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SYMPOSIUM: HIGHLIGHTS OF THE ISOLS/MSTS 2009 MEETING

Surgical Management of 121 Benign Proximal Fibula Tumors

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Abstract

Background Tumors of the fibula comprise only 2.5% of primary bone lesions. Patients with aggressive benign tumors in the proximal fibula may require en bloc resection. Peroneal nerve function, knee stability, and recurrence are substantial concerns with these resections. The incidence and fate of these complications is not well-known owing to the small numbers of patients in previous reports.

Questions/purposes We therefore analyzed the incidence of peroneal nerve palsy, knee stability, and local recurrence following surgical treatment of benign proximal fibula tumors.

Methods We retrospectively reviewed the charts of 120 patients (121 tumors) with histologically confirmed aggressive benign tumors of the proximal fibula. There were 56 males and 64 females with an average age of 24 years (range, 2–64 years). The most common diagnosis was osteochondroma (38%) followed by giant cell tumor (19%). Pain (94%), palpable mass (39%), and peroneal nerve symptoms (12%) were the most common presenting symptoms. Of the 121 tumors, 56 (46%) underwent en bloc resection. The minimum followup was 2 years (mean, 9 years; range 2 to 49 years; median, 7.4 years).

Results Postoperative complications included nine peroneal nerve palsies (six transient, three permanent), one deep venous thrombosis, and one wound dehiscence. No long-term knee instability was seen with repair of the lateral collateral ligament. Ten patients had recurrences, with 70% of local recurrences occurring in patients who underwent intralesional excision.

Conclusions Given the higher recurrence rate with curettage, patients with aggressive proximal fibula tumors benefit from en bloc resection. The overall morbidity is low, but postoperative permanent peroneal palsy remains a concern (3%).

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.
Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that waiver of informed consent was obtained from our Institutional Review Board given the minimal risk.
This investigation was performed at the Mayo Clinic, Rochester, MN, USA.

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Introduction

Tumors of the proximal fibula are rare with only 2.5% of all primary bone tumors occurring in the fibula [22]. Approximately one-third of all tumors in this anatomic location are benign [22]. Patients with aggressive benign tumors in the proximal fibula require surgical management. Most patients are managed by intralesional or marginal excision [9]. Some authors suggest aggressive tumors

(ie stage III symptomatic tumors that grow rapidly and are tender to palpation) be treated by en bloc resection with ligamentous repair [8, 16, 18].

Two main concerns associated with proximal fibula resection are postoperative peroneal nerve palsy and knee instability. Given the anatomic proximity of the common peroneal nerve, aggressive proximal fibula tumors with a substantial soft tissue mass may elevate and stretch the nerve (Fig. 1). Because the nerve is already tethered by fascial bands at the proximal fibula, displacement of the nerve by tumor may result in spontaneous or iatrogenic neurologic complications related to surgical interventions. The rate of this complication is not well-defined given the paucity of literature, with estimates ranging anywhere from 20–57% [8, 9, 16].

Marginal excision (shelling out of the tumor through the pseudocapsule or reactive zone) or en bloc resection of the proximal part of the fibula is occasionally performed for treating benign tumors. Malawer described the latter technique as removal of the proximal part of the fibula and a thin muscle cuff in all dimensions while preserving the peroneal nerve and all motor branches (Fig. 2A–B) [16]. This results in detachment of the lateral collateral ligament (LCL) and biceps femoris tendon from their insertions into the proximal part of the fibula. Given that the proximal tibiofibular joint transmits loads between the knee and ankle during weightbearing [7, 8, 23, 24], and because the LCL is the main resistor of varus loading in a partially flexed knee, knee instability may result [1–3, 7, 12]. Similar to peroneal nerve dysfunction, the rate of knee instability after proximal fibula resection is not well-established, with most reports simply noting patients did not have subjective complaints of knee instability or physical exam findings of varus instability [8, 9, 16].

As such, the goals of this study were to analyze postoperative (1) complications (including rate of peroneal nerve palsy); (2) knee stability; and (3) local recurrences.

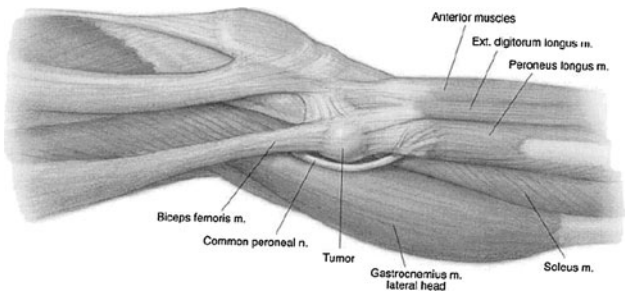

Fig. 1 Aggressive proximal fibula tumors with a substantial soft tissue mass may elevate and stretch the common nerve peroneal nerve.

Patients and Methods

We retrospectively reviewed our institution's pathology and surgery databases to identify all patients with benign tumors of the proximal fibula surgically treated from 1910 to 2007. Nonoperative cases were excluded. All diagnoses were histologically confirmed (Table 1). We identified 120 patients with 121 benign tumors of the proximal fibula (one patient had bilateral tumors). There were 56 males and 64 females with a mean age of 24.3 years (range, 2–64 years). The proximal epiphysis was involved in 60 patients (50%). The metaphyseal region of the proximal fibula was implicated in 59 patients (49%). The tumors were located on the right side in 50 patients (41%) and left side in 71 patients (59%). The minimum followup was 2 years (mean, 9.2 years; range, 2 to 49 years; median, 7.4 years). No patients were lost to followup. Patients were not recalled specifically for this study; data was obtained from the medical records. This study was approved by the Institutional Review Board at our institution.

Pain was the most common presenting symptom (94%) followed by a palpable mass in 47 patients (39%) and pathologic fracture in 20 patients (17%). Fifteen patients (12%) presented with signs and/or symptoms of peroneal nerve compression.

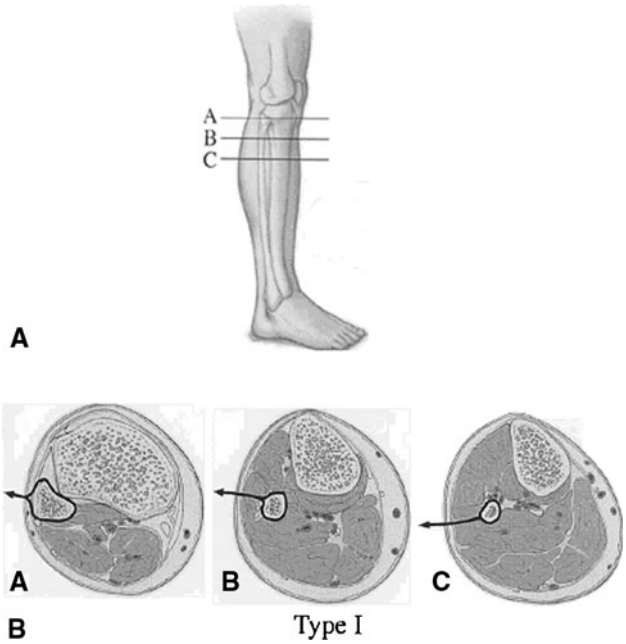

Fig. 2A–B (**A**) Figure representing locations of representative cross-sections (A–C) of the proximal fibula. (**B**) Schematic depicting a Type I en bloc resection at various cross-sections (A–C) through the proximal fibula. Type I resection includes removal of the proximal part of the fibula and a thin muscle cuff in all dimensions while preserving the peroneal nerve and all motor branches.

Table 1. Histologic diagnoses and surgical treatment of 121 benign lesions of the proximal fibula

Diagnosis	Surgical intervention (no.)				
	Total tumors by diagnosis (n = 121)	Intralesional excision (n = 30)	Marginal excision (n = 32)	En bloc resection (Type I) (n = 56)	Amputation (n = 3)
Osteochondroma	46 (38%)	7	28	11	–
Giant cell tumor	23 (19%)	2	1	18	2
Enchondroma	11 (9%)	–	2	9	–
Aneurysmal bone cyst	10 (8%)	3	–	7	–
Fibroma	8 (7%)	6	–	1	1
Simple bone cyst	7 (6%)	5	–	2	–
Fibrous dysplasia	6 (5%)	4	–	2	–
Intraosseous ganglion	2 (2%)	–	–	2	–
Ollier's disease	2 (2%)	–	–	2	–
Osteoid osteoma	2 (2%)	–	1	1	–
Mafucci's syndrome	1 (1%)	–	–	1	–
Eosinophilic granuloma	1 (1%)	1	–	–	–
Nonossifying fibroma	1 (1%)	1	–	–	–
Chondroblastoma	1 (1%)	1	–	–	–
Total tumors by surgical intervention (no.)	121 (100%)	30 (25%)	32 (26%)	56 (46%)	3 (3%)

In all 120 patients, the diagnosis was established by histologic analysis (Table 1). While slides were not rereviewed for the current study, the final histologic interpretation by the pathologist was utilized. Forty-six patients had osteochondromas (38%), 23 had a giant cell tumor (19%), 11 had an enchondroma (9%), 10 had an aneurysmal bone cyst (8%), eight had a fibroma (7%), seven had a simple bone cyst (6%), six had a fibrous dysplasia (5%), two had an intraosseous ganglion cyst (2%), two had an osteoid osteoma (2%), one had an eosinophilic granuloma (1%), one had a nonossifying fibroma (1%), and one patient had a chondroblastoma (1%). Two patients had Ollier's disease with multiple chondromas, and one patient had Maffucci's syndrome with multiple chondromas and angiomas of the soft tissues.

All patients included in this study had surgical treatment (Table 1). Intralesional excision of the lesion was performed in 30 patients (25%), marginal excision in 32 patients (26%), en bloc resection in 56 patients (46%), and amputation in three patients (3%). The most common indications for intralesional treatment were osteochondroma, nonossifying fibroma, and unicameral bone cysts. Marginal resections were most commonly performed for osteochondroma, and en bloc resection was most commonly performed for aggressive or epiphyseally located giant cell tumors, aneurysmal bone cysts, enchondromas, and osteochondromas (Table 1). Three patients in the remote past underwent above-knee amputation for aggressive local tumors. The type of operative treatment was individualized according to the diagnosis and extent of the tumor, age of the patient, functional demands, and preference of the patient (Table 1). Of the 46 osteochondromas, intralesional excision was performed in seven cases, marginal excision in 28 cases, and Type I resection of the proximal fibula in 11 cases. Of the 23 giant cell tumors of the proximal fibula, intralesional excision with or without bone grafting was performed in two patients, marginal excision in one patient, Type I resection in 18 patients, and an above-knee amputation in two patients with aggressive giant cell tumors. Of the 14 patients with enchondromas (including two patients with Ollier's disease and one with Maffucci's syndrome), two were treated with a marginal excision, whereas 12 underwent a Type I resection. Of the 10 aneurysmal bone cysts, intralesional excision was performed in three patients and a Type I en bloc resection in seven patients.

Type I en bloc resection included resection of the proximal fibula with 2 cm of normal diaphysis and a thin muscle cuff in all dimensions (Fig. 2A–B). The peroneal nerve and motor branches were preserved in all cases (Fig. 3), and the anterior tibial artery was spared if the local extent of the tumor allowed. A portion of the proximal tibiofibular joint was excised intraarticularly (Fig. 4) and repair of the LCL and biceps femoris tendon were performed. Reconstruction consisted of repairing the LCL and closing the soft tissue defect and exposed tibial shaft. The LCL and biceps femoris tendon were reattached with nonabsorbable sutures to soft tissue and the anterolateral capsule with the knee flexed 30°. This reattachment was supplemented using a staple or, more recently, a suture

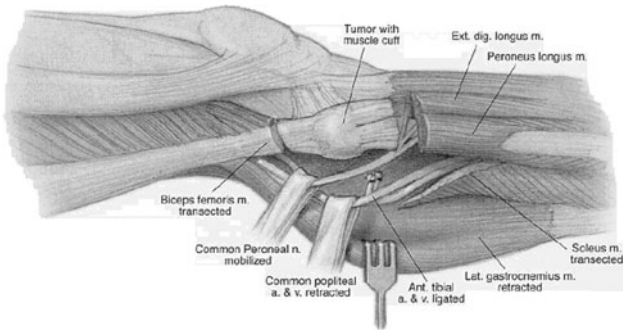

Fig. 3 This figure depicts a Type I en bloc resection of a proximal fibula tumor with a thin muscle cuff in all dimensions. Of note, the common peroneal nerve and common popliteal artery and vein are preserved.

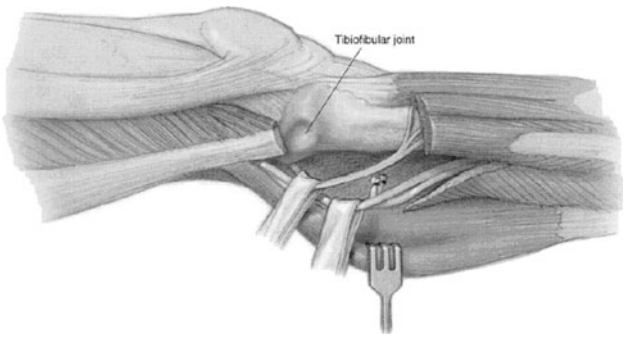

Fig. 4 Type I en bloc proximal fibula resections require detachment of the lateral collateral ligament and biceps femoris tendon. After the resection, the tibiofibular joint is exposed.

anchor to the tibia (Fig. 5A–B). All en bloc resections had histologically clear margins.

Patients were followed through our institution's tumor registry. Our recent followup routine included seeing patients at 2 weeks, 3 months, 6 months, 1 year, 2 years, 3 years, and 5 years postoperatively. Thereafter, followup was dependent upon the particular patient and pathology. Plain radiographs were obtained at each followup visit, while subsequent magnetic resonance imaging (MRI) was obtained at 6 months postoperatively, and then at yearly followups.

For the 30 patients seen since 1994, clinical knee stability was assessed by the varus stress test at 30° of flexion. Various physicians subjectively graded the amount of lateral opening, which was graded in millimeters as described previously [6]. Briefly, the affected limb is placed over the side of the examining table, with the clinician placing his or her fingers directly over the joint. A varus stress at 30° of flexion is then placed on the knee and the amount of lateral opening is quantified. Grade I injuries opened 0 to 5 mm, Grade II injuries opened 6 to 10 mm, and Grade III injuries opened greater than 10 mm [14]. All other patients

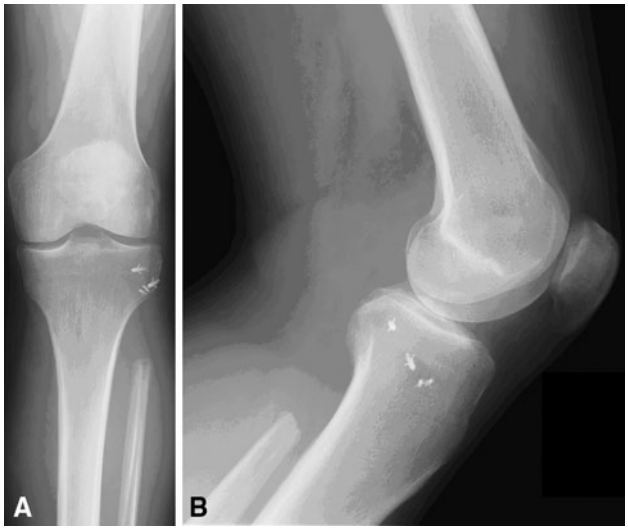

Fig. 5A–B (**A**) An AP radiograph of a 55-year-old man who underwent Type I en bloc resection with repair of the lateral collateral ligament and biceps femoris tendon with suture anchors is shown. (**B**) A lateral radiograph of the same patient is shown. At most recent followup, he was ambulating without any issues.

prior to 1994 were assessed based upon subjective complaints of knee instability and surgeon assessment of varus instability.

Given the long study period, rehabilitation was not identical for all patients after en bloc proximal fibular resection. However, the protocol has been similar for recent decades. Patients typically undergo rehabilitation similar to that after an acute injury of the lateral structures of the knee. In general, patients were partial weightbearing for 6 weeks. A knee immobilizer was used full-time for the first 4 weeks. For the subsequent 2 weeks, patients were allowed to perform gentle ROM exercises without the knee immobilizer. After 6 weeks, the knee immobilizer was discontinued and patients progressed to full weightbearing with the use of a gait aid for the next 4 weeks. Formal physical therapy was initiated after 6 weeks to work on ROM and strengthening.

We determined differences in recurrence rates between intralesional excision and en bloc resection overall and within the giant cell tumor and aneurysmal bone cyst groups using Fischer's exact test.

Results

Postoperative peroneal nerve palsy occurred in nine patients (8%). Six patients had undergone a Type I en bloc resection, two a marginal excision, and one an intralesional excision. Six of nine patients had spontaneous nerve recovery within the first postoperative year, and three had permanent palsies. One patient had a postoperative deep

venous thrombosis, whereas another patient had a wound dehiscence that resolved with local wound care. Finally, one patient with a chondroblastoma later developed pulmonary metastases. There were no postoperative infections or hematomas. No patient developed arterial insufficiency because of vessel ligation.

At the last followup, excluding three patients who had an amputation as the initial treatment, the remaining living patients were ambulatory. Three patients with postoperative permanent peroneal nerve palsies required an ankle–foot orthosis. One of these patients had a tendon transfer and triple arthrodesis for foot drop. None of the patients required further repair or reconstruction of the lateral knee for ligamentous instability. At the latest followup evaluation, none had greater than Grade II instability with the varus stress test at 30° of flexion. Furthermore, none of these patients had subjective complaints of knee instability.

There were 10 local recurrences (8%). Recurrences were statistically more common in patients undergoing intralesional excision as opposed to en bloc resection (23% versus 5%; $p = 0.029$). There were no local recurrences in patients who underwent marginal excision. Two of 10 (20%) recurrences were accompanied by the development of malignant histologic features, with one patient with a giant cell tumor developing an osteosarcoma and one patient with Ollier's disease developing a chondrosarcoma. Local recurrence most commonly occurred in giant cell tumors and aneurysmal bone cysts (Table 2). In this series, there was a 17% (four of 23) rate of recurrence for giant cell tumors after a median of 7 months (range, 3.5–16 months) postoperatively. Recurrence was less common in patients treated with initial aggressive surgery (two of three [67%] intralesional procedures had a recurrence, whereas only two of 18 [11%] en bloc resections did; $p = 0.08$). Of the three aneurysmal bone cyst recurrences, all were associated with intralesional excision, while the 7 patients undergoing en bloc resection did not experience any recurrences (100% versus 0%; $p = 0.008$). The recurrences occurred after a median of 14 years (range, 6 months to 50 years). All were treated successfully with repeat intralesional curettage and bone grafting.

Table 2. Local recurrences after index surgical treatment of 121 benign lesions of the proximal fibula

Diagnosis	Local recurrences according to type of index operation (no.)		
	Intralesional excision (n = 7)	Wide excision (Type I) (n = 3)	Total (n = 10)
Giant cell tumor	2/3 (66%)	2/18 (11%)	4 (19%)
Aneurysmal bone cyst	3/3 (100%)*	0/7 (0%)*	3/10 (30%)
Ollier's disease	0/0 (0%)	1/2 (50%)	1/2 (50%)
Osteochondroma	1/7 (14%)	0/11 (0%)	1/18 (5%)
Chondroblastoma	1/1 (100%)	0/0 (0%)	1/1 (100%)
Overall (no.)	7/30 (23%)*	3/56 (5%)*	10/121 (8%)

* Statistically significant difference with $p < 0.05$.

Discussion

Benign tumors of the proximal fibula are rare. Patients with locally aggressive tumors require surgical management. Most of these cases are managed by intralesional or marginal excision [9]. Various extensile approaches of the fibula and popliteal vessels have been described for limb-salvage procedures [4, 5, 15]. Intraarticular en bloc resection of the proximal fibula is often an adequate procedure for aggressive benign tumors [18]. Given the sensitive anatomy in this location, we sought to assess the incidence of peroneal nerve palsies, knee stability, and local recurrence after surgical treatment.

The current study is limited first by its long timeframe. Second, treatments were not standardized given the long study period and numerous surgeons who were involved. However, the long timeframe allows for the accrual of a large number of patients with relatively rare tumors with similar histologic characteristics and extended followup. Third, postoperative knee stability was not reliably assessed in a similar fashion by all clinicians throughout the study period. However, a consistent method was utilized beginning in 1994.

We found that peroneal nerve palsy developed in 8% of patients and was permanent in 3%. Palsy followed en bloc excision in six, marginal excision in two, and intralesional treatment in one patient. Other authors (Table 3) have reported similar complications at varying rates in smaller series [8, 9, 16]. This complication was a concern, especially after en bloc resection. However, more than half resolved within the first postoperative year. One patient

Table 3. Comparison of surgical treatment results in literature

Variable	Erler et al. [8]	Faezypour et al. [9]	Malawer [16]	Abdel et al. [current study]
Number of patients	7	5	5	112
Mean followup	43 months	46 months	N/A	108 months
Peroneal nerve palsy rate	57%	20%	20%	3%
Knee instability	None	60%	None	None
Local recurrence rate	0%	0%	0%	8%

underwent further surgery (tendon transfers and ankle fusion) for treatment of permanent palsy.

No functionally limiting knee instability was noted in these patients, consistent with other reports in the literature (Table 3) [8, 9, 16]. All patients undergoing an en bloc resection had repair of the LCL and biceps femoris tendon. Several studies have addressed instability after removal of the proximal fibula [7, 18, 20]. In these studies, the LCL and biceps femoris tendon have been reattached and subjective tests were performed to determine the laxity of the knee. In one of the studies, there was no varus instability and a negative pivot shift test in all 10 patients [8, 18]. In another, nine of 18 patients had moderate laxity of the LCL. In a third study, no differences were found between the side of the operation and the contralateral side [7]. The LCL likely provides the main resistance to varus rotation at the knee, whereas the biceps femoris is likely an important dynamic restraint to anterior displacement of the tibia [13]. We recommend that after the proximal part of the fibula is resected because of the presence of a tumor, the insertions of the LCL and biceps femoris tendon should be meticulously repaired. Repair of the LCL and biceps femoris tendon to the lateral aspect of the tibia is a straightforward, reliable technique. When choosing the point of attachment to bone, the knee is checked through flexion-extension range attempting to locate the most isometric point for repair. The ligament and tendon are attached using nonabsorbable sutures, metallic staples, or more recently, suture anchors. The lack of any symptomatic or functional instability in the patients in the present series treated with this technique suggests the method has merit.

Given the increased local recurrence rate with intralesional curettage and the malignant transformation of a relatively large portion of tumors (20%), we recommend en bloc resection for more aggressive tumors. Giant cell tumors in other anatomic locations are typically managed satisfactorily by curettage, chemical or thermal cautery of the walls of the cavity, and bone grafting [12]. However, in the proximal fibula, total en bloc excision of the tumor is the treatment of choice [10, 11, 17–19]. Others have similarly reported a higher recurrence rate after curettage and bone grafting (41%) as opposed to resection (7%) [21]. As such, we strongly recommend en bloc resection of giant cell tumors located in the proximal fibula. The current study does not allow us to comment on the role of radiation. Likewise, we recommend en bloc resection of aneurysmal bone cysts in the proximal fibula given that 100% (3 of 3) of lesions treated with intralesional excision recurred, whereas 0 of 7 recurred when treated with segmental resection of the entire lesion. If intralesional excision is performed, bone grafting of the resulting defect is necessary. However, the surgeon must be cognizant that recurrence is common after incomplete removal of the lesion.

We found benign tumors of the proximal fibula are rare. While postoperative permanent peroneal nerve palsies and local recurrences are concerns, knee stability is not if the appropriate repair is completed. Giant cell tumors and aneurysmal bone cysts in the proximal fibula require wide excision with intraarticular resection of the proximal tibiofibular joint given the concern for local recurrences and malignant transformation.

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