Survival at Stake: Surgical Decision-Making in Metastatic Femoral

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Pathological femoral fractures resulting from primary or metastatic tumors represent a complex clinical challenge for orthopedic surgeons, often requiring individualized treatment strategies. This retrospective study aimed to evaluate and compare the outcomes of different surgical approaches used in the management of pathological femoral fractures secondary to metastatic disease. A total of 46 patients (52 femoral fractures) who underwent surgical treatment between 2020 and 2023 were included in the study. Data collected encompassed demographic characteristics, tumor histology, surgical techniques employed, and clinical outcomes. Statistical analysis was conducted using appropriate parametric and non-parametric tests, depending on data distribution. Of the patients included, 51% underwent tumor resection followed by endoprosthetic reconstruction, 40% were treated with intramedullary nailing, and 9.4% underwent plate osteosynthesis. The highest postoperative mortality rate was observed among patients with lung cancer metastases. Blood transfusions were necessary in 66% of cases. The overall mean survival time following surgery was 4.5 months, with significant variation according to tumor type and metastatic burden. The findings of this study underscore the importance of a multidisciplinary approach in the surgical management of pathological femoral fractures caused by metastatic tumors. Surgical interventions such as intramedullary nailing, plate fixation, and endoprosthetic reconstruction can effectively restore mechanical stability and contribute to improved patient quality of life. Selection of the optimal surgical technique should be guided by tumor histopathology, anatomical location and extent of bone involvement, number of metastatic lesions, and overall patient prognosis. Timely and appropriate surgical intervention remains critical to minimizing complications and enhancing survival outcomes in this patient population.

Keywords: Pathological femoral fractures, Metastatic bone disease, Intramedullary nailing, Endoprosthetic reconstruction, Orthopedic oncology.

INTRODUCTION

Pathological fractures of the femur, most commonly resulting from metastatic tumors, represent a significant clinical challenge in both orthopedic and oncologic practice due to their profound impact on patient mobility and quality of life, as well as their association with increased morbidity and mortality[1]. These fractures predominantly occur in individuals with advanced-stage malignancies and frequently necessitate surgical stabilization to alleviate pain and restore functional capacity[2]. However, despite surgical management, the overall prognosis for this patient population remains poor, with limited post-treatment survival in many cases[3].

The biological characteristics of the primary malignancy have emerged as critical determinants influencing both surgical decision-making and clinical outcomes. Studies have shown that patients with metastatic carcinomas, especially those originating in the lung and breast, tend to exhibit significantly lower survival rates compared to individuals with metastases from other primary tumor types[4,5]. Lung cancer metastases, in particular, are characterized by a highly osteolytic profile and are frequently associated with systemic complications that hinder postoperative recovery[6,7].

Surgical treatment modalities for pathological femoral fractures include intramedullary nailing, plate osteosynthesis, and endoprosthetic reconstruction. The choice of surgical technique is largely dictated by factors such as tumor location, extent of osseous

involvement, and anticipated prognosis[2,4]. While these procedures offer prompt mechanical stabilization, they are also accompanied by considerable perioperative risks. Surgical demands, including extended operative duration, prolonged hospitalization, and increased transfusion requirements, present significant challenges, particularly in patients with limited functional reserves or multisystem involvement[8].

Despite a growing body of literature, few studies have quantitatively examined the relationship between tumor histopathology and both short-term survival and perioperative burden, including transfusion needs and delays from fracture to definitive surgery[9]. Understanding these associations is crucial for developing individualized treatment strategies, particularly in the context of palliative care, where the primary objective is to enhance quality of life rather than pursue oncologic cure.

This retrospective study evaluates 47 patients with pathological fractures of the femur, aiming to elucidate the impact of tumor type on short-term survival and procedural burden. We hypothesize that the aggressive biological behavior of carcinoma metastases correlates with increased mortality, greater perioperative transfusion requirements, and longer hospitalization. Furthermore, we propose that tumor aggressiveness may serve as a prognostic marker for surgical outcomes and aid in guiding perioperative management strategies.

MATERIAL AND METHODS

This retrospective study analyzed data from patients diagnosed with pathological femoral fractures secondary to metastatic tumors who were admitted to our institution between 2020 and 2023. Prior to data collection, ethical approval was obtained from the institutional review board (Approval No: 157, Date: 28.02.2024). All study procedures adhered strictly to the principles outlined in the Declaration of Helsinki, and written informed consent was obtained from all participants.

Patients aged 18 years and older with radiologically and clinically confirmed pathological fractures of the femur due to metastatic disease were included. Exclusion criteria comprised individuals under the age of 18, patients whose fractures resulted from non-oncologic etiologies such as metabolic bone disorders, drug-induced fragility, or fatigue-related stress fractures, as well as in patients with pathological fractures located outside the femur, particularly in the axial skeleton or other regions of the appendicular skeleton. Additionally, patients who survived but had less than one year of clinical follow-up were excluded to ensure consistency and reliability of the dataset.

All patients with suspected pathological femoral fractures were evaluated by a Multidisciplinary Orthopedic Oncology Council. Each patient underwent a comprehensive diagnostic work-up, including detailed medical history, thorough physical examination, and advanced imaging modalities. Based on these evaluations, the council formulated individualized treatment plans, and definitive surgical interventions were promptly performed in accordance with institutional protocols.

Postoperative Care

Patients were instructed in-bed exercises; those treated with prosthesis or intramedullary nailing were mobilized with controlled loading, while those who underwent plate fixation were mobilized without loading until suture removal. In cases of tumor resection prosthesis, drains were monitored under negative pressure for 3–7 days and removed once drainage decreased. Unless contraindicated, triple antibiotic prophylaxis was administered until drain removal and continued with first-generation cephalosporins until discharge. Postoperative physiotherapy was initiated in all patients during hospitalization, with either in-bed exercises or assisted mobilization under the supervision of a physiotherapist, depending on their general condition. However, variations in oncological prognosis and survival limited the applicability of standardized functional scoring during follow-up.

Multidisciplinary Evaluation

Postoperative evaluations for adjuvant or final treatment were conducted by the Orthopedic Oncology Council based on the pathology report. All patients in the resection group had clear surgical margins (R0 resections) as confirmed by postoperative histopathological evaluation. All patients with metastasis of a pathological fracture received radiotherapy after wound healing during the postoperative period. This postoperative radiotherapy policy applied to both resection and osteosynthesis groups unless contraindicated.

Statistical analysis

Statistical analyses were performed using SPSS for Windows 25.0 (Armonk, NY: IBM Corp. 2017). The distribution properties of the data were determined using the Shapiro-Wilk test, and variance homogeneity

was assessed using Levene's test. Data were evaluated using appropriate parametric or non-parametric tests based on the distribution characteristics. Chi-square correlations and Kaplan-Meier analyses were used. Statistical significance was set at $p < 0.05$.

RESULTS

The study included 46 patients with 52 affected femurs. Of these, 18 (39.1%) were male, and 28 (60.9%) were female. The distribution of fractures was as follows: 29 (55.8%) on the right side and 23 (44.2%) on the left side. Regarding fracture type, 30 (57.7%) were proximal femoral fractures, 12 (23.1%) were shaft fractures, and 10 (19.2%) were distal femoral fractures. Femoral neck fractures were identified in 9 (17.3%) patients (Table I). Nine of 52 femurs (17.3%) were operated for impending fracture, while 43/52 (82.7%) underwent surgery for complete pathological fracture. The mean Mirels score for the patients who underwent surgery for an impending fracture was 9.89 ± 0.601 (range: 9–11, median = 10).

The mean age of the patients was 60.00 ± 14.50 years (range: 28 to 86 years). The median Karnofsky performance score was 80.00, and the median ECOG performance score was 1.00. The mean duration between fracture and surgery was 14.49 ± 14.68 days (range: 2 to 70 days). The average operation time was 125.14 ± 60.05 minutes (range: 40 to 290 minutes). The average total hospital stay for the patients was 22.02 ± 14.98 days (range: 5 to 88 days) (Table II).

Preoperatively, the mean hemoglobin (HgB) level was 11.00 ± 1.90 g/dl (range: 7.9-14.8 g/dl), whereas postoperatively, it was 9.51 ± 1.69 g/dl (range: 6.3-14.5 g/dl). The average time between surgery and final follow-up or death was 12.78 ± 14.06 months (range: 0.5-39 months) (Table II).

The preliminary diagnosis predominantly consisted of carcinoma metastases (37 cases, 71.2%). Other preliminary diagnoses included bone tumor metastases

Table I. — Patient demographics, fracture laterality, anatomic location, and fracture type.

			Number	Percent
Gender	Male		18	39.1 %
	Female		28	60.9 %
Side	Right		29	55.8 %
	Left		23	44.2 %
Location	Proximal	Neck	9	17.3 %
		Other	21	40.4 %
	Diaphysis		12	23.1 %
	Distal		10	19.2 %
Fracture Type	Impending		9	17.0%
	Actual		44	83.0%

Table II. — Descriptive statistics for age, performance status (Karnofsky, ECOG), perioperative intervals, operative time, hospital stay, and hemoglobin values.

	Mean	Std. Deviation	Median	Minimum	Maximum
Age	60.63	14.81	60	28	86
KARNOFSKY	80.96	7.48	80	70	90
ECOG	1.33	0.51	1	0	2
Fracture-to-Surgery Interval (Days)	14.33	14.77	9.50	2	70
Surgery Duration (Min)	124.65	59.55	107.5	40	290
Hospital Stay (Days)	22.02	14.98	19	5	88
Preoperative Hemoglobin (HB)	11.00	1.90	10.95	7.9	14.8
Postoperative Hemoglobin (HB)	9.51	1.69	9.45	6.3	14.5
Preop–Postop Hb Difference	1.49	1.89	1.15	- 1.90	6.20
Surgery-to-Follow-up/Outcome Interval (Months)	12.78	14.06	6	0.5	39

Table III. — Preoperative diagnosis, surgical method utilization, transfusion and embolization rates, pathology results, and vital status at last follow-up.

		Number (n)	Percent (%)
Preliminary Diagnosis	Unknown	4	7.7
	Carcinoma Metastasis	37	71.2
	Bone Tumor	4	7.7
	Hematogenous	6	11.5
	Skin	1	1.9
Surgical Method	Endoprosthetic Replacement	26	50.0
	PFN veya IMN	21	40.4
	Plate + Osteosynthesis	5	9.6
Blood Transfusion	No	18	34.6
	Yes	34	65.4
Embolization	No	47	90.4
	Yes	5	9.6
Pathology Result	Nonspecific	6	11.5
	Carcinoma	32	61.5
	Sarcoma	2	3.8
	Hematogenous	8	15.4
	Other	4	7.7
Exitus	Death	37	71.2
	Alive	15	28.8

Table IV. — Primary tumor distribution within the metastatic carcinoma subgroup (n = 32).

Primary site	n	%
Breast	14	43.8
Lung	13	40.6
Renal cell	3	9.4
Prostate	1	3.1
Colorectal	1	3.1
Total	32	100

Table V. — Surgical procedures performed for metastatic femoral disease: technique and subtype distribution (n = 52 femurs).

Procedure category	Total n	(%)
Endoprosthetic Replacement (all)	26	50.0
• Hemiarthroplasty	7	13.5
• Total hip arthroplasty	1	1.9
• Modular tumor/resection prosthesis	16	30.8
• Intercalary prosthesis	2	3.8
Intramedullary nailing (IMN)	21	40.4
Plate osteosynthesis	5	9.6
Total	52	100

Table VI 1a. — Distribution of surgical method by fracture level (proximal, diaphyseal, distal).

Endoprosthetic Replacement PFN or IMN			Surgical Method			Total
			Plate			
Level of fracture	Proximal	n	19	9	2	30
		%	36.5%	17.3%	3.8%	57.7%
	Diaphysis	n	3	9	0	12
		%	5.8%	17.3%	0.0%	23.1%
	Distal	n	4	3	3	10
		%	7.7%	5.8%	5.8%	19.2%
Total %		n	26	21	5	52
		%	50.0%	40.4%	9.6%	100.0%

Table VI 1b. — Association between fracture level and surgical method (chi-square test).

			Endoprosthetic Replacement	Others	Total	χ2	p
Level of fracture	Proximal	n	19	11	30		
		%	36.5%	21.2%	57.7%		
	Diaphysis + Distal	n	7	15	22	3.861	**0.049***
		%	13.5%	28.8%	42.3%		
Total %		n	26	26	26		
		%	50.0%	50.0%	50.0%		
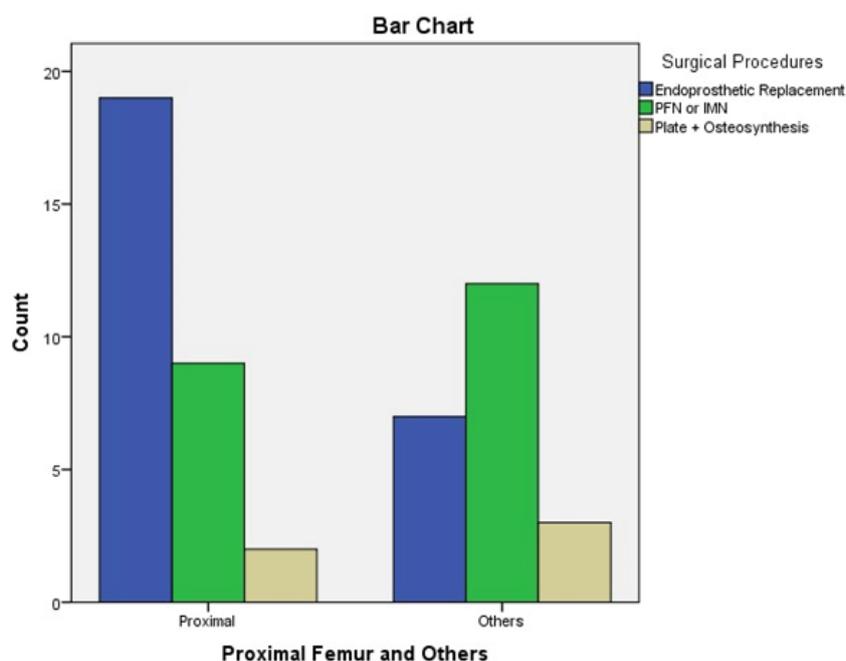
Fig. 1 — Distribution of surgical procedures for pathologic femoral fracture.

(4 cases, 7.7%), hematogenous malignancy metastases (6 cases, 11.5%), unknown primary sites (5 cases, 7.7%), and skin tumor metastasis (1 case, 1.9%) (Table III).

Various surgical procedures were performed, including tumor resection prosthesis or proximal femoral endoprosthetic replacement in 26 patients (50.0%), PFN or IMN in 21 patients (40.4%), and plate and osteosynthesis in five patients (9.6%) (Tables III,V and VI, Figure 1). The endoprosthetic replacement included hemiarthroplasty and total hip arthroplasty in addition to modular tumor/resection and intercalary prostheses. In our study, the endoprosthetic replacement subtypes were hemiarthroplasty (n = 7), total hip arthroplasty (n = 1), modular tumor/resection prosthesis (n = 16), and intercalary prosthesis (n = 2) (Table V).

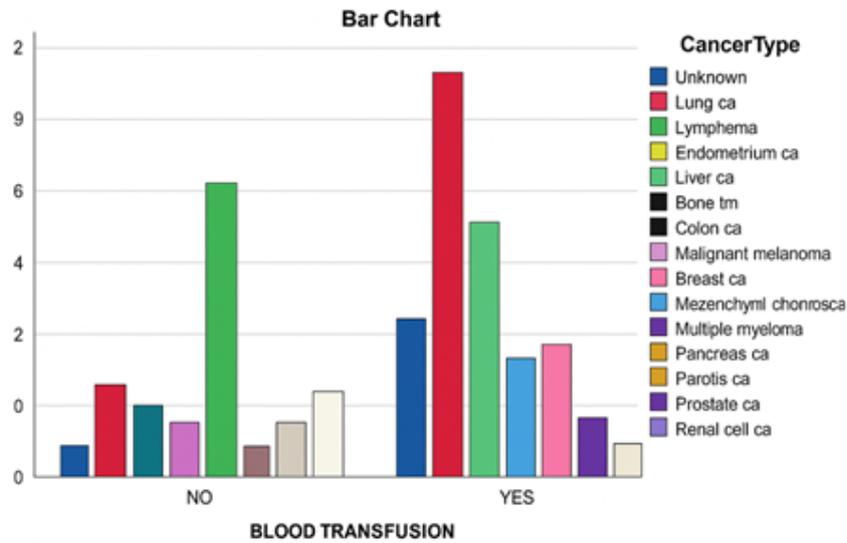Eighteen (34.6%) patients did not receive a blood transfusion, whereas 34 (65.4%) did. Only 5 (9.6%)

Bar Chart

Fig. 2 — Transfusion requirement by primer tumor type.
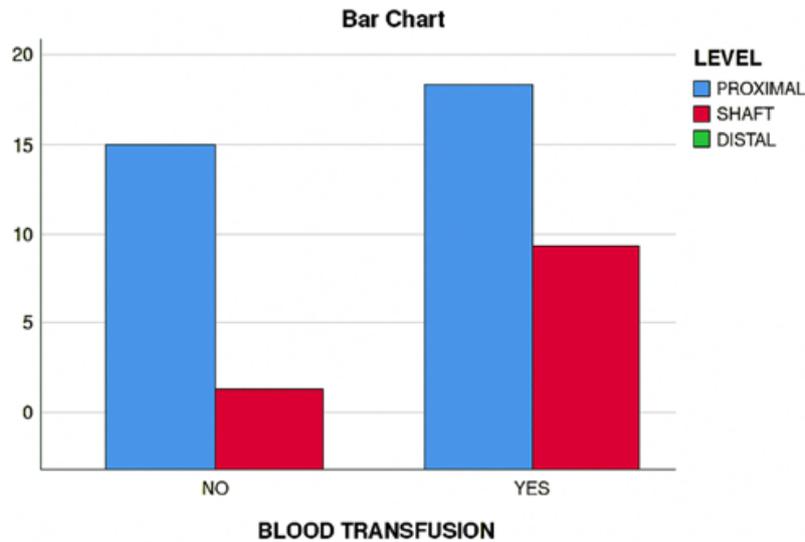
Bar Chart

Fig. 3 — Transfusion requirement by anatomic fracture level.

underwent preoperative embolization, while the remaining 47 patients (90.4%) did not receive this treatment (Table III). Of the 30 patients with pathological fractures of the proximal femur, 16 (53.3%) received blood transfusions (Figure 3). Blood transfusions were administered to 17 (65.4%) of the 26 patients who underwent prosthesis placement (Figure 6.3).

Among patients with metastatic carcinoma confirmed pathologically (n = 32), the primary sites were breast (n = 14; 43.8%), lung (n = 13; 40.6%), renal cell carcinoma (n = 3; 9.4%), prostate (n = 1; 3.1%), and colorectal (n = 1; 3.1%) (Table IV). Thus, breast was the most common carcinoma metastasis accounting for 43.8% (14/32) of the carcinoma group. The highest mortality rate (92.3%) was observed

in fractures due to lung cancer metastasis (12 of 13 patients died).

Due to the lack of skewness and kurtosis in the time between fracture and surgery, and total hospital stay data, non-parametric tests were used. When comparing the time between fracture and surgery across different surgical techniques, the mean duration for endoprosthetic applications was 19.62 ± 18.25 (2-70) days, while the mean time for other surgical techniques was 9.04 ± 7.35 (2–36) days. A statistically significant difference was found between the two groups (p = 0.016).

Surgical duration, survival, blood loss, and Karnofsky scores all demonstrated a normal distribution, and parametric values were utilized for analysis. No statistically significant differences
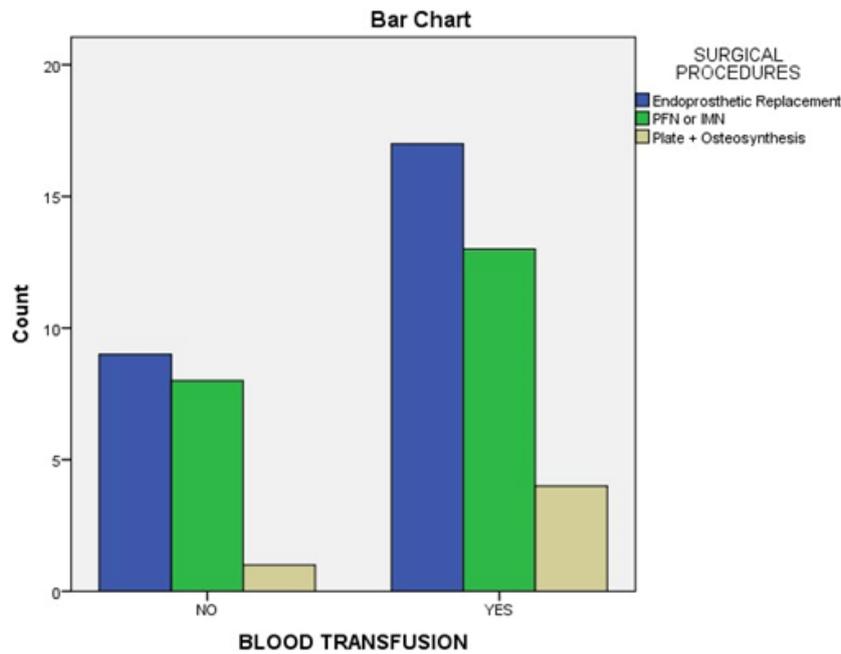
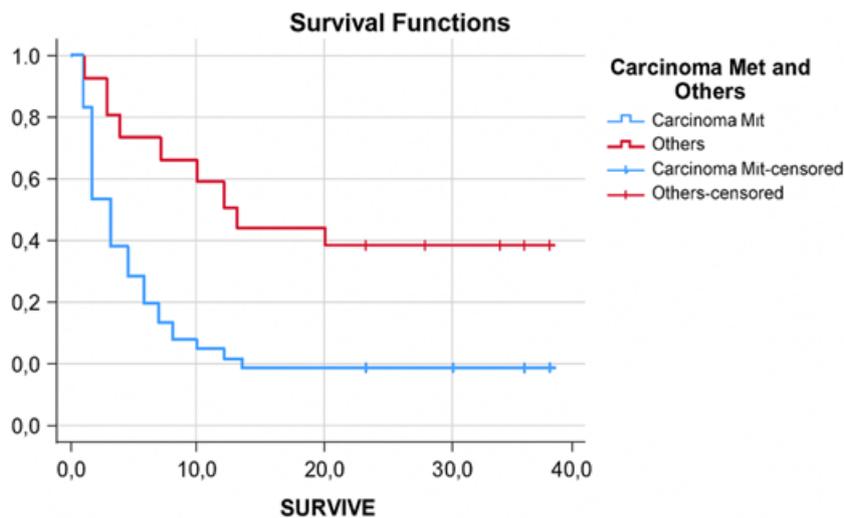*Fig. 4 — Transfusion requirement by surgical method.*

Fig. 5 — Kaplan–Meier survival by pathology category.

were found in these parameters during the statistical analysis.

The highest demand for blood transfusions was observed in patients with actual fractures (28 patients, 53.8%). The greatest need for transfusions occurred in patients with proximal femur fractures (16 patients, 30.8%). The highest number of transfusions was performed in patients who underwent endoprosthetic placement (17 patients, 32.7%). The highest blood transfusion requirement was observed in patients with carcinoma metastasis-related fractures (23 patients, 44.2%). Among these, lung cancer metastasis fractures accounted for the highest number of transfusions (11 patients, 21.2%), followed by breast cancer

metastasis fractures (7 patients, 13.5%). All multiple myeloma patients (4 patients, 7.7%) received blood transfusions.

All patients who underwent preoperative embolization had actual fractures (5 patients, 9.6%). Embolization was performed in all patients with fractures due to renal cell carcinoma metastasis (3 patients, 5.8%; one patient received a transfusion, two did not). All embolized patients received endoprosthetic treatment (5 patients, 9.6%). Statistical analysis did not reveal any significant differences in these groups.

Pathological results revealed various findings, including non-specific results in 6 cases (11.5%),

carcinoma in 32 cases (61.5%), sarcoma metastasis in 2 cases (3.8%), hematogenous malignancy metastasis in 8 cases (15.4%), and others in 4 cases (7.4%) (Table III). All patients included in our study were diagnosed with multimetastatic cancer.

Of the total cohort, while 37 patients (71.2%) died 15 patients (28.8%) survived. The average postoperative survival for deceased patients was 4.51 ± 4.77 months (range: 1-20 months), while surviving patients had a mean follow-up duration of 33.26 ± 5.52 months (range: 23-39 months) (Table III).

Our statistical analysis compared healthy patients with deceased patients. Chi-square analysis revealed that carcinoma metastasis was the most common type of metastasis, with a significantly higher mortality rate compared to other cancer types causing pathological fractures (p = 0.019) (Table VII).

Breast cancer metastasis (8 patients, 15.4%) and lung cancer metastasis (7 patients, 13.5%) fractures most commonly received PFN or IMN. The most frequent endoprosthetic replacement were seen in patients with breast cancer metastasis (5 patients, 9.6%). Statistical analysis did not reveal any significant differences between these groups.

Correlation analysis showed a strong positive correlation between the total length of hospitalization and the time between fracture and surgery (rho = 0.756, p < 0.001). A strong negative correlation was found between the total length of stay and Mirels score (rho = -0.840, p = 0.005). Other data showed weak-to-moderate correlations (Table VI).

Malignancy causing pathological fractures was the most common factor affecting mortality. Carcinoma metastasis was the most frequent malignancy. Survival analysis revealed that the median life expectancy of patients with pathological fractures due to carcinoma metastasis after surgery was 2 months, compared to 21.5 months for other types. Among the 32 patients with carcinoma metastasis, 27 died during follow-up. In the other group, 10 of 20 patients died (Tables IX, X, XI, Figure 5).

Postoperative complications were rare, with only three patients experiencing issues. Two patients had wound-site complications, one of whom was treated through serial debridement, while the other patient died before debridement. The third patient developed

Table VII. — Mortality status (deceased vs alive) by fracture pattern, sex, fracture level, surgical method, transfusion, and pathology (chi-square analysis).

		SURVIVAL STATUS		Total	χ^2	p
		DEATH	ALIVE			
		Number %	Number %	Number %		
Fracture Pattern	Impending	5 9.6%	4 7.7%	9 17.3%		0.419
	Actual	32 61.5%	11 21.2%	43 82.7%		
Gender	Male	16 30.8%	7 13.5%	23 44.2%	0.000	1.000
	Female	21 40.4%	8 15.4%	29 55.8%		
Level of Fracture	Proximal	20 38.5%	10 19.2%	30 57.7%	0.275	0.600
	Others	17 32.7%	5 9.6%	22 42.3%		
Surgery Method	Endoprosthetic Replacement	17 32.7%	9 17.3%	26 50.0%	0.375	0.540
	Osteosynthesis	20 38.5%	6 11.5%	26 50.0%		
Blood Transfusion	No	12 23.1%	6 11.5%	18 34.6%	0.039	0.843
	Yes	25 48.1%	9 17.3%	34 65.4%		
Pathologic Result	Carcinoma	27 51.9%	5 9.6%	32 61.5%	5.510	0.019*
	Others	10 19.2%	10 19.2%	20 38.5%		

Table VIII. — Correlation matrix among clinical and perioperative variables (Spearman correlation test).

		Impending / Actual Fracture	Mirels' Score	Ex	Age	Gender	Cancer Type	Survival	Level	Surgical Procedure	Fracture-to-Surgery Time (days)	Operative Time (min)	Total Hospital Stay (days)	Blood Transfusion	PREO-PHB
Age	C. C.	,283*													
	p	0,040													
Survival	C. C.			,805**											
	p			0,000											
Surgical procedure	C. C.								,306*						
	p								0,026						
Time from Fracture to Surgery (days)	C. C.	,342*								-,384**					
	p	0,012								0,005					
Operation Time (min)	C. C.				,320*										
	p				0,021										
Total Hospital Stay (days)	C. C.	,273*	-,840**					-,318*		-,310*	,760**	,276*			
	p	0,048	0,005					0,020		0,024	0,000	0,048			
Postop hb	C. C.								-,300*					-,538**	,402**
	p								0,029					0,000	0,003
Embolization	C. C.						,333*			-,306*		,294*			
	p						0,015			0,026		0,034			
Pathology Result	C. C.			,331*	-,327*			,278*		-,350*	,272*		,316*		
	p			0,015	0,017			0,044		0,010	0,049		0,021		
C. C. : Correlation Coefficient.															

hematoma accumulation at the wound site, which was drained by the Department of Interventional Radiology.

DISCUSSION

In our study, the mean age of patients was 60 years, and the cohort included 47 individuals with 53 pathological femoral fractures. Proximal femoral fractures were the most frequently observed (58.5%) and were predominantly caused by carcinoma metastases (60.4%). Breast (26.4%) and lung (24.5%) cancer metastases were the most common primary tumor types. Among patients with breast cancer metastases who underwent surgery, 9 (64.3%) died, while 5 (35.7%) remained under follow-up. In contrast, among patients with lung cancer metastases, 12 (92.3%) died postoperatively, and only 1 patient (7.7%) survived. All patients included in our study were diagnosed with multimetastatic cancer. Surgical procedures, including tumor resection, prosthetic replacement, and endoprosthetic reconstruction, were performed in 51% of cases. A substantial proportion of patients (66%) required perioperative blood transfusion. Despite these interventions, the postoperative mortality rate was 70%, with a mean survival of 4.5 months.

The relatively low fracture rate observed in our study can be attributed to a combination of clinical and institutional factors. A significant proportion of oncology patients were referred to our center at advanced stages of the disease, often after pathological fractures had already occurred, thereby limiting the opportunity for pre-fracture risk assessment. Additionally, we adopted a stricter threshold for identifying impending fractures, using a Mirels score of ≥9, whereas some studies in the literature have applied lower cut-off values, such as ≥8.

The incidence of pathological fractures due to primary malignancies varies depending on tumor histology. Rajković et al.[7] reported that breast (36.1%),

Table IX. — Life-table analysis of survival by pathology category with Breslow test.

Life Table Results			
Pathologic Result	Median Survival	Breslow	p value
Carsinoma Met	2.0	11.258	0.001*
Others	21.5		

Table X. — Mortality counts and proportions by pathology category.

Pathologic Result	Total N	Number of Death	Number of Survivors	
			N	Percent
Carsinoma Met	32	27	5	15.6%
Others	20	10	10	50.0%
Total	52	37	15	28.8%

Table XI. — Estimated survival (months) with 95% confidence intervals by pathology category.

			%95 Confidence Interval	
Pathologic Result	Estimate	Standart Error	Lower Bound	Upper Bound
Carsinoma Met	8.813	2.292	4.320	13.305
Others	23.250	3.650	16.097	30.403
Overall	14.462	2.235	10.080	18.843

lung (24.5%), kidney (14.5%), prostate (13.1%), colorectal (2.9%), and other cancers (8.9%) were the most prevalent primary tumors causing such fractures. Similarly, Christ et al.[5] found that lung (24.8%), prostate (19.4%), breast (19.3%), gastrointestinal (9.4%), and urological (6.5%) cancers most commonly led to metastatic bone disease. They also noted that renal (5.8%), myeloma (3.4%), gynecological (3.2%), lung (2.8%), and breast (2.7%) cancers were the most frequent sources of long bone pathological fractures. Saad et al. 6 further highlighted that multiple myeloma had the highest fracture incidence (43%), followed by breast (35%), prostate (19%), and lung cancer (17%). In line with these findings, our study identified carcinoma metastases, particularly those originating from the breast and lung, as the primary etiologies of pathological femoral fractures.

Pathological fractures of the proximal femur often require surgical intervention for pain relief and functional restoration[10]. Treatment decisions should be guided by both oncological and functional considerations, including patient survival expectations, local recurrence risks, pain control, and mobility outcomes[11,12]. Endoprosthetic replacement is increasingly preferred in cases of significant bone destruction due to its ability to provide immediate structural integrity, early mobilization, and weight-bearing[8,13]. Intramedullary nailing remains a viable option for diaphyseal involvement or when

extensive surgery is not feasible[14,15]. Modular tumor megaprostheses, especially in oligometastatic patients, offer a personalized and effective solution[10]. Nevertheless, complications such as dislocation and infection underscore the need for multidisciplinary care and detailed preoperative planning[10]. Importantly, the nature of the primary malignancy significantly influences treatment strategies[16]. Prophylactic fixation, guided by scoring systems like Mirels, has demonstrated benefits in preserving functional independence[17]. Hemiarthroplasty continues to serve as a durable and effective option for palliation in terminal-stage patients, offering pain control and mobility[18]. In our series, 51% of patients (n = 27) underwent tumor resection, prosthetic implantation, bipolar hemiarthroplasty, or intercalary prosthesis. Among these, 74% (n = 20) had proximal femoral fractures. Additionally, IMN or PFN was performed in 40% (n = 21) of patients, while plate-screw osteosynthesis was the least preferred method (n = 5, 9.4%). Bone cement was utilized in most surgical procedures.

The management of femoral diaphyseal pathological fractures necessitates a comprehensive evaluation, incorporating factors such as anticipated survival, extent of bone involvement, and patient preferences[19]. Intramedullary fixation offers effective pain control and enables early ambulation with minimal operative stress[16,20]. The necessity of prophylactic stabilization

of the femoral neck remains a topic of ongoing debate[20]. Reconstruction following wide resection must be tailored to the defect's location and size[21]. Total femoral replacement may be indicated in extensive tumor infiltration, although it carries increased procedural risk[22]. Intercalary prostheses are emerging alternatives for diaphyseal defects[23,24]. Post-radiation fracture risk, especially following sarcoma treatment with radiotherapy, mandates vigilant follow-up. Radiofrequency ablation offers palliative benefits in benign or advanced malignant cases. Distal femoral metastases or primary tumor-related fractures also require individualized surgical planning based on survival expectations and desired functional outcomes[25]. Several studies have enriched the literature by detailing nuanced management approaches and their outcomes[25-28]. In our study, two patients received intercalary prostheses; however, both succumbed to their illness.

Survival in patients with pathological femoral fractures varies considerably and depends on tumor type, therapeutic approach, and patient-related factors[29]. Chandrasekar et al.[30] demonstrated that patients with primary bone tumors had significantly better outcomes than those with metastases, with one- and five-year survival rates of 63.6% and 23.1%, respectively. Sarahrudi et al.[15] reported a median survival of 3.7 months in patients undergoing surgery for metastatic femur fractures. Parker et al.[31], in a study of 145 patients with proximal femoral metastases, observed a mean survival of 332 days, with prognosis varying by tumor histology. Mavrogenis et al.[32] found improved survival in patients undergoing surgery for impending fractures, with a median survival of 18 months.

Märdian et al.[33] reported a mean overall survival of 17.5 months in patients treated with intramedullary nails for femoral metastases. Tanaka et al.[34] also showed sustained implant survival post-intramedullary fixation, with two- and three-year postoperative survival rates of 14.2% and 8.4%, respectively. Effective management requires integration of radiographic assessment and multidisciplinary surgical planning. Angelini et al.[10] emphasized the importance of incorporating prognostic variables into surgical decision-making to enhance both survival and quality of life. Sofulu et al.[35] reported a one-year survival rate of 72% and a five-year survival rate of 10% in patients who underwent endoprosthetic reconstruction for actual or impending proximal femoral fractures. Additionally, prosthetic survival was reported at 100% at one year

and 97.3% at five years. Urban et al.[36] contributed further insights into optimizing treatment strategies to improve both survival and functional outcomes. In our cohort, the median survival was 12 months for patients with proximal fractures, one month for those with diaphyseal fractures, and 16 months for those with distal involvement.

This study has several limitations. Its retrospective nature, single-center scope, and relatively small sample size may limit the generalizability of the findings. Future research should aim for multicenter collaboration with larger patient cohorts to validate these results and explore long-term outcomes of various surgical strategies.

CONCLUSION

This study highlights the significant morbidity and mortality associated with pathological femoral fractures, particularly those caused by metastatic carcinoma. Proximal femoral fractures were the most frequent, and breast and lung cancers emerged as the predominant primary malignancies. Despite surgical interventions, ranging from endoprosthetic reconstruction to intramedullary nailing, postoperative survival remained limited, with a median overall survival of only 4.5 months. The prognosis was especially poor in patients with lung cancer metastases. Surgical management should be individualized, taking into account tumor type, anatomical location, expected survival, and functional goals. Although endoprosthetic and modular prosthetic solutions offer early mobilization and improved quality of life, survival outcomes remain influenced by oncological burden. These findings underscore the need for multidisciplinary evaluation and careful preoperative planning to optimize patient outcomes. Further multicenter, prospective studies are warranted to refine treatment algorithms and identify prognostic factors that can better guide surgical decision-making in this complex patient population.

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