent differences between these groups, direct outcome comparisons remain limited.

The aim of the study — to compare complication rates between surgically treated high- and low-energy distal femoral fractures and to assess whether injury mechanism independently influences outcomes.

Methods. A retrospective review of surgically treated distal femoral fractures at a single center over a decade was conducted. Cases were categorized into high- and low-energy mechanisms. Patient demographics, comorbidities, fracture characteristics, fixation methods, and annual incidence were analyzed. Primary outcomes included nonunion, infection, and hardware failure.

Results. A total of 162 cases were analyzed, with an overall complication rate of 12.3%: nonunion (6.8%), infection (3.1%), and hardware failure (2.5%). Complication rates were comparable between high- and low-energy groups (p = 0.551).

Conclusions. Despite distinct demographic profiles and injury mechanisms, complication rates were similar between groups, suggesting a complex balance of risk factors. This finding challenges the assumption that injury mechanism predicts outcomes and emphasizes the importance of personalized perioperative care addressing patient-specific risk factors rather than injury mechanism alone.

Keywords: distal femoral fractures; complications; high-energy trauma; low-energy trauma.

Cite as: Balziano S., Ginesin E. Beyond Mechanism: Comparable Complication Rates in High- and Low-Energy Distal Femoral Fractures Suggest Complex Risk Interplay. *Traumatology and Orthopedics of Russia*. 2025;31(4):76-83. https://doi.org/10.17816/2311-2905-17763.

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Submitted: 06.09.2025. Accepted: 21.10.2025. Published online: 07.11.2025.

Научная статья
УДК 616.718.46-001.5-06
https://doi.org/10.17816/2311-2905-17763

Только ли механизм травмы? Сопоставимая частота осложнений при высоко- и низкоэнергетических переломах дистального отдела бедренной кости как показатель сложной взаимосвязи факторов риска

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Реферат

Актуальность. Переломы дистального отдела бедренной кости (ДОБК), как правило, встречаются у молодых мужчин в результате высокоэнергетической травмы и у пожилых женщин при низкоэнергетической травме. Несмотря на существенные различия между этими группами населения, данных о сравнении исходов их лечения недостаточно.

Цель исследования — сравнить частоту осложнений при хирургическом лечении высоко- и низкоэнергетических переломов дистального отдела бедренной кости и оценить, влияет ли механизм травмы на исход лечения независимо от других факторов.

Материал и методы. Был проведен одноцентровый ретроспективный анализ результатов хирургического лечения переломов ДОБК за десятилетний период. Все наблюдения были разделены на группы высоко- и низкоэнергетических травм. Анализировали демографические данные пациентов, сопутствующие заболевания, характеристики переломов, методы фиксации и ежегодную частоту случаев. Были выявлены следующие осложнения: несращение, инфекция и несостоятельность металлоконструкции.

Результаты. Всего было проанализировано 162 случая. Общая частота осложнений составила 12,3%: несращение (6,8%), инфекция (3,1%) и несостоятельность металлоконструкции (2,5%). Частота осложнений была сопоставима в группах с высоко- и низкоэнергетическими травмами (p = 0,551).

Заключение. Несмотря на различия в демографических характеристиках и механизмах травмы, частота осложнений в группах была схожей, что указывает на комплексное взаимодействие факторов риска. Полученный результат ставит под сомнение предположение о том, что механизм травмы определяет исход лечения. Подчеркивается важность персонализированного периоперационного ведения пациента с учетом специфических факторов риска, а не только механизма травмы.

Ключевые слова: переломы дистального отдела бедренной кости; осложнения; высокоэнергетическая травма; низкоэнергетическая травма.

Для цитирования: Бальзиано С., Джинезин Э. Только ли механизм травмы? Сопоставимая частота осложнений при высоко- и низкоэнергетических переломах дистального отдела бедренной кости как показатель сложной взаимосвязи факторов риска. *Травматология и ортопедия России*. 2025;31(4):76-83. (На англ.). https://doi.org/10.17816/2311-2905-17763.

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Рукопись получена: 06.09.2025. Рукопись одобрена: 21.10.2025. Статья опубликована онлайн: 07.11.2025.

INTRODUCTION

Distal femoral fractures, though comprising only 1% of all fractures and 3-6% of femoral fractures, represent a significant clinical challenge warranting increased attention as demographic shifts predict a rising incidence, particularly with the expanding global geriatric population [1, 2].

These fractures present a unique dichotomy in their demographic distribution and mechanism of injury. The first group predominantly consists of young males sustaining high-energy trauma, while the second encompasses elderly females typically experiencing low-energy injuries [1, 2]. This distinct bimodal distribution offers a compelling opportunity to examine how different injury mechanisms and patient characteristics influence outcomes.

The current treatment landscape encompasses a spectrum of interventions, ranging from conservative management to various surgical fixation techniques. While the fundamental goal remains consistent across all approaches — maintaining joint architecture and ensuring articular stability [3] — the path to achieving these objectives varies considerably. The complexity of management is further compounded by significant complications, including malunion, nonunion, infection, and hardware failure, often necessitating challenging revision surgeries [2, 4, 5, 6]. These complications not only impact patient outcomes and quality of life but also pose substantial healthcare resource challenges [7, 8, 9]. Current literature reports considerable variation in complication rates, with nonunion rates spanning 6-38% and infection rates ranging from 3-15% [10, 11, 12, 13]. However, there remains a notable gap in comparative analyses between demographic groups.

The inherent physiological, mechanical, and demographic differences between these two distinct patient populations suggest potential variations in complication patterns and rates [14]. Understanding these variations could prove instrumental in developing targeted treatment algorithms and optimizing resource allocation. Given the relative infrequency of these fractures and their significant impact, there is a compelling need for comprehensive research in this area.

The aim of this study — to compare complication rates between surgically treated high- and low-energy distal femoral fractures and to assess whether injury mechanism independently influences outcomes.

METHODS

Study design

This single-center retrospective cohort study was conducted following institutional committee approval, analyzing outcomes of surgically treated distal femoral fractures over an eleven-year period (January 2006 — March 2017).

Patient selection and data collection

We identified 200 patients with surgically treated distal femoral fractures at Rambam Health Care Campus between January 2006 and March 2017 using ICD-9 codes. *Inclusion criteria* were: age ≥ 18 years; acute distal femoral fractures (AO/OTA 33 group) treated with definitive surgical fixation. All diagnoses were verified through detailed medical record review and preoperative radiographic assessment. *Exclusion criteria* were: periprosthetic fractures; bilateral fractures; miscoded cases not representing distal femoral fractures; preoperative mortality; and primary amputation due to vascular compromise. After applying these criteria, 162 patients remained for final analysis (Figure 1).

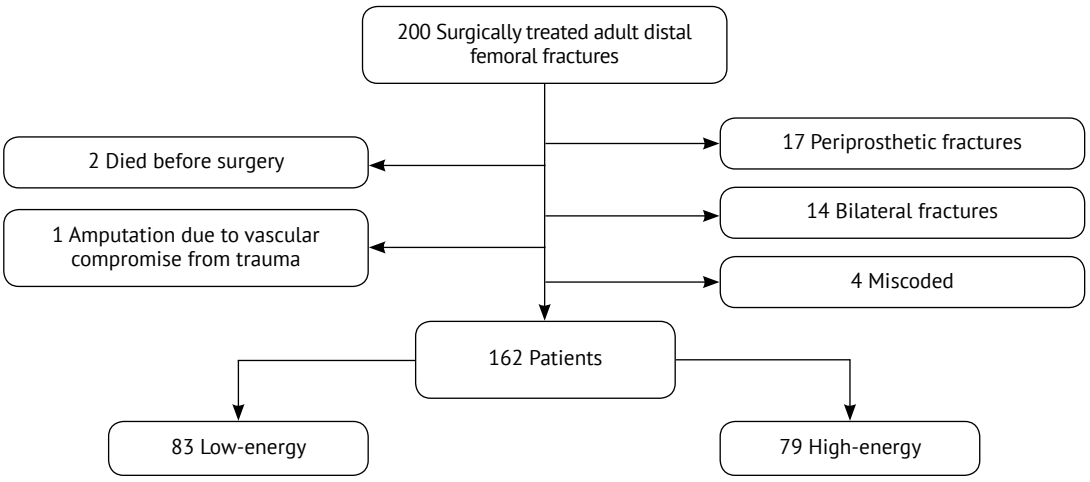

Figure 1. Patient selection flowchart

Cases were stratified by injury mechanism into two groups: low-energy trauma (falls from standing height) and high-energy trauma (motor vehicle accidents or falls from above standing height). Comprehensive data collection included demographic characteristics, lifestyle factors, and major comorbidities such as diabetes, hypertension, cardiac conditions, and chronic renal failure. Additionally, we documented fracture characteristics and associated injuries, which were quantified using the Injury Severity Score [15]. Fracture classification was performed using the AO/OTA system, with independent verification by two authors to ensure reliability.

Post-operative protocol

A standardized rehabilitation protocol was implemented, consisting of an initial six-week non-weight-bearing period followed by a subsequent six-week partial weight-bearing progression. The median follow-up duration was 7 months [4; 12], with 60.5% of patients completing extended follow-up (> 3 months).

Outcome measures

Complications were defined according to standardized criteria. Nonunion was defined as cessation of consolidation progress after 8 months or lack of radiographic improvement over 3 consecutive months. Hardware failure was characterized as implant breakage or significant radiological loosening resulting in re-displacement, shortening, or fracture movement. Surgical site infection was documented as microbial contamination within one year of implant placement [16].

Statistical analysis

Continuous variables were assessed for normality using the Shapiro-Wilk test and were found to be non-normally distributed. Therefore, they are presented as median (Me) with interquartile range [Q_1; Q_3] and compared using the Mann-Whitney U test. Categorical variables are presented as counts and percentages and compared using Pearson's chi-square or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant. All analyses were performed using SPSS version 26.0 (IBM, Armonk, NY, USA).

RESULTS

Demographics and lifestyle characteristics

The final cohort comprised 162 adult cases with surgically treated distal femoral fractures, distributed between low-energy (51.2%) and high-energy (48.8%) mechanisms. The overall median age was 57.9 years [35.4; 73.2], with significant age disparity between groups: low-energy cases had median age of 70.0 years compared to 36.0 in high-energy cases (p < 0.001). Gender distribution showed significant variation, with female predominance in the low-energy group and male predominance in the high-energy group (p < 0.001) (Table 1). The age and sex distribution of the cohort demonstrates peaks in young males and elderly females (Figure 2).

In the subset of patients with available BMI data (22.2%, n = 36), the low-energy group demonstrated significantly higher median values (29.1 vs 23.1; p = 0.002). Smoking status, documented in 35.1% of cases (n = 57), was significantly more prevalent in the high-energy group (p = 0.002). Comorbidity analysis revealed significantly higher rates of diabetes (p = 0.015), hypertension (p < 0.001), and cardiac diseases (p < 0.001) in the low-energy group (see Table 1).

Table 1

Patient characteristics at baseline

Parameter	Low-energy group	High-energy group	p-value
Age, years, Me [Q_1; Q_3]	70.0 [59.3; 79.7]	36.0 [26.8; 53.5]	**< 0.001**
Gender (F), n (%)	71 (85.5)	27 (34.1)	**< 0.001**
BMI, kg/m², Me [Q_1; Q_3]	29.1 [24.9; 33.3]	23.1 [20.7; 27.5]	**0.002**
Smoker, n (%)	8 (30.7)	22 (70.9)	**0.002**
Co-morbidities, n (%)			
Diabetes	22 (26.5)	9 (11.3)	**0.015**
Hypertension	32 (38.5)	9 (11.3)	**< 0.001**
Cardiac condition	17 (20.4	2 (2.5)	**< 0.001**
Renal condition	2 (2.4)	1 (1.2)	0.589

BMI — body mass index.

Statistically significant values are shown in bold.

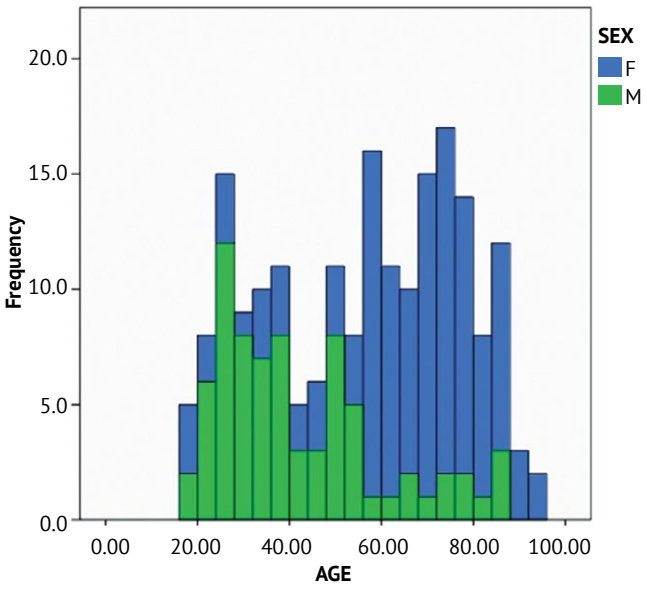

Figure 2. Distribution of the cohort with the subdivision between sexes. F — female, M — male

Fracture characteristics

Fracture laterality showed equal distribution between groups (p = 0.542). According to AO/OTA classification, type 33-A fractures predominated (58.6%), followed by type 33-B (30.3%) and type 33-C (11.1%). Detailed characteristics of the fractures are presented in Table 2.

Surgical management

All procedures were performed within 7 days of injury. Plate fixation was the predominant surgical technique, employed in 107 cases (66.0%). Detailed fixation method distribution is presented in Table 2.

Complications and outcomes

The overall complication rate was 12.3% (n = 20), comprising nonunion (6.8%), infection (3.1%), and hardware failure (2.5%). Notably, complication rates showed no significant difference between high and low-energy groups (p = 0.551) (Table 3), surgical techniques (p = 0.445), open fractures (p = 0.177), or injury severity scores (p = 0.281).

Table 2

Fracture and fixation methods distribution

Parameter	Low-energy group		High-energy group		p-value
	n	%	n	%	
AO/OTA classification					0.921
33-A	50	60.2	45	56.9	
33-B	9	10.8	9	11.3	
33-C	24	28.9	25	31.6	
Injury characteristics					
Open fracture	0	0.0	18	22.8	**< 0.001**
Injury Severity Score					**< 0.001**
Moderate	0	0.0	54	68.4	
Severe	0	0.0	16	20.3	
Critical	0	0.0	9	11.4	
Fixation method					**0.004**
Plate	57	68.6	50	63.3	
Nail	24	28.9	15	19.0	
K-Wire	1	1.2	0	0.0	
Screws	1	1.2	4	5.1	
External fixator	0	0.0	10	12.7	

Statistically significant values are shown in bold.

Table 3

Complication rates

Complication	Low-energy group		High-energy group		p-value
	n	%	n	%	
Infection	1	1.2	4	5.1	
Nonunion	6	7.2	5	6.3	
Hardware failure	2	2.4	2	2.5	
Total	9	10.8	11	13.9	0.551

Management of nonunion cases (n = 11) involved revision surgery performed 6-12 months post-initial procedure. Treatment strategies included isolated bone grafting (5 cases), plating (4 cases), and combined plating with bone grafting (2 cases). All revision cases demonstrated radiographic healing within 3 months post-revision.

Post-operative outcomes

All patients achieved functional range of motion, defined as absence of extension lag and minimum flexion of 110 degrees, with no discrepancy in leg length at final follow-up.

DISCUSSION

Our study of distal femoral fractures, conducted at a major medical center serving approximately two million residents, revealed an incidence of 9.56 cases per million per year. This finding aligns with existing literature and reinforces the relative rarity of these fractures [17], underlining the importance of comprehensive analysis to better understand their epidemiology.

The demographic distribution in our cohort strongly supports the bimodal pattern theory, contrasting with Court-Brown and Caesar's original unimodal distribution model [18]. Our data demonstrated clear peaks in young males and elderly females, as in several other studies [17, 19], with corresponding injury mechanisms: high-energy trauma predominantly affecting young males and low-energy falls primarily involving elderly females [17, 20, 21]. The low-energy group predictably exhibited a higher prevalence of comorbidities, reflecting the age-related health challenges in this population.

Regarding fracture patterns, our finding of AO/OTA 33-A predominance showed no correlation with injury mechanism, consistent with several previous studies [17, 19, 22]. This contrasts with some reports suggesting higher rates of complex articular fractures (AO/OTA 33-C) in high-energy trauma [23], highlighting the complex nature of fracture pattern determinants.

The mean follow-up period of 9.7 months, while shorter than some published series, proved sufficient for assessing primary outcomes and complications. This duration adequately captured the critical healing period, as evidenced by our observation that all revision cases achieved union within 3 months post-revision. Moreover, the local healthcare structure, where patients with persistent problems remain in follow-up while those achieving satisfactory outcomes often return to community care, suggests that our complication rates likely represent a comprehensive capture of significant adverse events. This follow-up pattern reflects real-world clinical practice and provides valuable insights into the actual trajectory of these injuries.

Our findings regarding surgical management align with current evidence supporting operative intervention, particularly in older patients [8]. The preference for plate fixation at our institution reflects broader trends in the literature [17, 22, 24]. Notably, our data corroborates previous studies showing comparable outcomes between intramedullary nailing and locking plates [25, 26, 27], supporting surgical decision-making based on individual patient and fracture characteristics rather than rigid protocol-based approaches.

Our overall complications align with published data, with nonunion rates of 6.7% matching M. Zlowodzki's systematic review findings of 6.0% across 1.670 cases [7]. Similarly, our deep infection rate of 3.0% corresponds well with the literature rate of 2.7% [7, 28, 29, 30].

A key finding of our study was the comparable complication rates between high- and low-energy groups ($p = 0.551$), which presents an intriguing paradox given their distinctly different demographic and clinical profiles. Our observations suggest a compelling hypothesis about the equilibrium of risk factors between these groups. The high-energy group faced challenges from severe initial soft tissue trauma, higher smoking rates ($p = 0.002$), and potentially more complex injury patterns, while the low-energy group contended with reduced physiological reserves, increased comorbidities, and potentially compromised bone quality. This balance of competing risk factors may explain the similar outcomes between groups. For instance, while advanced age and comorbidities in the low-energy group might predispose to complications, the increased soft tissue damage and higher smoking rates in the high-energy group could pose comparable risks through different mechanisms.

This finding carries significant clinical implications. First, it suggests that the traditional assumption of higher complication rates in either group may need reconsideration. Second, it emphasizes the importance of individualized risk assessment rather than relying solely on injury mechanism as a predictor of complications. Third, it highlights the need for careful preoperative optimization and meticulous surgical technique in both groups, as neither appears to have an inherent advantage in terms of complication risk.

Study limitations

Study limitations include its retrospective, single-center design and incomplete data collection for certain variables. However, the substantial cohort size and comprehensive complication analysis provide valuable insights into the management of these challenging fractures. Future prospective studies incorporating patient-reported outcomes would further enhance our understanding of these injuries.

CONCLUSIONS

Our study demonstrates that despite distinct demographic profiles and injury mechanisms in distal femoral fractures, complication rates remain comparable between high- and low-energy trauma groups. This finding challenges traditional assumptions about outcome predictors and emphasizes that each population faces unique risk factors that may ultimately balance out: soft tissue damage and higher smoking rates in the high-energy group versus reduced physiological reserves and increased comorbidities in the low-energy group. These results underscore the importance of personalized perioperative care strategies that address patient-specific risk factors rather than relying primarily on injury mechanism. Future research could further elucidate the complex relationship between patient characteristics, injury mechanisms, and outcomes in these challenging fractures.

DISCLAIMERS

Author contribution

Snir Balziano — study concept and design, literature search and review, data acquisition and interpretation, statistical data processing, editing the manuscript.

Eyal Ginesin — study concept and design, drafting the manuscript.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

Funding source. This study was not supported by any external sources of funding.

Disclosure competing interests. The authors declare that they have no competing interests.

Ethics approval. Not applicable.

Consent for publication. The authors obtained written consent from patients to participate in the study and publish the results.

Use of generative artificial intelligence. The ChatGPT language model was used to improve readability and language of this article. After using the tool, the authors have reviewed and edited the content as needed and take full responsibility for the content of the publication.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Заявленный вклад авторов

Снир Бальзиано — концепция и дизайн исследования, поиск и анализ литературы, сбор и интерпретация данных, статистическая обработка данных, редактирование текста рукописи.

Эяль Джинезин — концепция и дизайн исследования, написание текста рукописи.

Все авторы прочли и одобрили финальную версию рукописи статьи. Все авторы согласны нести ответственность за все аспекты работы, чтобы обеспечить надлежащее рассмотрение и решение всех возможных вопросов, связанных с корректностью и надежностью любой части работы.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Возможный конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Этическая экспертиза. Не применима.

Информированное согласие на публикацию. Авторы получили письменное согласие пациентов на участие в исследовании и публикацию результатов.

Генеративный искусственный интеллект. Для улучшения стиля и качества изложения использовалась языковая модель ChatGPT. Авторы проверяли и при необходимости редактировали полученный текст и несут полную ответственность за содержание статьи.

REFERENCES

1. Gwathmey F.W. Jr., Jones-Quaidoo S.M., Kahler D., Hurwitz S., Cui Q. Distal femoral fractures: current concepts. *J Am Acad Orthop Surg*. 2010;18(10):597-607. doi: 10.5435/00124635-201010000-00003.
2. Singh R., Ambade R., Landge S., Goyal S., Goel S. Comprehensive Review on Distal Femur Fractures: From Epidemiology to Treatment Strategies. *Cureus*. 2024;16(4):e57937. doi: 10.7759/cureus.57937.
3. Chauhan S., Dhanger S.K., Singh B.P. Study of surgical management of distal femur fracture using locking compression plate. *Int J Orthop Sci*. 2021;7:921-925. doi: 10.22271/ortho.2021.v7.i1n.2589.
4. De Mauro D., Smakaj A., Casiraghi A., Galante C., Bove F., Arduini M. et al. Double plating versus nail-plate construct in AO 33C distal femur fractures: treatment choice affects knee alignment, clinical outcomes, and quality of life — a multicenter study. *J Orthop Traumatol*. 2025;26(1):22. doi: 10.1186/s10195-025-00834-1.
5. Muhammad J., Muahmmad N.Ch., Muhammad R.S., Abdul A., Muhammad H., Kashif A.N. Functional Outcome of Retrograde Femur Nail and DFLCP in Extra Articular Distal Femur Fracture. *IJBR*. 2025;3:650-654. doi: 10.70749/ijbr.v3i6.2019.
6. Alcaide D.M., Blackwood N., Arthur R., Patch D.A., Rutz R.W., Spitler C.A. Distal Interlock Backout in the RFN-Advanced Retrograde Femoral Nailing System (RFNA) in Femur Fractures: Short Term Outcome Analysis. *J Orthop Trauma*. 2025;39(7):357-361. doi: 10.1097/BOT.0000000000002979.
7. Zlowodzki M., Bhandari M., Marek D.J., Cole P.A., Kregor P.J. Operative treatment of acute distal femur fractures: systematic review of 2 comparative studies and 45 case series (1989 to 2005). *J Orthop Trauma*. 2006;20(5):366-371. doi: 10.1097/00005131-200605000-00013.
8. Trikha V., Kumar A. Osteoporotic Distal Femur Fractures: An Overview. *Indian J Orthop*. 2025;59(3):311-325. doi: 10.1007/s43465-025-01345-1.

9. Fu F., Liu B., Pu H., Wang Y., Zhang P., Wei S. et al. Global Trends in the Incidence and Primary Causes of Femoral Fractures, Excluding Femoral Neck Fractures: A Global Epidemiological Study. *Risk Manag Healthc Policy*. 2025;18:117-129. doi: 10.2147/RMHP.S498918.
10. Southeast Fracture Consortium. LCP Versus LISS in the Treatment of Open and Closed Distal Femur Fractures: Does it Make a Difference? *J Orthop Trauma*. 2016;30(6): e212-e216. doi: 10.1097/BOT.0000000000000507.
11. Henderson C.E., Lujan T.J., Kuhl L.L., Bottlang M., Fitzpatrick D.C., Marsh J.L. 2010 mid-America Orthopaedic Association Physician in Training Award: healing complications are common after locked plating for distal femur fractures. *Clin Orthop Relat Res*. 2011;469(6):1757-1765. doi: 10.1007/s11999-011-1870-6.
12. Ebraheim N.A., Martin A., Sochacki K.R., Liu J. Nonunion of distal femoral fractures: a systematic review. *Orthop Surg*. 2013;5(1):46-50. doi: 10.1111/os.12017.
13. Bai Y., Zhang X., Tian Y., Tian D., Zhang B. Incidence of surgical-site infection following open reduction and internal fixation of a distal femur fracture: An observational case-control study. *Medicine (Baltimore)*. 2019;98(7):e14547. doi: 10.1097/MD.0000000000014547.
14. Stenquist D.S., Albertson S., Bailey D., Paladino L., Flanagan C.D., Stang T. et al. High- Versus Low-Energy Intertrochanteric Hip Fractures in Young Patients: Injury Characteristics and Factors Associated With Complications. *J Orthop Trauma*. 2023;37(5):222-229. doi: 10.1097/BOT.0000000000002587.
15. Baker S.P., O'Neill B., Haddon W. Jr., Long W.B. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*. 1974;14(3):187-196.
16. Horan T.C., Gaynes R.P., Martone W.J., Jarvis W.R., Emori T.G. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. *Infect Control Hosp Epidemiol*. 1992;13(10):606-608.
17. Khan A.M., Tang Q.O., Spicer D. The Epidemiology of Adult Distal Femoral Shaft Fractures in a Central London Major Trauma Centre Over Five Years. *Open Orthop J*. 2017;11:1277-1291. doi: 10.2174/1874325001711011277.
18. Court-Brown C.M., Caesar B. Epidemiology of adult fractures: A review. *Injury*. 2006;37(8):691-697. doi: 10.1016/j.injury.2006.04.130.
19. Pietu G., Lebaron M., Flecher X., Hulet C., Vandenbussche E. SOFCOT. Epidemiology of distal f emur fractures in France in 2011-12. *Orthop Traumatol Surg Res*. 2014;100(5):545-548. doi: 10.1016/j.otsr.2014.06.004.
20. Baron J.A., Karagas M., Barrett J., Kniffin W., Malenka D., Mayor M. et al. Basic epidemiology of fractures of the upper and lower limb among Americans over 65 years of age. *Epidemiology*. 1996;7(6):612-618. doi: 10.1097/00001648-199611000-00008.
21. Ng A.C., Drake M.T., Clarke B.L., Sems S.A., Atkinson E.J., Achenbach S.J. et al. Trends in subtrochanteric, diaphyseal, and distal femur fractures, 1984-2007. *Osteoporos Int*. 2012;23(6):1721-1726. doi: 10.1007/s00198-011-1777-9.
22. Smith J.R., Halliday R., Aquilina A.L., Morrison R.J., Yip G.C., McArthur J. et al. Collaborative - Orthopaedic Trauma Society (OTS). Distal femoral fractures: The need to review the standard of care. *Injury*. 2015;46(6):1084-1088. doi: 10.1016/j.injury.2015.02.016.
23. Paiva M.M., Leal D.P., Kuroki P.K., Barroso B.G., Reyna M.A.A., Leonhardt M.C. et al. Distal femoral fractures from high-energy trauma: a retrospective review of complication rate and risk factors. *Acta Ortop Bras*. 2022;30(spe2):e256896. doi: 10.1590/1413-785220223002e256896.
24. Kayali C., Agus H., Turgut A. Successful results of minimally invasive surgery for comminuted supracondylar femoral fractures with LISS: comparative study of multiply injured and isolated femoral fractures. *J Orthop Sci*. 2007;12(5):458-465. doi: 10.1007/s00776-007-1156-8.
25. Dunbar R.P., Egol K.A., Jones C.B., Ertl J.P., Mullis B., Perez E. et al. Locked Lateral Plating Versus Retrograde Nailing for Distal Femur Fractures: A Multicenter Randomized Trial. *J Orthop Trauma*. 2023;37(2):70-76. doi: 10.1097/BOT.0000000000002482.
26. Markmiller M., Konrad G., Südkamp N. Femur-LISS and distal femoral nail for fixation of distal femoral fractures: are there differences in outcome and complications? *Clin Orthop Relat Res*. 2004;(426):252-257. doi: 10.1097/01.blo.0000141935.86481.ba.
27. Hierholzer C., von Rüden C., Pötzel T., Woltmann A., Bühren V. Outcome analysis of retrograde nailing and less invasive stabilization system in distal femoral fractures: A retrospective analysis. *Indian J Orthop*. 2011;45(3):243-250. doi: 10.4103/0019-5413.80043.
28. Zhu C., Zhang J., Li J., Zhao K., Meng H., Zhu Y. et al. Incidence and predictors of surgical site infection after distal femur fractures treated by open reduction and internal fixation: a prospective single-center study. *BMC Musculoskelet Disord*. 2021;22(1):258. doi: 10.1186/s12891-021-04132-9.
29. Baertl S., Metsemakers W.J., Morgenstern M., Alt V., Richards R.G., Moriarty T.F. et al. Fracture-related infection. *Bone Joint Res*. 2021;10(6):351-353. doi: 10.1302/2046-3758.106.BJR-2021-0167.R1.
30. Almwuad'a M.H.H. Distal femur locked plate for fixation of open distal femur fracture. *J Musculoskeletal Surg Res*. 2025;9(3):323-328. doi: 10.25259/JMSR_10_2025.

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