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Research Article

Retrospective clinicopathological analysis of 193 cases of bone and soft tissue tumors in the foot and ankle

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ABSTRACT

Objective: The aim of this study was to evaluate the epidemiological features, anatomical distribution, and treatment methods of bone and soft tissue tumors in the foot and ankle region.

Methods: This retrospective study included 193 cases evaluated at the musculoskeletal tumor board of the institution between January 2014 and December 2024. Patients' demographic data (84 males, 109 females; mean age, 37.8 years), lesion type, anatomical location, histopathological subtype, and treatment modalities were recorded. Tumors were classified according to the 2020 World Health Organization classification of bone and soft tissue tumors.

Results: Of the 193 cases, 128 (66.3%) were true tumors and 65 (33.7%) were tumor-like lesions. Among the tumors, 70 (54.7%) were bone tumors, 54 (42.2%) were soft tissue tumors, and 4 (3.1%) were metastases. Benign lesions accounted for 79.7%, malignant for 14.0%, and intermediate for 6.3% of all tumors. Tumors were most frequently located in the forefoot (44%), followed by the ankle (29%). Intraosseous lipoma was the most common benign bone tumor, giant cell tumor of the tendon sheath the most common benign soft tissue tumor, and ganglion cyst the most frequent tumor-like lesion. Excisional biopsy was the main treatment, whereas amputation was mainly performed for malignant tumors.

Conclusion: Foot and ankle tumors are rare but clinically significant as misdiagnosis or delayed diagnosis can lead to poor outcomes. Although most are benign, malignant cases, especially in the ankle region, require aggressive management. Awareness of their regional distribution and histopathological spectrum is essential for early recognition, accurate diagnosis, and appropriate treatment planning.

Level of Evidence: Level IV, Diagnostic study.

Introduction

Bone and soft tissue tumors occurring in the foot and ankle region are rare; however, they represent approximately 5%-10% of all musculoskeletal tumors.[1-10] This representation rate is relatively high when considering the total volume of this anatomical area compared with the whole body. The diagnosis and treatment of tumoral lesions in this region are influenced by the compact and complex anatomical structure of the foot, which accommodates diverse tissue types within limited spaces. However, because malignant tumors in this region are rare, diagnosis is often delayed or incorrect.[3,4] These malignancies are frequently misdiagnosed as benign lesions, which can lead to inadequate or inappropriate treatment. This may result in a greater risk of recurrence and even amputation. For this reason, unexplained or persistent lumps in the foot and ankle should always be evaluated against tumoral lesions during differential diagnosis.

The purpose of this study was to evaluate the epidemiological features of bone and soft tissue tumors in patients who presented with a preliminary diagnosis of a tumor in the foot and ankle region. In this context, this study aims to analyze the histopathological subtypes and anatomical distribution patterns of these tumors. The aim is to contribute to the diagnostic evaluation of masses evaluated in clinical practice, to enable earlier recognition of malignancy and to support the development of appropriate treatment strategies. In addition, this research is expected to contribute to the existing literature and also provide a scientific basis for future research. The outcomes of this study are anticipated to increase clinical awareness regarding the early diagnosis of foot and ankle tumors, guide proper treatment planning, and reduce the incidence of limb loss.

Material and methods

This study is a retrospective analysis of patient data discussed at the Musculoskeletal Tumor Board of the Trakya University Faculty of Medicine between January 2014 and December 2024. A total of 193 cases were included, all of whom had been referred to the tumor board with a prediagnosis of a tumor in the foot or ankle region.

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The inclusion criteria were patients with bone or soft tissue tumors or tumor-like lesions localized to the foot and ankle that were evaluated at the tumor board during the study period and whose clinical, radiological, and/or histopathological data were available. The exclusion criteria were cases without a tumor prediagnosis, cases with lesions outside the foot or ankle, and patients with incomplete data that prevented accurate classification or analysis. Tumor-like lesions are defined as nonneoplastic conditions that can mimic true neoplasms clinically and/or radiologically, such as ganglion cysts, simple bone cysts, or infections. Cases with partially missing data were reviewed, and if key demographic, radiological, or pathological information was missing, they were excluded from the final analysis.

Age, gender, anatomical location of the lesion, treatment modalities, and radiological and/or histopathological diagnoses for each patient were collected from the hospital's data archiving system, picture archiving and communication system, and tumor board records. In a previous study, the ankle was defined as the region extending from the talocrural joint to a distance equal to the widest portion of the growth plate.[8] Additionally, the ankle region was defined as the length from the talocrural joint to the widest part of the growth plate or tibial plafond (Figure 1). The hindfoot was defined as the area between the talocrural joint and the Chopart joint, the midfoot was defined as the region between the Chopart and Lisfranc joints, and the forefoot was defined as the area distal to the Lisfranc joint (Figure 2). All tumors were classified according to the 2020 World Health Organization (WHO) Classification of Soft Tissue and Bone Tumors.[11,12]

The data were analyzed via descriptive statistical methods. All the statistical analyses were carried out via SPSS version 25.0 (IBM SPSS Corp.; Armonk, NY, USA). Ethical approval for this study was obtained from the Non-Interventional Clinical Research Ethics Committee of Trakya University Faculty of Medicine (Protocol No: TUTF-GOBAEK 2025/246 Date: 23.06.2025).

Results

The study population consisted of 193 cases, including 84 males and 109 females. A total of 128 (66.3%) cases were diagnosed with bone or soft tissue tumors. Tumor-like lesions were diagnosed in the remaining 65 (33.7%) cases. Among the cases diagnosed with tumors, 70 were diagnosed with bone tumors, 54 with soft tissue tumors, and 4 with metastatic tumors. The distributions of tumors and tumor-like lesions by type, gender and average age are given in Table 1.

There were 54 cases of soft tissue tumors. Ten (18.5%) tumors were located in the ankle, 4 (7.4%) were in the hindfoot, 4 (7.4%) were in the midfoot, and 36 (66.7%) were in the forefoot. Forty-one of the soft tissue tumors were benign, 2 were intermediate, and 11 were malignant. Among the benign tumors, the most common diagnosis was giant cell tumor of the tendon sheath (16 cases; 39%), followed by fibroma of the tendon sheath (6 cases; 14.6%), and hemangioma and neurofibromas (3 cases; 7.3%). Both intermediate soft tissue tumors were atypical lipomatous tumors. The most common malignant soft tissue tumor was squamous cell carcinoma, with 4 cases (36.4%). The remaining 7 cases each represented a distinct histologic subtype, including epithelioid sarcoma (n=1), malignant melanoma (n=1), malignant peripheral nerve sheath tumor (n=1), synovial sarcoma (n=1), myxoid liposarcoma (n=1), extraskeletal myxoid chondrosarcoma (n=1), and basal cell carcinoma (n=1).

There were 70 cases with bone tumors. Twenty-six (37.1%) tumors were located at the ankle, 24 (34.3%) were at the hindfoot, and 20 (28.6%) were at the forefoot. There was no bone tumor located

HIGHLIGHTS

- Foot and ankle tumors represented 8.9% of all musculoskeletal tumors in this series.
- The forefoot was the most common site for both tumors and tumor-like lesions.
- Intraosseous lipomas and giant cell tumors of tendon sheath were the most common benign tumors.
- Malignant tumors were rare and mostly located in the ankle region.
- In forefoot tumors, swelling was the most common reason for admission, whereas in ankle and hindfoot tumors, pain was more prominent.
- The treatment approach used varied significantly depending on the anatomical location.

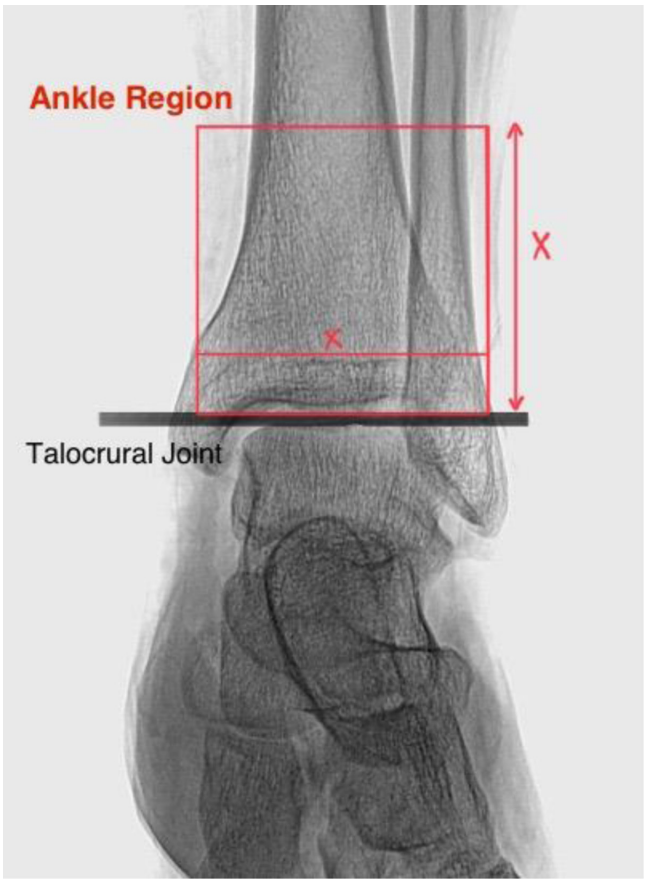

Figure 1. Ankle region on radiograph.

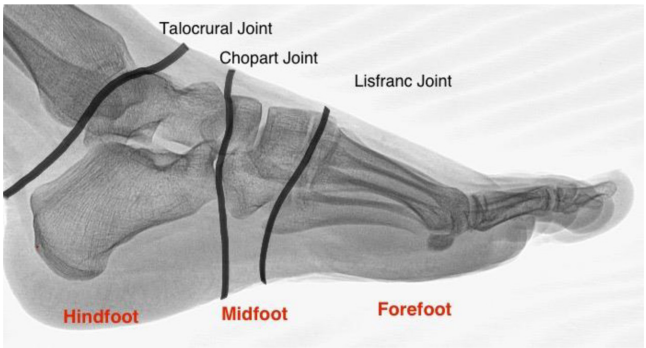

Figure 2. Hindfoot, midfoot, and forefoot on radiograph.

Table 1. Distribution of tumor and tumor-like lesions by type, sex, and mean age

	Total (%)	Male (%)	Female (%)	Mean age (years)
All cases	193 (100)	84 (43.5)	109 (56.5)	37.8
Tumor cases	128 (66.3)	60 (46.9)	68 (53.1)	36.3
Benign tumors	102 (52.8)	46 (45.1)	56 (54.9)	32.6
Intermediate tumors	8 (4.1)	2 (25.0)	6 (75.0)	46
Malignant tumors	18 (9.3)	12 (66.7)	6 (33.3)	53.8
Soft tissue tumors	54 (28.0)	26 (48.1)	28 (51.9)	43.7
Benign subtypes	41 (21.2)	19 (46.3)	22 (53.7)	39.1
Intermediate subtypes	2 (1.0)	0 (0.0)	2 (100.0)	43.5
Malignant subtypes	11 (5.7)	7 (63.6)	4 (36.4)	60.7
Bone tumors	70 (36.3)	31 (44.3)	39 (55.7)	29.6
Benign subtypes	61 (31.6)	27 (44.3)	34 (55.7)	28.3
Intermediate subtypes	6 (3.1)	2 (33.3)	4 (66.7)	46.8
Malignant subtypes	3 (1.6)	2 (66.7)	1 (33.3)	18.3
Metastasis	4 (2.1)	3 (75.0)	1 (25.0)	53.2
Tumor-like lesions	65 (33.7)	24 (36.9)	41 (63.1)	40.6

at the midfoot. Sixty-one of the bone tumors were benign, 6 were intermediate, and 3 were malignant. The most common diagnosis among benign tumors was intraosseous lipoma (14 cases), followed by osteoid osteoma, aneurysmal bone cyst, simple bone cyst and enchondroma (8 cases each). Intermediate tumors included synovial chondromatosis in 3 cases, giant cell tumors of the bone in 2 cases and osteoblastoma in 1 case. The malignant tumors included 2 cases of Ewing's sarcoma and one case of conventional osteosarcoma.

When the distribution of tumors within the foot and ankle region was evaluated, the tumors were most frequently located in the forefoot (44%), followed by the ankle (29%) region (Figure 3). When the distribution of tumors in the ankle region was examined, 37 cases were included. The most common benign bone tumor was non-ossifying fibroma, with 5 cases. This was followed by aneurysmal bone cyst and osteoid osteoma in 3 cases each. A total of 6 cases with intermediate bone tumors were found, and all of them were in the ankle region. Two cases had Ewing's sarcoma, and 1 case had conventional osteosarcoma. Giant cell tendon sheath tumors were the most common benign soft tissue tumors, while malignant soft tissue tumors were found in 4 cases (Table 2).

When hindfoot tumors were examined, intraosseous lipomas were the most common tumor type among the benign bone tumors, accounting for 13 cases. Five cases had simple bone cysts (Table 3). The midfoot region was the least common site for tumors, and no bone tumors were observed in this area. However, half of the metastatic cases were located in the midfoot region (Table 4).

When all tumors were evaluated, the tumors were most frequently (44%) located in the forefoot. The most common benign bone tumor observed in the forefoot was enchondroma in 6 cases, followed by aneurysmal bone cysts and osteoid osteomas in 3 cases. The most frequently encountered benign soft tissue tumor was giant cell tumor of the tendon sheath (12 cases), followed by fibroma of the tendon sheath (4 cases). Among the malignant soft tissue tumors, 3 were squamous cell carcinomas. Additionally, 1 case each of myxoid liposarcoma, extraskeletal myxoid chondrosarcoma, and basal cell carcinoma was identified (Table 5).

Tumor-like lesions are frequently encountered at outpatient clinics. It is important to distinguish tumor-like lesions from real tumor

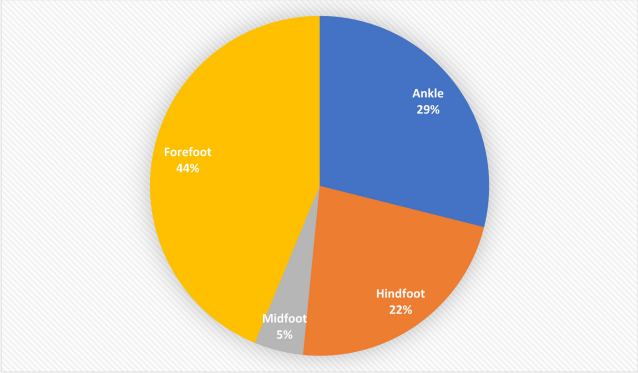

Figure 3. Regional distribution of tumors.

lesions. The tumors were evaluated by the tumor board on the basis of their clinical, radiological, and histopathological features. Tumor-like lesions have a similar distribution to tumoral lesions and are most commonly observed in the forefoot, followed by the ankle and hindfoot. The most frequently found tumor-like lesions were ganglion cysts, Morton's neuroma, stress fractures, and epidermoid cysts. (Table 6).

When the cases were evaluated in terms of initial presenting complaints, swelling and pain were found to be the most common reasons for admission. Some patients presented with pain, others with swelling, and some with both pain and swelling simultaneously. In addition, certain cases were incidentally detected during hospital visits for unrelated reasons. Regionally, patients with tumors located in the ankle and hindfoot presented more frequently with pain, whereas those with tumors in the forefoot most commonly presented with swelling (Figure 4).

In terms of treatment modalities, excision was the most preferred treatment method. In excision surgery, wide excision was performed

Table 2. Distribution of ankle bone and soft tissue tumors

Category	Tumor type	Count	Percentage (%)
Benign bone tumors	Non-ossifying fibroma	5	13.5
	Aneurysmal bone cyst	3	8.1
	Osteoid osteoma	3	8.1
	Osteochondroma	2	5.4
	Simple bone cyst	2	5.4
	Enchondroma	1	2.7
	Intraosseous lipoma	1	2.7
Intermediate bone tumors	Synovial chondromatosis	3	8.1
	Giant cell bone tumor	2	5.4
	Osteoblastoma	1	2.7
Malignant bone tumors	Ewing sarcoma	2	5.4
	Conventional osteosarcoma	1	2.7
Benign soft tissue tumors	Giant cell tumor tendon sheath	2	5.4
	Leiomyoma	1	2.7
	Fibroma of tendon sheath	1	2.7
	Neurofibroma	1	2.7
	Myositis ossificans	1	2.7
Intermediate soft tissue tumors	Atypical lipomatous tumor	1	2.7
Malignant soft tissue tumors	Epithelioid sarcoma	1	2.7
	Malignant melanoma	1	2.7
	Malignant peripheral nerve sheath tumor	1	2.7
Metastasis	Urothelial carcinoma metastasis	1	2.7
Total		**37**	**100**

Table 3. Distribution of hindfoot bone and soft tissue tumorsos

Category	Tumor type	Count	Percentage (%)
Benign bone tumor	Intraosseous lipoma	13	44.8
	Simple bone cyst	5	17.2
	Osteoid osteoma	2	6.9
	Aneurysmal bone cyst	2	6.9
	Chondromyxoid fibroma	1	3.5
	Osteochondroma	1	3.5
Intermediate bone tumor	–	0	0
Malignant bone tumor	–	0	0
Benign soft tissue tumor	Neurofibroma	2	6.9
	Giant cell tumor of tendon sheath	1	3.5
Intermediate soft tissue tumor	–	0	0
Malignant soft tissue tumor	Synovial sarcoma	1	3.5
Metastasis	Lung carcinoma metastasis	1	3.5
Total		**29**	**100**

for malignant and intermediate tumors. However, owing to the complex anatomical structure of the region, wide excision was not always possible. Amputation was preferred in some cases. Amputation was performed in 9 cases. Of these, 3 were below the knee amputations, 2 were ray amputations, 3 were at the level of the metatarsophalangeal joint, and 1 was at the level of the distal phalanx. All amputation cases, except for 1, were due to malignant tumors. One case had an aneurysmal bone cyst and was amputated because local control could not be achieved despite sclerotherapy treatment. Radiofrequency ablation treatment was performed by an interventional radiologist under the supervision of an orthopedic surgeon in cases with osteoid osteoma. Intralesional curettage was the preferred treatment method for cases with forefoot osteoid osteoma (Table 7).

Discussion

Musculoskeletal tumors are rarely found in the foot-ankle region. In various studies, the incidence of musculoskeletal tumors located in this area has been reported to be 5%-10%.[1-10] In this study, tumors and tumor-like lesions located in the foot and ankle regions evaluated at the local tumor board between 2014 and 2024 were discussed. Between 2014 and 2024, 128 foot and ankle lesions were discussed by the tumor board, out of a total of 1437 cases. Tumors of the foot and ankle region were observed in 8.9% of the cases, which is in accordance with the literature.[1-10] Some tumor-like lesions are frequently confused with tumor lesions in clinical practice.[13] Therefore, tumor-like lesions were included.

Table 4. Distribution of midfoot bone and soft tissue tumors

Category	Tumor type	Count	Percentage (%)
Benign bone tumor	–	0	0
Intermediate bone tumor	–	0	0
Malignant bone tumor	–	0	0
Benign soft tissue tumor	Giant cell tumor of tendon sheath	1	16.7
	Fibroma of tendon sheath	1	16.7
	Intramuscular lipoma	1	16.7
Intermediate soft tissue tumor	–	0	0
Malignant soft tissue tumor	Squamous cell carcinoma	1	16.7
Metastasis	Lung carcinoma metastasis	1	16.7
	ALL infiltration	1	16.7
Total		**6**	**100**

ALL, acute lymphoblastic leukemia.

Table 5. Distribution of forefoot bone and soft tissue tumors

Category	Tumor type	Count	Percentage (%)
Benign bone tumor	Enchondroma	6	10.7
	Aneurysmal bone cyst	3	5.4
	Osteoid osteoma	3	5.4
	Osteochondroma	2	3.6
	Subungual exostosis	2	3.6
	Nora lesion (BPOP)	2	3.6
	Chondromyxoid fibroma	1	1.8
	Simple bone cyst	1	1.8
Intermediate bone tumor	–	0	0
Malignant bone tumor	–	0	0
Benign soft tissue tumor	Giant cell tumor of tendon sheath	12	21.4
	Tendon sheath fibroma	4	7.2
	Hemangioma	3	5.4
	Reparative granuloma	2	3.6
	Schwannoma	2	3.6
	Heterotopic ossification	1	1.8
	Leiomyoma	1	1.8
	Extraskeletal enchondroma	1	1.8
	Epithelioid hemangioma	1	1.8
	Lipoma	1	1.8
	Glomus tumor	1	1.8
Intermediate soft tissue tumor	Atypical lipomatous tumor	1	1.8
Malignant soft tissue tumor	Squamous cell carcinoma	3	5.4
	Myxoid liposarcoma	1	1.8
	Extraskeletal myxoid chondrosarcoma	1	1.8
	Basal cell carcinoma	1	1.8
Metastasis	–	0	0
Total		**56**	**100**

In this study, tumors were evaluated in 4 anatomical regions: the ankle, hindfoot, midfoot, and forefoot. Swellings and lumps are easily recognized in the foot and ankle region because of the lack of musculature and thin subcutaneous fat tissue layer. Pain also occurs at an earlier stage. However, the low frequency of tumors in this region causes delays in diagnosis and treatment.[14,15] It is important to know the incidence and distribution patterns of tumors in these anatomical regions. Therefore, it is expected that this study will contribute to the literature.

There were a total of 193 cases with 128 tumor lesions and 65 tumor-like lesions. Sixty-eight (53.1%) of the tumor cases were female. This rate was 54.9% in Chou et al[7] and 56.2% in Sheele et al,[16] which were similar to the rates reported. The mean age of the patients was 36.3 years (range 5-91 years). Chou et al[7] reported a mean age of 33.2 years (range 1-84 years). The mean age was 53.8 years (range 12-91 years) in 18 patients with malignant tumors and 32.6 years (range 5-69 years) in 102 patients with benign tumors. The mean age at presentation of benign cases was significantly lower than the mean age at presentation of malignant cases. Similarly, Scheele et al[16] reported that the mean age at presentation of benign cases was lower than the mean age at presentation of malignant cases. However, they stated that it

Table 6. Distribution of tumor-like lesions

Region	Diagnosis	Count	Percentage (%)
Ankle (17 cases)	Ganglion cyst	4	6.2
	Subchondral cyst	3	4.6
	Stress fracture	2	3
	Chronic inflammation	2	3
	Abscess	1	1.5
	Enthesitis	1	1.5
	Hematoma	1	1.5
	Osteomyelitis	1	1.5
	Xanthoma	1	1.5
	Synovitis	1	1.5
Hindfoot (5 cases)	Bone marrow reconversion	2	3
	Bone marrow edema	2	3
	Osteomyelitis	1	1.5
Midfoot (1 case)	Bone marrow reconversion	1	1.5
Forefoot (42 cases)	Ganglion cyst	9	13.9
	Morton's neuroma	6	9.2
	Epidermoid cyst	5	7.7
	Stress fracture	4	6.2
	Chronic granulomatous inflammation	3	4.6
	Osteomyelitis	3	4.6
	Bone marrow edema	2	3
	Tophus	2	3
	Abscess	1	1.5
	Arthrosis	1	1.5
	Hemorrhagic cyst	1	1.5
	Synovial cyst	1	1.5
	Active chronic inflammation	1	1.5
	Bursitis	1	1.5
	Fibrosis	1	1.5
	Macrodactyly	1	1.5
Total		**65**	**100**

would not be appropriate to consider age as a discriminating factor and to try to make a diagnosis according to age because of the wide age range. In this study, age was not considered very effective in guiding the diagnosis because of the wide age range.

The tumors were histopathologically classified according to the 2020 WHO classification of soft tissue and bone tumors.[11,12] In this study, 79.7% of the tumors were benign, 14% malignant, and 6.3% were intermediate tumors. The rate of malignant tumors was 25.6% in Ruggieri et al,[17] 39.2% in Cho et al,[7] and 35.9% in Karadeniz et al.[9] The rate of malignant tumors was much lower (13.4%). In the literature, there are various sample sizes, and larger series may reveal more accurate results. Unlike in other studies, tumors were classified not only as benign or malignant but also as benign, malignant, or intermediate according to the 2020 WHO classification. The presence of intermediate tumors and the new changes in the classification system may explain the difference in malignant tumor rates.

In terms of general distribution, 70 (54.7%) of the cases had primary bone tumors. Among the 70 bone tumors, 61 were benign, 6 were intermediate, and 3 were malignant primary bone tumors. Various studies in the literatüre reported different results in terms of the incidence of tumors. Studies in the literature have reported that the most common primary bone tumors are osteochondroma, simple bone cysts, exostosis, etc.[7,14,20] The most common primary benign bone tumor was intraosseous lipoma, with 14 cases (23%). Intraosseous lipomas were followed by osteoid osteomas, aneurysmal bone cysts, and simple bone cysts, with 8 cases (13.1%) each. Among the malignant tumors, there were 2 Ewing's sarcomas and 1 conventional osteosarcoma located in the ankle.

In terms of soft tissue tumors, giant cell tendon sheath tumors are generally ranked first in the literature in terms of incidence.[7,18,20] There are also reports that ganglion cysts and synovial chondromatosis are the most common tumors, but according to the 2020 WHO classification, ganglion cysts are classified as non-tumoral lesions, and synovial chondromatosis is classified as an intermediate bone tumor.[12,17,23] In this series, giant cell tendon sheath tumors were the most common primary benign soft tissue tumors, accounting for 16 cases (39%). The second most common tumor was tendon sheath fibroma, which occurred in 6 cases (14.6%). Among malignant soft tissue tumors, synovial sarcoma is the most common tumor in the literature.[17,18,20,22,23] In the study by Özdemir et al,[6] the most common malignant soft tissue tumor was squamous cell carcinoma Eleven cases (19%) had malignant soft tissue tumors. Among the 4 cases, squamous cell carcinoma was the most common malignant soft tissue tumor.

Metastatic lesions in the foot and ankle regions are relatively rare.[22,24] Lung metastases are the most common.[9,25] Four metastatic tumors

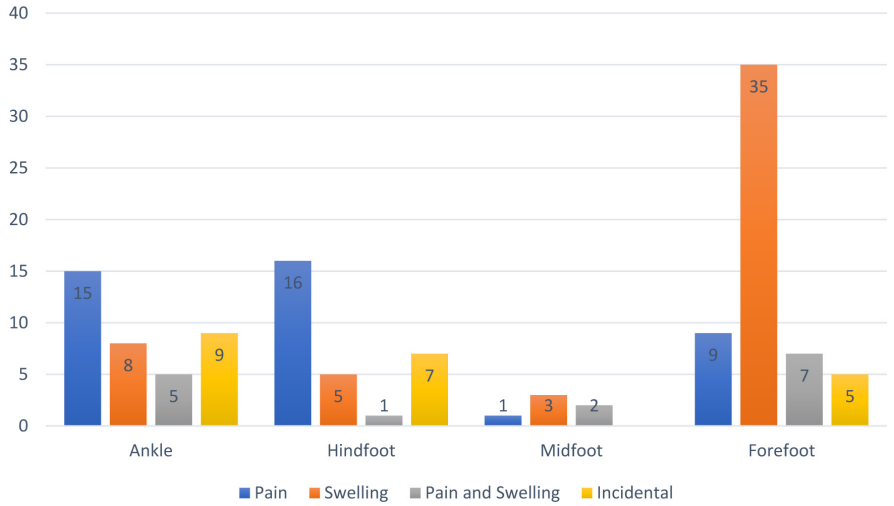

Figure 4. Regional distribution of initial presenting symptoms.

Table 7. Regional distribution of treatments

Treatment method	Ankle	Hindfoot	Midfoot	Forefoot
Below-knee amputation (%)	1 (2.7)	1 (3.4)	1 (16.7)	–
Distal phalanx amputation (%)	–	–	–	1 (1.8)
Metatarsophalangeal joint amputation (%)	–	–	–	3 (5.4)
Ray amputation (%)	–	–	–	2 (3.6)
Excisional biopsy (%)	17 (46)	6 (20.7)	3 (50.0)	33 (58.9)
Curettage (%)	–	–	–	2 (3.6)
Curettage+Grafting (%)	3 (8.1)	10 (34.5)	–	5 (8.9)
Curettage+Cementing (%)	2 (5.4)	–	–	2 (3.6)
Cyst aspiration+steroid injection (%)	–	3 (10.3)	–	–
Radiofrequency ablation (%)	3 (8.1)	2 (6.9)	–	–
Sclerotherapy (%)	2 (5.4)	–	–	1 (1.8)
Follow-up only (%)	8 (21.6)	7 (24.1)	2 (33.3)	7 (12.5)
Deceased before treatment (Ex) (%)	1 (2.7)	–	–	–
Total cases	**37**	**29**	**6**	**56**

were observed in the foot and ankle region. Two patients were of pulmonary origin, 1 patient had urothelial metastasis, and 1 patient had acute lymphoblastic leukemia infiltration.

Considering the local distribution of tumors in the foot-ankle region, Murahashi et al[18] reported a regional distribution of 39.8% in the forefoot, 11.7% in the midfoot, 19.4% in the hindfoot, and 29.1% in the ankle in a study of 103 patients. The midfoot was the least common site for tumor occurrence. Similarly, 44% of the tumors were distributed in the forefoot, 5% in the midfoot, 22% in the hindfoot, and 29% in the ankle (Figure 3). Although there was a slight change in the rates, the incidence of tumors was in the same order as that reported in the literature.[18] The forefoot was the most common site of tumors, whereas the midfoot was the least common site.

When examining the location of tumors according to the anatomical features of the ankle and foot, very few studies exist on this subject in the literature.[16,26] When ankle-located tumors were examined in detail, 26 (70.3%) cases had bone tumors, 10 (27%) cases had soft tissue tumors, and 1 (2.7%) case had metastasis. Chou et al[7] reported a similar distribution (67.3% bone, 32.7% soft tissue) in their study. However, Scheele et al,[16] reported bone tumors at a rate of 32.2% and soft tissue tumors at a rate of 67.8%, which is different from the findings of the study. The most common primary benign bone tumor in the ankle was non-ossifying fibroma. It is believed that the 13.5% rate of non-ossifying fibromas among ankle tumors is actually higher. This is because non-ossifying fibromas are generally "don't-touch" lesions diagnosed by direct radiography. Scheele et al[16] reported that the most common bone lesion they encountered was the intraosseous ganglion. Intraosseous ganglions are non-tumoral lesions. Tumor-like lesions were reported as separate data.

When hindfoot tumors were examined, all the bone tumors were found to be benign. The most common benign primary bone tumor was an intraosseous lipoma. The midfoot was an anatomical region where tumors were rarely observed. Only 6 (5%) of the cases were located at the midfoot. No bone tumors were detected at the midfoot.

The forefoot was the most common site of tumors, with 56 (44%) cases. The most commonly detected benign primary bone tumor in the forefoot was enchondroma. Enchondroma was followed by osteoid osteoma and aneurysmal bone cyst. The most common benign soft tissue tumor was giant cell tendon sheath tumor. In the study by Scheele et al,[26] who investigated the distribution of tumors and tumor-like lesions in the forefoot and midfoot, when tumor-like lesions were excluded, the most frequently detected benign bone tumor was enchondroma, and the most frequently detected benign soft tissue tumor was giant cell tumor of the tendon sheath. No intermediate or malignant bone tumors were detected in the forefoot region. However, 6 (54.5%) of the malignant soft tissue tumors in the series were located at the forefoot. The most common malignant soft tissue tumor was squamous cell carcinoma.

There were 65 cases with tumor-like lesions in the study. The most common lesions were located in the forefoot (64.6%; Table 6). The most common lesions were ganglion cysts (20.1%), Morton's neuromas (9.2%), stress fractures (9.2%), and epidermoid cysts (7.7%). Regionally, ganglion cysts at the ankle and forefoot ranked first. The greater frequency of these cysts, especially in the forefoot, may be related to the repetitive microtrauma to the metatarsophalangeal and interphalangeal joints. Morton's neuroma was found only in the forefoot (n=6), and this finding is consistent with expectations considering its classical location in the second-third or third-fourth metatarsal spaces where the interdigital nerves are compressed.[27] Subchondral cysts (n=3) found in the ankle region usually occur as a result of degenerative changes, especially around the talar dome and tibial pylon. In addition, inflammatory and traumatic conditions, such as stress fractures, enthesitis, hematoma, and synovitis have also been observed in this region. In a study of 37 cases of epidermoid cysts at the foot and ankle, 28 (75.7%) were located at the forefoot.[28] There were 5 cases of epidermoid cysts, all of which were located at the forefoot. Considering that these lesions are formed after trauma by the migration of ectodermal cells into deeper tissue planes, it is logical that they occur at this location. In addition, many rare lesions of the forefoot that require clinical attention include tofus, hemorrhagic cysts, synovial cysts, macrodactyly, and active chronic inflammation. These lesions reveal both the need to consider a wide spectrum of differential diagnoses in the diagnostic process and the morphologic diversity of forefoot pathologies. In conclusion, the data obtained in this study reveal that tumor-like lesions in the foot and ankle regions show regional differences and that these differences may be related to anatomical, biomechanical, and traumatic factors. In particular, the forefoot region is the area where suspected bone and soft tissue lesions are most frequently localized, and awareness of this region is highly important in clinical evaluation and treatment planning.

The degree of presenting complaints varied according to the anatomical region. While swelling was the most frequent reason for admission in forefoot lesions, pain was more prominent in tumors located in the ankle and hindfoot. This finding may be attributed to the

more superficial localization of forefoot tumors, making them easier to detect, whereas pain tends to be the initial symptom in deeper lesions. Furthermore, the incidental detection of a number of cases highlights the need to consider tumors that may follow an asymptomatic course. The findings are consistent with the literature, which reports swelling as the most common presenting symptom in foot and ankle tumors.[9]

When regional evaluation was performed in terms of treatment, the treatment methods used for the bone and soft tissue lesions in the foot-ankle region differed according to the anatomical region (Table 7). Excision was the most preferred treatment method in all regions, especially for the forefoot (58.9%) and ankle (46%). This situation can be explained by the greater occurrence of well-defined, benign, and resectable lesions in these regions. The excision rate was also high in the midfoot (50%); however, this finding cannot be generalized due to the small number of cases. Amputation procedures were generally performed in a limited number of cases but were most common in the forefoot. Amputation surgeries were performed for all the malignant tumors except for in 1 case. In a patient who was treated for an aneurysmal bone cyst but local control was not achieved and experienced recurrence which was unsuitable for reconstruction, ray amputation was performed despite the presence of a benign tumor. Intralesional curettage and grafting were performed in 34.5% of the lesions at the hindfoot, which was significantly greater than that in other regions. The frequency of lesions located close to the articular surfaces in the hindfoot and ankle regions indicates the necessity of grafting or cementing procedures to restore bone stability after curettage in this region. Radiofrequency ablation was used for the treatment of the osteoid osteoma. Radiofrequency ablation was preferred for ankle and hindfoot osteoid osteoma cases, whereas curettage was the preferred treatment method for 2 forefoot cases. Among the cases with forefoot osteoid osteomas, 1 case had a metatarsal osteoma and 1 case had a phalangeal osteoma. Different treatment modalities were mentioned in a review on osteoid osteomas localized at the foot and ankle.[29] Radiofrequency ablation was not preferred for osteoid osteomas localized in the phalanx because of its proximity to the articular surface.[29,30]

The observation-only approach was preferred more frequently for ankle (21.6%) and hindfoot lesions (24.1%), whereas this rate was significantly lower for forefoot lesions (12.5%). This finding suggests that deep lesions may not be symptomatic or that conservative follow-up should be prioritized due to the high degree of surgical risk. Particularly in the ankle and hindfoot regions, the dense concentration of neurovascular and tendon structures, together with their critical role in load-bearing and locomotion, renders surgical procedures more prone to complications and functional impairment. On the other hand, the tendency toward surgery is greater due to the earlier development of functional loss in the forefoot and more prominent cosmetic or functional complaints of the patients. In general, the data obtained show that the anatomical location of the lesion directly affects the choice of treatment. Region-specific approaches should be adopted in surgical planning, considering the biomechanical loading characteristics and functional significance of the anatomical region, as well as the histopathological type and spread pattern of the lesion.

The study's main limitation is the small sample size and the exclusion of asymptomatic benign cases because the study was performed on cases evaluated in a single tertiary center and was performed only on cases evaluated in the musculoskeletal multidisciplinary tumor board.

In conclusion, early recognition of foot and ankle tumors is crucial to prevent diagnostic delays. This retrospective analysis showed that forefoot lesions more often present with swelling, whereas hindfoot and ankle lesions typically manifest with pain, and this anatomical distribution directly affects treatment choices. While marginal excision or amputation is more frequently required in forefoot tumors, curettage, grafting, or reconstructive procedures are often necessary for hindfoot and ankle lesions. These findings highlight the importance of region-specific strategies in clinical practice and should be validated by larger prospective studies.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

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