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Fibulectomy for primary fibular tumors
A Decade of experience at the National Cancer Institute, Egypt

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ABSTRACT

Primary fibular tumors, whether benign or malignant, are uncommon and include entities such as osteochondroma, giant cell tumor, aneurysmal bone cyst, Ewing sarcoma, and osteosarcoma. Optimal management depends on careful radiological assessment to guide precise surgical planning and achieve adequate oncological outcomes. This study assessed surgical technique with post-treatment sequelea and survival analysis for fibular tumors. This retrospective study analyzed 22 patients with primary fibular tumors who underwent surgical resection at the National Cancer Institute, Cairo University, Egypt, between January 2013 and January 2023, evaluating clinical characteristics, treatment modalities, surgical techniques, postoperative sequelae, and survival outcomes. All patients presented with leg swelling, and the proximal fibula was the most frequently involved site (81.8%), followed by the distal fibula and diaphysis (each 9.1%). Osteosarcoma was the most common histopathological diagnosis (40.9%), followed by Ewing sarcoma (27.3%), giant cell tumor (22.7%), and chondrosarcoma (9.1%). Neoadjuvant therapy was administered in 68.2% of cases. Surgical management included proximal fibulectomy in 36.4% of patients, segmental resection in 27.3%, and above-knee amputation in 13.6%, with preservation of the common peroneal nerve achieved in 68.2% of patients. With a median follow-up of 32 months, the overall recurrence rate was 50%, including 22.7% among osteosarcoma cases. Overall survival rates at one, two, and three years were 94.4%, 75.4%, and 50.2%, respectively, while event-free survival rates at one, two, and three years were 79.4%, 56.3%, and 42.9%. The fibula presents unique surgical challenges due to its anatomical relationship with critical neurovascular structures, particularly the common peroneal nerve, and its contribution to knee and ankle stability; therefore, meticulous preoperative planning and appropriate surgical techniques are essential to achieve safe tumor resection with adequate margins, as inadequate surgery is strongly associated with tumor recurrence.

Keywords: fibula, fibular tumors, fibulectomy, peroneal nerve, osteosarcoma.

INTRODUCTION

Primary tumors of the fibula are rare, accounting for approximately 2.5% of bone tumors occurring in the extremities[1]. The proximal third of the fibula is affected more frequently than the middle or distal thirds[2]. The most commonly reported tumors include osteochondroma, giant cell tumor, osteosarcoma, and Ewing sarcoma. Although 50–75% of fibular tumors are benign, malignant lesions are associated with significant morbidity and mortality[3].

Preoperative evaluation of fibular tumors requires detailed imaging to define tumor extent and its relationship to surrounding structures. Magnetic resonance imaging (MRI) and computed tomography (CT) scans are routinely used, and angiography may be required in selected cases. In patients with suspected malignant tumors, staging investigations typically include chest CT to assess pulmonary metastasis, technetium-99m methylene diphosphonate bone scanning to detect skeletal involvement, and histopathological grading to determine tumor aggressiveness[4].

Because many fibular tumors are locally aggressive or malignant, wide surgical excision is often required to achieve adequate oncologic margins[5]. However, preservation of limb function and maintenance of knee, ankle, and foot stability remain key surgical goals[6]. Resection of tumors in the proximal fibula is particularly challenging due to the close proximity

of critical neurovascular and ligamentous structures, including the tibial vessels, the common peroneal nerve, and the lateral collateral ligament complex[7].

Two types of en bloc resection of the proximal fibula were described by Malawer. Type I (marginal resection) involves removal of the proximal fibula with a 2–3 cm segment of the diaphysis and the surrounding muscle attachments. In contrast, Type II (wide extra-compartmental resection) includes removal of the proximal fibula with 5–6 cm of the diaphysis, the anterior and lateral muscle compartments, the anterior tibial artery, and the common peroneal nerve[8].

MATERIALS AND METHODS

This retrospective cohort study included 22 consecutive patients with primary fibular tumors who were diagnosed and surgically treated at the National Cancer Institute (NCI), Cairo University, between January 2013 and January 2023. Inclusion criteria were histologically confirmed primary fibular bone tumor (benign aggressive or malignant), arising from any segment of the fibula (proximal, diaphyseal, or distal), with complete preoperative imaging and staging work-up. Metastatic diseases to fibula were excluded from this study. Investigations for local assessment and systemic staging were done including (MRI of the affected leg to assess intraosseous extent, soft tissue extension, joint involvement, and neurovascular proximity or encasement, with chest CT "computed tomography" and Tc 99m bone scan to exclude pulmonary and skeletal metastases). Data on demographic characteristics (age, gender), tumor location, size, histological type, radiodiagnostic imaging, surgical resection types, and complications were assessed. Surgical margins were assessed histologically according to standard oncological criteria. R0 resection was defined as complete tumor excision with microscopically negative margins (no residual tumor). R1 resection was defined as complete macroscopic tumor excision with microscopic residual disease present at the margin. All patients were followed up during the study period.

RESULTS

The cohort included 11 males (50%) and 11 females (50%), with a median age of 21 years (range, 9–46 years). The patient flow diagram is presented in Figure 1. All patients presented with lower-limb swelling (100%). Tumor characteristics according to anatomical location and laterality are summarized in Table I.

Preoperative imaging with MRI and CT demonstrated purely osseous lesions in 13 patients (59%). Soft-tissue extension was observed in five patients (22.7%), while three patients (13.6%) showed definite neurovascular involvement. One patient (4.5%) presented with purely intramedullary disease.

The pathological types of fibular tumors in this cohort are listed in Table II.

Neoadjuvant therapy was administered to 15 patients (68.2%) diagnosed with Ewing sarcoma or osteosarcoma. The surgical procedures performed and associated complications are summarized in Table III. No major postoperative complications were recorded. Hematoma formation occurred in two patients (9%), and partial wound dehiscence occurred in another two patients (9%); both complications were managed conservatively with repeated wound dressings.

Postoperative common peroneal nerve palsy occurred in two patients (9%) following limb-salvage surgery. In both cases, the deficit represented transient neurapraxia, with complete neurological recovery within 4–6 months. No permanent motor deficits or sensory loss were documented. Among the 15 patients in whom the nerve was preserved, postoperative neurological function remained intact in 13 patients (86.6%).

The common peroneal nerve was preserved in 15 patients (68.2%) and sacrificed in 7 patients (31.8%) due to direct tumor infiltration of the neurovascular bundle. Among these seven patients, four underwent amputation, whereas three underwent wide en bloc resection with nerve excision.

Among the eight patients who underwent proximal fibulectomy, the lateral collateral ligament (LCL) and posterolateral corner (PLC) were preserved and reattached in one case (12.5%) using tibial-based fixation techniques. In the remaining seven cases (87.5%), oncological considerations required resection of these structures. Despite this, no clinical knee instability was documented during follow-up, and no secondary reconstructive ligament procedures were required.

Histopathological assessment confirmed negative surgical margins (R0) in 16 patients (72.7%) and microscopically positive margins (R1) in 6 patients (27.3%). R1 resections occurred predominantly in tumors with neurovascular or soft-tissue encasement, most commonly osteosarcoma (n = 3) and Ewing sarcoma (n = 2). All three chondrosarcoma cases achieved R0 margins (Table IV).

Tumor relapse occurred in 11 patients (50%). Patterns of recurrence and their management are detailed in Tables V and VI.

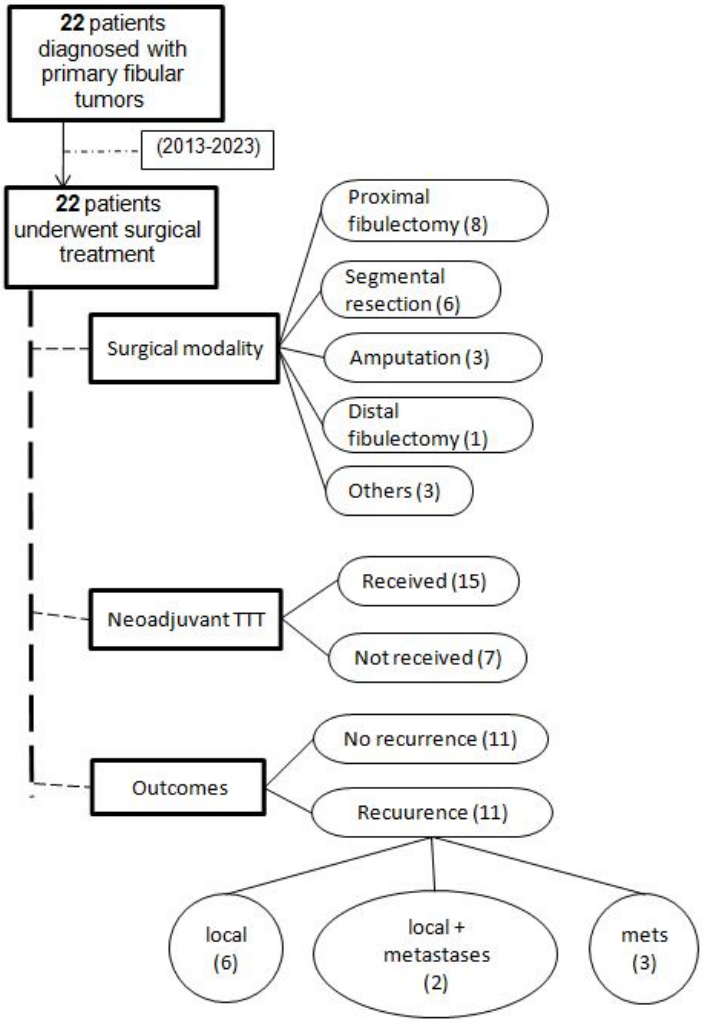

Fig. 1 — Flowchart of patient enrollment, surgical management, and outcomes for patients with primary fibular tumors treated between January 2013 and January 2023.

Table I. — Laterality and Site characteristics.

Characteristics		Number	%
Laterality	Left	12	54.4
	Right	10	45.5
Site	Proximal	18	81,8
	Distal	2	9.1
	Shaft (Mid 1/3)	2	9.1

Table II. — Pathology of Fibular Tumors.

Pathology	Number	%
Osteosarcoma	9	40.9
Ewing sarcoma	6	27.3
Giant Cell Tumor	5	22.7
Chondrosarcoma	2	9.1

Table III. — Type of Surgical Intervention and Complications.

		Number	%
Type of Surgery	Proximal Fibulectomy	8	36.4
	Segmental resection	6	27.3
	Intralesional resection	2	9.1
	Distal Fibulectomy	1	4.5
	Total Fibulectomy	1	4.5
	Above Knee Amputation	3	13.6
	Below knee Amputation	1	4.5
Coplications	Hematoma	2	9.1
	Partial wound dehiscence	2	9.1
	Transient peroneal nerve palsy	2	9.1
	Mechanical instability	0	0
	Vascular Injury	0	0

Table IV. — Surgical Margins by Histology.

Histological Type (n)	Wide/Clear Margins (n, %)	Close/Positive Margins (n, %)
Osteosarcoma (9)	6 (66.7%)	3 (33.3%)
Ewing's Sarcoma (5)	3 (60%)	2 (40%)
Giant Cell Tumor (5)	4 (80%)	1 (20%)
Chondrosarcoma (3)	3 (100%)	0 (0%)

The follow-up duration ranged from 12 to 134 months, with a median of 32 months. The overall survival rates at 1 and 2 years were 94.4% and 75.4%, respectively, decreasing to 50.2% at 3 years. Event-free survival rates at 1 and 2 years were 79.4% and 56.3%, respectively, declining to 42.9% at 3 years (Table VII). Kaplan–Meier survival curves for event-free survival and overall survival are presented in Figures 2 and 3.

DISCUSSION

At our cancer institute, multidisciplinary team (MDT) meetings are regularly conducted and include different specialties as pediatric oncology, medical oncology, radiology, and surgical oncology. This collaborative environment facilitates coordinated treatment planning and reflects the relatively high proportion of sarcoma patients in our cohort.

Consistent with previous reports, most fibular tumors in our study involved the proximal third of the bone. Gumustas Murat et al.[9] reported that proximal fibular involvement was the most frequent (61%), followed by distal (27%) and diaphyseal locations (11%). In our series, proximal fibular tumors accounted for 81.8% of cases. All patients presented with proximal leg swelling (Figure 4), emphasizing the importance of careful clinical examination. Magnetic resonance imaging (MRI) proved essential for evaluating tumor extent, joint involvement, and neurovascular relationships (Figure 5).

The most common pathological type in our cohort was osteosarcoma, representing 40.9% of cases, followed by Ewing sarcoma (27.3%), giant cell tumor (22.7%), and chondrosarcoma (9.1%). The predominance of malignant sarcomas enriched our series by including diverse management strategies, including neoadjuvant and adjuvant therapy, various surgical techniques, and the management of recurrent or metastatic disease.

In contrast, Arikan Yavuz et al.[10] reported that the most common fibular tumors were osteochondroma (24.4%) and chondrosarcoma (29.1%), followed by enchondroma (17.7%) and aneurysmal bone cyst (17.3%). This discrepancy may be explained by the fact that benign fibular tumors are frequently asymptomatic and therefore may remain underreported or undiagnosed.

Neoadjuvant therapy was administered in 68.2% of our patients, in accordance with established treatment protocols for osteosarcoma and Ewing sarcoma. Induction chemotherapy plays a critical role in reducing tumor burden, facilitating limb-sparing procedures, and increasing the likelihood of achieving wide surgical margins.

Surgical management for most fibular tumors involves wide excision with adequate oncological

Table V. — Patterns and Management of Recurrences.

			Number	%
Patterns of Recurrence		Distant	5 (Lung Mets 3, Bone Mets 2)	2.7
		Local	3	3.6
		Local and Distant	3	3.6
Management of Recurrence	Local recurrence	Surgical Treatment	3 (Above Knee Amputations 2, Wider resection 1)	3.6
	Distant Lung Metastases	Lung Metastasectomy + Chemotherapy	3	3.6
	Local & Distant Metastases	Chemotherapy	3	3.6

Table VI. — Recurrences according to Pathology.

Diagnosis	Number of recurrences & (%)	Pattern of Recurrences
Osteosarcoma	5 (22.7%)	2 (local & lung mets) 2 (lung mets) 1 (local)
Ewing sarcoma	3 (13.6%)	2 (lung and bone mets) 1 (local & lung mets)
Giant Cell Tumor	2 (9%)	Local
Chondrosarcoma	1 (4.5%)	Lung mets

Table VII. — Survival Rates.

Survival			Survival (%)			
	N	n of events	1 year	2 years	3 years	Median
Overall Survival	19	7	94.4	75.4	50.2	*
Event Free Survival	21	11	79.4	56.3	42.9	28

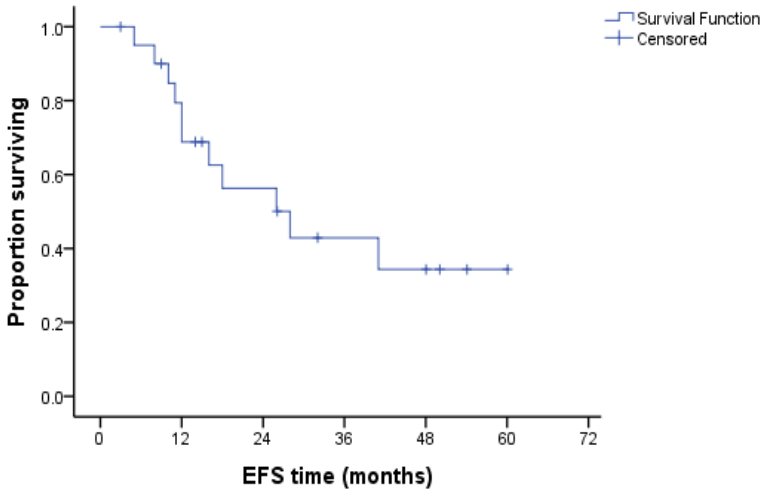

Fig. 2 — Kaplan–Meier curve showing event-free survival (EFS) of patients with primary fibular tumors. Time zero was defined as the date of surgical resection. Tick marks represent censored observations. Numbers of patients at risk are shown below the x-axis. The median EFS was 28 months (95% CI: 18.6–37.4 months).

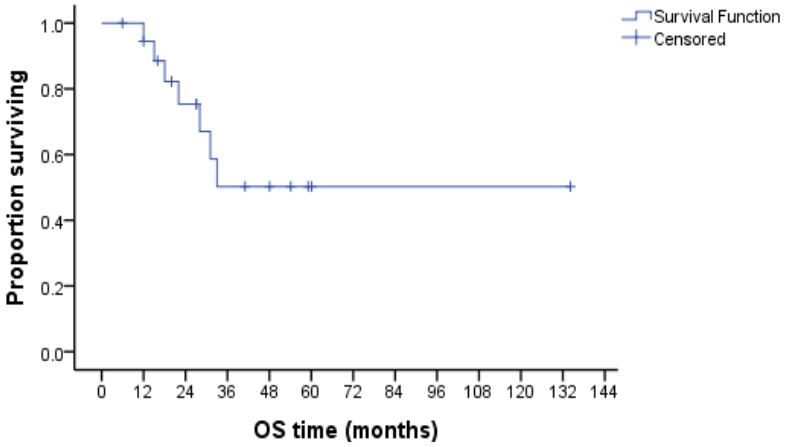

Fig. 3 — Kaplan–Meier curve illustrating overall survival (OS) following surgical treatment of fibular tumors. Survival time was calculated from the date of surgery to death or last follow-up. Tick marks indicate censored data. Numbers at risk are displayed beneath the plot. Median OS was not reached; three-year OS was 50.2%.

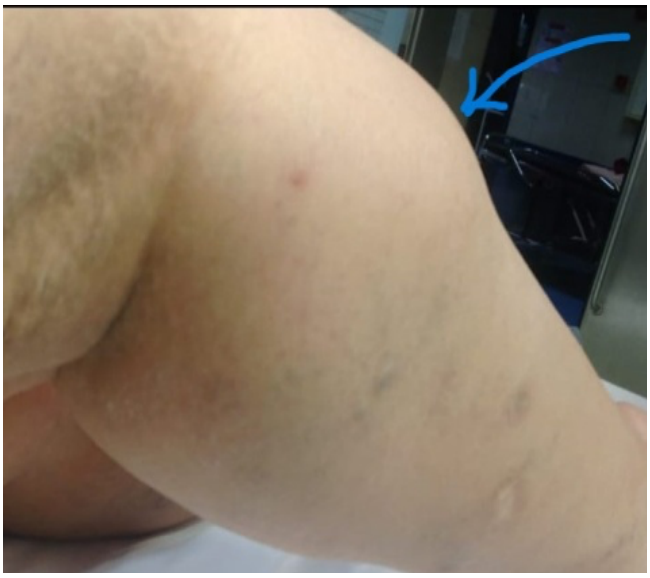

Fig. 4 — Clinical photograph showing proximal leg swelling in a patient with a right proximal fibular tumor (blue arrow).

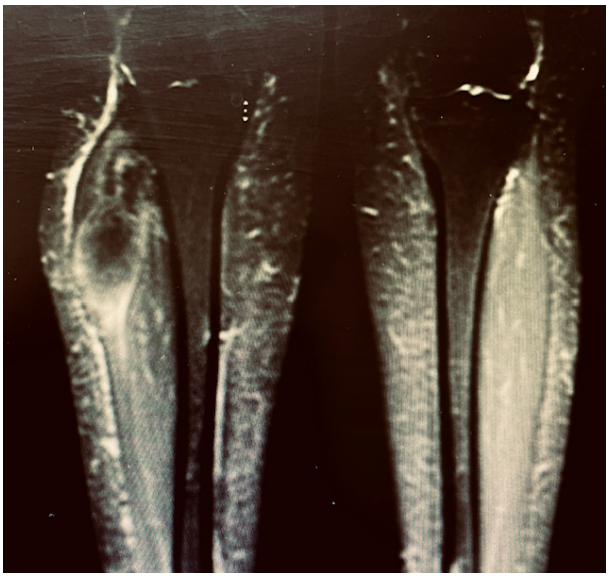

Fig. 5 — T2-weighted MRI demonstrating a giant cell tumor of the proximal fibula.

margins. Depending on tumor size, anatomical extent, and pathological type, surgery may involve en bloc wide resection or marginal excision (Figure 6). Proximal fibulectomy was performed for tumors confined to the proximal third without circumferential neurovascular encasement, whereas segmental resection was indicated for diaphyseal fibular tumors with limited soft-tissue extension. Amputation was reserved for tumors with definite neurovascular invasion or massive local recurrence.

The common peroneal nerve represents a critical anatomical structure during proximal fibular tumor surgery. It arises as one of the terminal branches of the sciatic nerve and passes beneath the peroneus longus muscle. During surgical exposure, the articular branch to the knee joint was sacrificed and the peroneus longus tunnel was unroofed to allow safe mobilization of the nerve (Figure 7).

In cases of locally aggressive tumors, meticulous dissection was performed to preserve the common peroneal nerve whenever feasible. However, when performing Type II resections—particularly when tumors involved the nerve together with the anterior tibial or peroneal vessels—the nerve was sacrificed to ensure complete oncologic resection with negative margins (Figure 8). According to Malawer Michael M., Type II resection is indicated for high-grade sarcomas involving the common peroneal nerve and

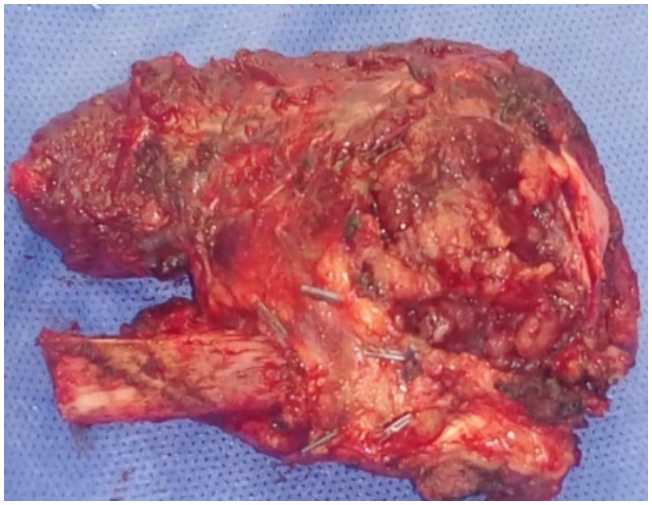

Fig. 6 — Gross proximal fbular resection specimen with surrounding soft tissues from a patient with giant cell tumor.

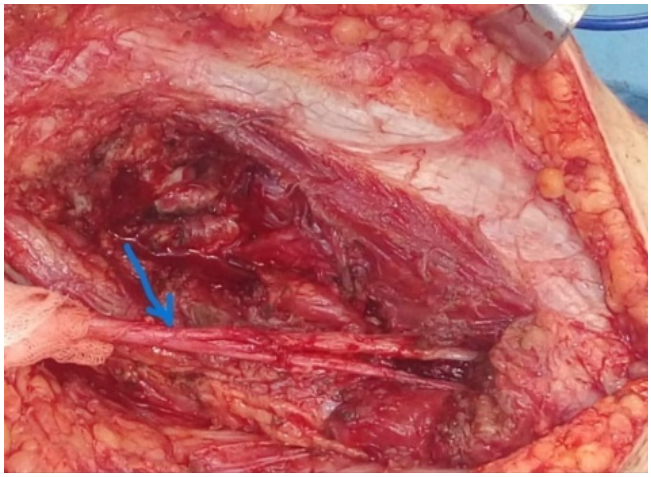

Fig. 7 — Intraoperative view following proximal fibulectomy showing preservation of the common peroneal nerve and its superficial and deep branches (blue arrow).

the anterior and lateral muscle compartments[11].

Functional preservation remains a major objective in fibular tumor surgery. In our series, transient peroneal nerve palsy occurred in 13.6% of patients, which is lower than rates reported in the literature, ranging from 3% to 57%[12]. Importantly, all cases in our cohort recovered spontaneously without permanent deficits. Erler Kadir et al.[6] reported that traction of the nerve branches during intraoperative dissection may lead to temporary neuropraxia, typically resolving within six months.

Historically, amputation was the standard treatment for aggressive fibular tumors; however, advances in systemic therapy and surgical techniques have allowed limb-sparing procedures to become the preferred approach[13]. In our study, only one patient (4.5%) required below-knee amputation due to extensive tumor infiltration of the tibiofibular trunk and its bifurcation.

When tumor proximity prevented preservation of stabilizing structures during proximal fibulectomy (n = 7), the lateral collateral ligament (LCL) and posterolateral corner (PLC) were resected en bloc with the tumor. These patients were managed postoperatively with functional bracing and did not develop symptomatic knee instability. When oncologically feasible (in one case), the LCL insertion was reconstructed using transosseous sutures into the lateral tibial metaphysis, with the knee positioned at 30° of flexion and neutral rotation during fixation. The PLC soft-tissue sleeve, including the biceps femoris tendon and arcuate complex, was reattached to adjacent capsular and fascial structures to restore posterolateral stability.

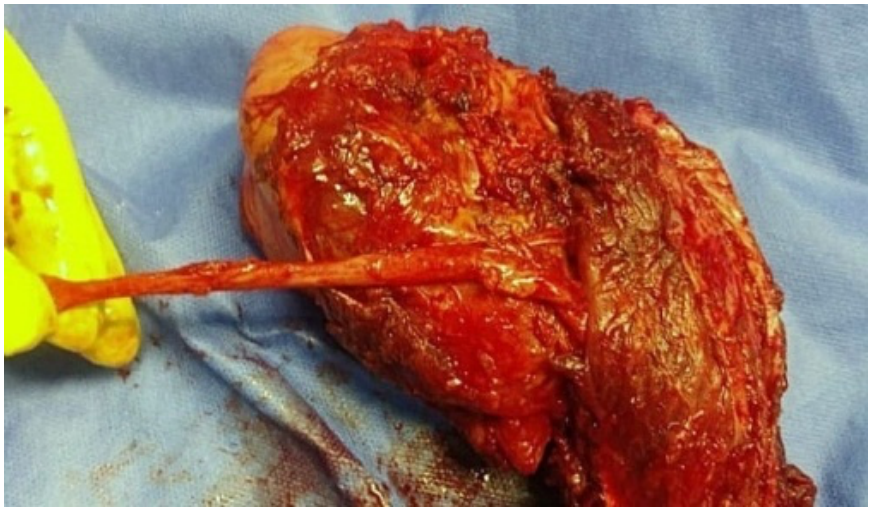

Fig. 8 — Type II proximal fibular resection for chondrosarcoma showing sacrifice of the common peroneal nerve (held by gloved hand).

Reported recurrence rates for fibular tumors in the literature vary widely, ranging from 22.7% to 67%[14]. These variations may be attributed to differences in tumor pathology, as malignant tumors demonstrate a higher propensity for recurrence, particularly when associated with inadequate surgical margins or suboptimal surgical techniques.

The median follow-up period in our study was 32 months. The overall recurrence rate was relatively high (50%), which can be explained by the predominance of malignant tumors in our cohort. Even giant cell tumors, although classified as benign, are locally aggressive and may have recurrence rates approaching 53%[15]. Local recurrence, either isolated or associated with distant metastasis, occurred in 27.2% of cases.

Guo Chao et al.[16] reported a lower local recurrence rate of 7.7%; however, this difference may be explained by the fact that 84.6% of their cohort consisted of benign tumors, whereas only 15.4% were malignant.

When recurrence patterns were analyzed by pathological subtype, recurrence was highest among patients with Ewing sarcoma (60% of five cases) and osteosarcoma (55% of nine cases). These findings are comparable to those reported by Sabharwal Sanjeev et al.[17] in their series of malignant proximal fibular tumors, which demonstrated a recurrence rate of approximately 50% among osteosarcoma patients following resection. These observations suggest that fibular osteosarcoma may have a less favorable prognosis compared with tumors arising in other skeletal locations.

Among patients with locally recurrent osteosarcoma in our series, three underwent further surgical intervention (two above-knee amputations and one extended resection), while two patients with pulmonary metastases underwent lung metastasectomy. Similarly, Takahashi Shinji et al.[18] emphasized that wide resection with optimal bony and soft-tissue margins during the initial surgery is associated with improved prognosis in fibular osteosarcoma.

Overall survival in our cohort was 94.4% at one year, declining to 50.2% at three years. Event-free survival was 79.4% at one year and 42.9% at three years, with a median event-free survival of 28 months. These findings highlight the importance of close postoperative surveillance, aggressive adjuvant therapy, and timely surgical management of recurrences when feasible.

CONCLUSION

Resection of fibular tumors presents unique surgical challenges due to the fibula's anatomical contribution to knee and ankle stability and its close relationship to critical neurovascular structures, particularly the common peroneal nerve. Careful surgical planning is therefore essential to achieve adequate oncological margins while preserving limb function.

Optimal surgical management depends on multidisciplinary team (MDT) decision-making and the experience of the operating surgeon. With meticulous preoperative planning and appropriate surgical technique, fibular tumors can be resected safely despite these anatomical complexities, thereby improving oncological outcomes and functional preservation.

Limitations

Data of this retrospective study were dependent on the accuracy and completeness of medical records, and treatment decisions were not standardized prospectively. The small sample size limits statistical power and restricts subgroup analysis according to tumor type and surgical technique. Assessment of knee stability and neurological recovery was based primarily on clinical documentation rather than objective functional testing. Therefore, although limb preservation and nerve recovery were satisfactory in our cohort, the functional results should be interpreted with caution. Prospective studies with standardized functional assessment tools and longer follow-up are warranted.

Conflict of Interest: The authors declare no conflicts of interest.

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Ethical Approval: Institutional Review Board approval was obtained from the National Cancer Institute, Cairo University (approval number 202101-04-10001; issue date 17 January 2021). All procedures were performed in accordance with institutional and international ethical standards and the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from all patients or their legal guardians prior to inclusion in the study and prior to treatment.

Data Availability: Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Authors' Contributions: All authors contributed to study conception, data acquisition, analysis, interpretation, drafting, and critical revision of the manuscript. All authors approved the final version and take responsibility for the integrity of the work as a whole.

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