Original
ISSN 2413-0516

Clinicopathological Characteristics and Treatment Outcomes of Bone and Soft Tissue Tumors

Motaz Alaqeel[1], Mohammed A. Almousa[2*], Nawaf H. Almadi[2*]

[1]Department of Orthopedic Surgery, College of Medicine, King Saud University, Riyadh, Saudi Arabia.
[2]College of Medicine, King Saud University, Riyadh, Saudi Arabia.
*Correspondence to: Mohammed A. Almousa (E-mail: m7md1almousa@gmail.com); Nawaf H. Almadi (E-mail: nawaf.hamad@gmail.com)
(Submitted: 05 January 2026 – Revised version received: 21 January 2026 – Accepted: 11 February 2026 – Published online: 26 February 2026)

Abstract

Objective: To delineate the clinicopathological characteristics of bone tumors (BT) and soft tissue tumors (STT) and to evaluate management outcomes.

Methods: A retrospective cross-sectional analysis was performed on patients diagnosed with BT and STT between 2020 and 2025. Tumor characteristics and treatment outcomes were assessed and compared.

Results: A total of 359 patients (median age, 32 years; 50.7% male) were included. BT accounted for 163 cases (45.4%), while 196 (54.6%) were STT. Osteochondroma represented the most common BT (37.4%), whereas lipoma was the most frequent STT (30.6%). Patients with BT were younger (median age, 22 years) and predominantly male, whereas STT patients were older (median age, 43 years) with female predominance. Malignancy was more frequent among STT compared with BT (26.5% vs 13.5%, $P = 0.002$). Radiotherapy was administered more often in STT than BT (13.3% vs 3.7%, $P = 0.002$). Mortality occurred in two BT patients (1.2%). No significant differences in overall management outcomes were observed between groups.

Conclusion: The clinical profile of BT and STT in this Saudi cohort aligns with published data, although variations in age distribution and sex predominance were observed. Mortality rates were low for both BT (1.2%) and STT (2.0%). Constitutional manifestations, such as unexplained weight loss and progressive fatigue, may heighten suspicion of malignancy, particularly in the presence of a mass and localized bone symptoms. Strengthening early detection strategies and adopting multidisciplinary management pathways may improve diagnostic accuracy and optimize sarcoma care.

Keywords: Bone neoplasms, soft tissue neoplasms, clinical characteristics, treatment outcome, Saudi Arabia

Background

Primary bone (BT) and soft tissue tumors (STT) represent a rare and heterogenous group of mesenchymal neoplasms, notable for their complex biology and the significant challenges they pose in clinical management.[1] They collectively account for less than 1% of all adult cancers yet comprise 5% to 15% of malignancies in pediatric and young populations worldwide.[2] The World Health Organization (WHO) classifies BT and STT based on cell of origin, differentiation and underlying molecular characteristics, thereby facilitating accurate diagnosis and informed treatment decisions.[3,4] In recent years, an apparent rise in the prevalence of BT has been observed, with malignant types such as osteosarcoma, Ewing sarcoma, and chondrosarcoma as well as the STT malignant forms such as liposarcoma and rhabdomyosarcoma.[5–7]

In Saudi Arabia, the prevalence of BT and STT is low compared to western countries, with approximately 2 or 3 occurring per million of the population annually.[8] Previous reports showed BT is more localized to the lower limbs, has a male preponderance, most commonly osteosarcoma, and presents more commonly at a younger age.[8,9] On the other hand, STT present with localized pain, swelling and occasionally pathological fractures lasting for few months before a diagnosis is made.[10–13] Localized tumors respond very well with multi-modal treatment.[14] However, the prognosis is worsened and treatment becomes more difficult when there is metastasis, delay in the diagnosis or delay in the management.[10–15] The current concern in the unique epidemiological and clinical heterogeneity in BT and STT is the need for an enhanced knowledge, characterization and understanding the epidemiology of bone tumors.[9] Therefore, we conducted this study to characterize BT and STT and evaluate treatment outcomes among patients treated at a tertiary medical center in Saudi Arabia.

Methods

This was a retrospective medical chart review conducted at the Surgical Oncology Clinics of King Saud University Medical City, King Saud University in Riyadh, Saudi Arabia. Demographic, clinical and surgical information of patients diagnosed with BT and STT from 2020 to 2025 were collected from the electronic medical records and were analyzed. Patients with incomplete information were excluded from the study.

Prior to the study, the collected data was anonymized for confidentiality and privacy protection of patients. Data was de-identified to remove name, address, email and contact numbers and assigned a serial number for each patient. Data collected was analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM SPSS, Armonk, New York, USA). Normality of distribution was tested using the Kolmogorov-Smirnov test. Descriptive results for categories are expressed as numbers and percentages and mean and standard deviation (SD) or median and interquartile range (IQR) for continuous variables. Association between two or more categories was performed using the Pearson Chi-square test. Difference in the mean ± SD values was determined using the independent samples T test, while Mann-Whitney test was used to determine the nonparametric difference between median and IQR. A P value of < 0.05 was considered statistically significant.

Results

A total of 359 patients were included in the study. The median age was 32 years old (2 years old to 84 years old). There were 182 (50.7%) males and 177 (49.3%) females. Majority of the patients (n = 328, 91.4%) were Saudi nationals. There were 163 (45.4%) BT and 196 (54.6%) STT cases. The mean BMI was 26.99 ± 6.8. Dyslipidemia was the most prevalent comorbidity (n = 42, 11.7%), and 255 (71.0%) presented with lumps or swelling. Median duration of follow-up was 3.6 months, of which six deaths (1.7%) from all causes were recorded. Table 1 shows the detailed demographic and medical characteristics of 359 patients with bone and soft tissue tumors.

Table 2 shows the characteristics of BT in 163 patients. The median age was 22 years old with a preponderance to the male gender (n = 97, 59.5%). Majority (86.5%) were benign. The most prevalent subtype was osteochondroma in 60 patients (36.8%). All-cause mortality was recorded in 2 (1.2%) of patients. Of the 95 BT patients who had surgery, one male patient (1.1%) showed a recurrence of osteochondroma at the same location 3 months after surgery.

Table 3 shows the characteristics of STT in 196 patients. The median age of patients was 43 years old with a female preponderance (n = 111, 56.6%). Majority of the tumors were benign (n = 144, 73.5). The most prevalent STT was lipoma in 60 (30.6%) of patients. All-cause mortality was recorded in 4 (2.0%) patients. Of the 114 SST patients who had surgery, seven patients (6.1%) showed a recurrence of the tumor at the same location 3.6 months after surgery was done.

The median age was significantly older among patients who had STT (43.0, IQR: 26.0–53.0) than BT (22.0, IQR: 16.0–32.0) (P < 0.001), The mean BMI was significantly higher among STT patients than in BT patients (27.73 ± 6.4 versus 26.06 ± 7.1, P = 0.026). A significant difference in the gender preponderance was observed between the two groups, where STT had a significant predilection towards the female gender, while BT had a male preponderance (P = 0.002). The prevalence of hypertension was higher in STT (n = 28, 14.3%) than BT (n = 11, 6.7%), P = 0.022. Dyslipidemia was

Table 1. **Demographic and medical characteristics of 359 patients with bone and soft tissue tumors**

Characteristics	Results
Age in years, median and IQR	32.0 (20.0, 49.0)
Duration from initial visit to surgery in months, median (IQR)	3.6 (1.4, 7.0)
Duration of follow-up in months, median (IQR)	6.1 (4.0, 10.5)
Gender, *n* (%)	
Male	182 (50.7%)
Female	177 (49.3%)
Nationality, *n* (%)	
Saudi	328 (91.4%)
Non-Saudi	31 (8.6%)
BMI in kg/m^2, mean ± SD	26.99 ± 6.8
Tumor type, *n* (%)	
Soft tissue	196 (54.6%)
Bone	163 (45.4%)
Tumor behavior, *n* (%)	
Benign	285 (79.4%)
Malignant	74 (20.6%)
Comorbidities present, *n* (%)	
Hypertension	39 (10.9%)
Dyslipidemia	42 (11.7%)
Diabetes mellitus	33 (9.2%)
Hypothyroidism	16 (4.5%)
Allergies	10 (2.8%)
Clinical presentation, *n* (%)	
Lumps or swelling	255 (71.0%)
Pain	208 (57.9%)
Weight loss	15 (4.2%)
Fatigue	10 (2.8%)
Difficulty of breathing	6 (1.7%)
Digestive issues	5 (1.4%)
All-cause mortality, *n* (%)	6 (1.7%)

Table 2. **Bone tumor characteristics in 163 patients**

Characteristics	*n* (%)
Age in years, median (IQR)	22.0 (16.0, 32.0)
BMI in kg/m^2, mean ± SD	26.1 ± 7.1
Duration from initial visit to surgery in months, median (IQR)	2.3 (0.9, 6.6)
Duration of follow-up in months, median (IQR)	5.6 (3.9, 9.2)
Gender, *n* (%)	
Male	97 (59.5%)
Female	66 (40.5%)
Tumor behavior, *n* (%)	
Benign	141 (86.5%)
Malignant	22 (13.5%)
Bone tumors diagnosis, *n* (%)	
Osteochondroma	61 (37.4%)
Osteoid osteoma	17 (10.4%)
Giant cell tumor	11 (6.7%)
Ewing's sarcoma	11 (6.7%)
Non-ossifying fibroma	11 (6.7%)
Osteosarcoma	9 (5.5%)
Enchondroma	6 (3.7%)
Fibrous dysplasia	4 (2.5%)
Aneurysmal bone cyst	4 (2.5%)
Chondrosarcoma	3 (1.8%)
Metastatic carcinoma to the bone	3 (1.8%)
Langerhans cell histiocytosis	3 (1.8%)
Chondroblastoma	2 (1.2%)
Osteoblastoma	2 (1.2%)
Bone lymphoma	2 (1.2%)
Intraosseous lipoma	1 (0.6%)
Vanished bone syndrome	1 (0.6%)
Atypical cartilaginous tumor	1 (0.6%)
Not specified	11 (6.7%)
Side of tumor, *n* (%)	
Left	83 (50.9%)
Right	74 (45.4%)
Not mentioned	6 (3.7%)
Lymphovascular invasion, *n* (%)	1 (0.6%)
Surgery done, *n* (%)	95 (58.3%)
Chemotherapy done, *n* (%)	13 (8.0%)
Radiotherapy done, *n* (%)	6 (3.7%)
Same disease occurred at same location after surgery, *n* (%)	1 (1.1%)
All-cause mortality, *n* (%)	2 (1.2%)

Table 3. **Soft tissue tumor characteristics in 196 patients**

Characteristics	*n* (%)
Age in years, median (IQR)	43.0 (26.0, 53.0)
BMI in kg/m^2, mean ± SD	27.7 ± 6.4
Duration from initial visit to surgery in months, median (IQR)	4.1 (1.8, 8.1)
Duration of follow-up in months, median (IQR)	6.5 (4.6, 12.3)
Gender, *n* (%)	
Male	85 (43.4%)
Female	111 (56.6%)
Tumor behavior, *n* (%)	
Benign	144 (73.5%)
Malignant	52 (26.5%)
Soft tissue tumors diagnosis, *n* (%)	
Lipoma	60 (30.6%)
Sarcoma	52 (26.5%)
Liposarcoma	22 (11.2%)
Myxofibrosarcoma	16 (8.2%)
Pleiomorphic	4 (2.0%)
Dermatofibrosarcoma	3 (1.5%)
Fibromyxoid sarcoma	3 (1.5%)
Angiosarcoma	1 (0.5%)
Chondrosarcoma	1 (0.5%)
Leiomyosarcoma	1 (0.5%)
Rhabdomyosarcoma	1 (0.5%)
Hemangioma	20 (10.2%)
Ganglion cyst	16 (8.2%)
Villonodular synovitis	8 (4.1%)
Cystic lesion	4 (2.0%)
Desmoid fibromatosis	4 (2.0%)
Lymphoma	4 (2.0%)
Neurofibroma	3 (1.5%)
Schwannoma	3 (1.5%)
Dermatofibroma	3 (1.5%)
Calcinosis	2 (1.0%)
Chondromatosis	2 (1.0%)
Epidermal inclusion cyst	2 (1.0%)
Nodular fasciitis	2 (1.0%)
Spindle cell neoplasm	2 (1.0%)
Invasive melanoma	2 (1.0%)
Angioleiomyoma	1 (0.5%)
Myoepithelioma	1 (0.5%)
Myositis ossificans	1 (0.5%)
Pilomatricoma	1 (0.5%)
Poroid hidradenoma	1 (0.5%)
Trichilemmal cyst	1 (0.5%)
Recurrent Baker's cyst	1 (0.5%)
Clear cell carcinoma	1 (0.5%)
Squamous cell carcinoma	1 (0.5%)
Side of tumor, *n* (%)	
Left	102 (52.0%)
Right	89 (45.4%)
Not mentioned	5 (2.6%)
Lymphovascular invasion, *n* (%)	5 (2.6%)
Surgery done, *n* (%)	114 (58.2%)
Chemotherapy done, *n* (%)	12 (6.1%)
Radiotherapy done, *n* (%)	26 (13.3%)
Same disease occurred at same location after surgery, *n* (%)	7 (6.1%)
All-cause mortality	4 (2.0%)

more prevalent in STT (15.3% versus 7.4%, $P = 0.020$). No significant differences in the prevalence of diabetes (11.7% versus 6.1%, $P = 0.067$) and hypothyroidism (5.1% versus 3.7%, $P = 0.516$) between the two groups. STT significantly presented with lumps or swelling ($n = 163$, 83.2% versus $n = 92$, 56.4%, $P < 0.001$) whereas BT significantly presented with pain ($n = 108$, 66.7% versus 100 (51.0%), $P = 0.003$. No significant differences in the other presenting complaints such as weight loss ($P = 0.544$), digestive issues ($P = 0.803$), difficulty of breathing ($P = 0.154$) and fatigue ($P = 0.728$). There was no significant difference in the median duration of follow-up between BT and STT ($P = 0.089$). However, the duration from first visit to the time of surgery was significantly longer among STT patients than BT patients ($P = 0.028$). Malignancy was more prevalent in STT than BT (26.5% versus 13.5%, $P = 0.002$). Radiotherapy was done significantly more in STT than BT patients (13.3% versus 3.7%, $P = 0.002$). Recurrence of the same disease at the same location after surgery was more significantly common in STT than BT (4.1% versus 0.6%, $P = 0.036$). No significant differences in the outcome of the management between the two groups ($P = 0.453$).

In BT, unadjusted regression analysis showed that the presence of fatigue significantly increased the odds by 39.7% for malignancy (OR = 8.397, 95% CI = 1.177–67.842, $P = 0.034$). When adjusted for age and gender, the presence of fatigue symptom was found to be insignificant (OR = 8.411, 95% CI = 0.989–71.545, $P = 0.051$). Age, gender, BMI and the presence of other constitutional signs and symptoms were found to be insignificant predictors for malignancy in BT. Unadjusted regression analysis examining predictors of malignancy in STT indicated that weight loss increased the odds for malignancy (OR = 1.203, 95% CI = 1.063–16.616, $P = 0.041$). When predictors were adjusted for age and gender, fatigue turned out to significantly increase the odds for malignancy in STT (OR = 6.058, 95% CI = 1.040–32.274, $P = 0.045$) as well as weight loss (OR = 5.063, 95% CI = 1.194–21.480, $P = 0.028$). Age, gender, BMI and the presence of other constitutional signs and symptoms were found to be insignificant predictors for malignancy in STT. Overall, regardless of tumor type, the unadjusted independent predictors for malignancy included age (OR = 1.022, 95% CI = 1.008–1.036, $P = 0.002$), presence of lumps or swelling (OR = 1.978, 95% CI = 1.050–3.725, $P = 0.035$), fatigue (OR = 6.199, 95% CI = 1.702–22.576, $P = 0.006$) and weight loss (OR = 3.227, 95% CI = 1.242–8.382, $P = 0.016$). When these predictors were adjusted for age and gender; lumps or swelling (OR = 1.927, 95% CI = 1.016–3.654, $P = 0.045$), fatigue (OR = 6.122, 95% CI = 4.642–22.820, $P = 0.007$) and weight loss (OR = 3.379, 95% CI = 1.268–9.004, $P = 0.015$) remained significant.

Discussion

This study aimed to characterize both BT and STT clinically as well the outcome of management. A number of the study's findings that might be consistent with or inconsistent with those of earlier research need to be highlighted.

First, the median age at presentation for STT is 37 years old. This is consistent with a local study done by AlShamsan et al., in 2025 reporting the same median age at presentation.[16]

However, compared to reports from studies conducted from other countries, the median age at presentation was 46 years old.[17] That is 9 to 14 years older compared to our study population. Variations in the age at presentation for STT across countries can be primarily driven by variations in population demographics, regional disease prevalence, socioeconomic development, and the diagnostic infrastructure of the country. While STT generally presents at age 50 and above, developing or developed regions with highly advanced healthcare access including Saudi Arabia may often have a relatively higher proportion of younger patients. BT on the other hand usually has a bimodal peak at age of presentation. Most commonly, BT presents between 10 and 25 years old with a second, smaller peak in patients over 50–60 years old which is similar to the findings of this study.[18,19]

Second, the gender preponderance in BT as well as STT conforms with previous local studies.[10,20,21] In terms of gender distribution, bone tumors in this study showed a male preponderance while soft tissue tumors exhibited female preponderance. Studies on the gender preponderance towards the male gender were reported by studies and confirmed by this study.[10,20] With STT on the other hand, the female gender predominance is demonstrated by complex patterns since many subtypes of uterine leiomyosarcomas are very prevalent similar to this study.[21] Third, BT is primarily benign, with osteochondroma being the most common in this study consistent with the multiple local studies which reported a rate of 12.7% to 39.4% of cases.[22–24] BT are mostly benign because they frequently arise as developmental, lack aggressive behavior, non-cancerous or localized growth abnormalities particularly in children and adolescents.[25,26] On the other hand, STT exhibited a higher malignancy rate compared to BT (26.5% vs. 13.5%). STT exhibits a higher, albeit still rare, malignancy rate (specifically soft tissue sarcomas) compared to primary BT largely due to delayed detection and a higher metastatic potential.[27] Furthermore, benign, non-fatty soft tissue masses are often misdiagnosed, leading to inadequate initial surgery, whereas primary BT are rare overall.[27]

Fourth, the clinical presentations differed, with pain more predominantly in BT as opposed to lumps in STT which is consistent with previous reports.[13,28] This emphasizes the need for heightened vigilance for early diagnosis. A study showed that pain symptoms speed up the diagnosis among BT patients since they present earlier for care, whereas the findings of lumps and sensory disorder symptoms among patients with STT. are delayed as patients and providers may not recognize and associate these symptoms to the disease.[28] These data indicate that the understanding of symptom specific diagnostic delays will improve the education process of patients and healthcare providers leading to earlier detection and improved outcomes. Fifth, the appearance of the same tumor on the same site after surgery differed significantly for different tumor types, with a higher recurrence rate for STT compared to BTT consistent with a previous report.[16] Mortality on the other hand, was not different between BT and STT in this study. STT and BT are associated worldwide with greater mortality, especially in advanced disease.[29] Despite these regional factors being evident with prolonged duration of symptoms (median duration of eight months) and considerable metastatic presentation, the survival outcomes in the Saudi cohort are also in keeping with the international trends.[29]

Sixth, dyslipidemia. In this study, dyslipidemia was the most common comorbid finding most particular among patients with STT rather than in BT patients. This confirms the previous report by Al-Raddadi et al., that dyslipidemia is more common among STT patients.[30] Dyslipidemia is common in STT patients due to a combination of metabolic reprogramming within tumor cells, the tumor's interaction with host fat metabolism, and the effects of treatment.[31–33] And seventh, the symptom of increased fatigability is a common symptom in many cancers and not much research has identified fatigue as a significant or reliable predictor of malignancy in BT specifically. In this study, the presence of fatigability symptoms in both BT and STT patients significantly increases the odds for malignancy. Though many research cancer-related fatigue is ascribed as a predisposing or perpetuating factor, it was not regarded as a validated predictor of tumor malignancy.[34–36] On the other hand, "unexplained" or "unintentional" weight loss has been a hallmark of cancer and reported to increase the probability that an underlying malignancy is present. Although this increases the likelihood of malignancy, it is often regarded as "non-specific" and does not specifically point to a specific cancer type since only around 16–20% turn out to be malignant.[37,38] However, weight loss in both BT and STT is usually a late, systemic sign that increases suspicion when combined with a mass or focal bone symptoms clinicians need to be aware of.[37,38]

The limitations of this study included diagnostic challenges due to the overlapping features and the probability of biopsies that may have missed heterogeneous or small high-grade regions resulting in the accuracy of the results. Also, the lack of standardized diagnostic criteria and the difficulty in generalizing findings posed challenges in the diagnosis of BT and STT. These are tumors that constitute a very diverse group, making it difficult to apply generic study results to individual patients. Furthermore, similar to other cancers, both are dynamic diseases, and studying it can be challenging due to its complexity and the need for multiple diagnostic tools which this study was not able to collect information. The median follow-up duration is relatively short, which may have limited the long-term outcome interpretation, particularly regarding recurrence and mortality.

Conclusions

The characteristics of BT and STT in this Saudi population is similar to that was widely reported in the literature. There were some variations in the age at presentation as well as gender preponderance, mortality rates for both BT and STT were low at 1.2% and 2.0%, respectively. Constitutional symptoms including unintentional weight loss and increasing fatigability may increase clinical suspicion of an underlying malignancy especially when combined with a mass with focal bone symptoms. However, despite these, identifying the unique characteristics of both BT and STT as well as their behaviors and responses to therapy, there is a need for an enhanced screening effort, as well as multidisciplinary approaches to treatment to help decrease the gap in sarcoma diagnostic capability and management. There is a need for immediate referrals of patients once disease is recognized at an earlier time, increased awareness and education among front-line clinicians in the country, expansion of the national tumor registry systems,

and enhancement of inter-institutional collaboration that will contribute to a timely diagnosis of these tumors.

List of Abbreviations

IQR – interquartile range
SD – standard deviation
SPSS – Statistical Package for Social Sciences
STOES – soft tissue and other extraosseous sarcomas
WHO – World Health Organization

Declarations

Ethical Approval

Ethical approval for the study was granted by the Institutional Review Board (IRB) of the College of Medicine, King Saud University, Riyadh, Saudi Arabia (E-25-10242, 15 October 2025). The IRB approval covered previously collected records. A waiver of informed consent was granted.

Consent for Publication

All authors have read the manuscript have given their consent for publication.

Availability of Data and Materials

Data will be available depending on the agreement and written formally valid consent from the authors.

Competing Interests

All authors declare no competing interest.

Funding

The study was not funded by any organization or funding institution

Authors' Contributions

MA – planned and supervised the study, writing and analysis, MAA – data collection, analysis and writing, NHA – data collection, analysis and writing.

Acknowledgements

We would like to thank the IRB of the College of Medicine, King Saud University for the approval of the project, as well as the nurses of the Orthopedics Department, College of Medicine, King Saud University Medical City, Riyadh, Saudi Arabia for the assistance in the electronic data collection.

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