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*Research Article*

# Soft tissue recurrence in giant cell tumor of bone: Risk factors and radiological and histopathological features

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ABSTRACT

***Objective:*** Giant cell tumor of the bone (GCTB) is a locally aggressive benign tumor with unpredictable recurrence patterns. While intraosseous recurrences are well-documented, soft tissue recurrence (STR) remains underrecognized. This study aimed to identify risk factors, radiographic features, and histopathological characteristics associated with STR of GCTB.

***Methods:*** This retrospective study included 69 patients treated for GCTB between 1996 and 2022. Demographic data, tumor location, surgical method, recurrence history, and adjuvant treatments were extracted from medical records. Radiologic assessments were performed using a picture archiving and communication system, and lesions were graded by Campanacci classification. Histopathological evaluation included H3F3A immunohistochemistry in cases with STRs. Statistical analysis was performed using chi-square, Fisher's exact, and Mann–Whitney *U*-tests.

***Results:*** The initial surgical approach was curettage in 55 patients (79.7%), resection in 14 (20.3%). Recurrence occurred in 24 patients (34.8%), and STR was identified in 7 (10.1%). Most STRs were located near the distal femur. Among these, 4 had prior intraosseous recurrence, and 5 had Campanacci grade 3 lesions. No statistically significant association was found between STR and variables including age, sex, tumor volume, Campanacci grade, tumor location, denosumab, or local adjuvant use. H3F3A analysis was performed in 6 out of 7 patients with STR, and positivity was detected in 3 of them. Pulmonary metastasis was documented in 8 patients overall, including 3 of 7 with STR (42.9%) compared with 5 of 62 without STR (8.1%), representing a significant difference.

***Conclusion:*** Soft tissue recurrence in GCTB may occur independently or following intraosseous recurrence and is frequently observed in high-grade lesions. Although not statistically significant, the findings suggest a possible association between tumor aggressiveness and STR. Histological features remain consistent with osseous lesions, but the diagnostic value of H3F3A expression in STRs warrants further investigation. Importantly, STR represents a distinct recurrence pattern and may be associated with an increased risk of pulmonary metastasis, underscoring the need for vigilant long-term follow-up and systematic surveillance.

***Level of Evidence:*** Level III, Prognostic Study.

## Introduction

Giant cell tumor of the bone (GCTB) displays a unique morphology and exhibits an unpredictable clinical course both during and after treatment. Despite being histologically benign with a locally aggressive nature, its high recurrence rate and potential for metastasis complicate the standardization of follow-up strategies and the management of recurrent cases.[1]

Various studies have aimed to standardize these challenges and propose applicable solutions. Extended curettage techniques, such as the use of high-speed burrs, along with adjuvant topical agents including phenol and hydrogen peroxide, have been utilized to prevent local recurrence.[2-4]

Soft tissue recurrence (STR) of GCTB has remained a relatively underexplored topic in the literature. The first 2 cases were reported after tumor resection, 1 preceded by radiotherapy and the other involving surgery alone. Both presented with recurrent cutaneous or subcutaneous lesions that were histologically consistent with the original tumor.[5] Additionally, Cooper et al[6] described this clinical entity in a series of 17 patients, introducing the term "soft tissue implants" to define these lesions. They described it as a radiographically consistent lesion, typically presenting as a soft tissue mass encircled by a thin ossified shell or, less commonly, containing a central area of ossification, with sizes ranging from millimetric nodules to lesions measuring up to 13 centimeters. To categorize these radiological patterns, Xu et al[7] and Cui et al[8] have proposed 2 distinct classifications for STR in GCTB. Recent genomic studies have demonstrated that more than 90% of GCTBs harbor H3F3A mutations, most commonly the G34W variant, which has emerged as a valuable diagnostic and differential-diagnostic marker.[9,10] Nevertheless, there is a paucity of data regarding the role of H3F3A immunohistochemical analysis in STRs of GCTB, which the authors aimed to investigate in the present study.

**Dr. Mehmet Ali Deveci is currently serving as a member of the journal's editorial board.**

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**Table 1.** Campanacci grading of giant cell tumor of the bone

| Campanacci grade | Definition |
|---|---|
| I | Well-marginated border of a thin mature bone, and the cortex was intact or slightly thinned but not deformed. |
| II | Relatively well-defined margins but no radio-opaque rim; the combined cortex and rim of reactive bone was rather thin and moderately expanded but still present. |
| III | Fuzzy borders, suggesting a rapid and possibly permeative growth; the tumor bulged into the soft tissue, but the soft-tissue mass did not follow the contour of the bone and was not limited by an apparent shell of reactive bone. |

To the authors' knowledge, no previous study has reported using H3F3A immunohistochemical evaluation as a diagnostic histopathological approach in cases of STR of GCTB. In this study, it was hypothesized that STR in GCTB may be related to tumor aggressiveness and could exhibit characteristic radiological and histopathological features, with H3F3A immunohistochemistry potentially contributing as a supportive diagnostic tool.

## Materials and methods

The study was conducted at Çukurova University Hospital and was approved by the local ethics committee under the meeting number 152 and decision number 54, dated February 7, 2025. Informed consent was obtained from all patients before surgery; for patients under the age of 18, consent was obtained from their parents or legal guardians. Sixty-nine patients who underwent surgery for a diagnosis of GCTB between November 1996 and December 2022 were included in the study, while patients with less than 1 year of follow-up, insufficient imaging data, or lesions not confirmed as conventional GCTB were excluded from the study. The demographic characteristics of the patients (age, sex), anatomical tumor locations, surgical techniques, number of recurrences, and time intervals between surgeries were extracted from the hospital database. The status of neoadjuvant or adjuvant systemic treatment with denosumab was also noted. Additionally, the presence of secondary malignant lesions, metachronous lesions, and prior pathological fractures was documented.

The picture archiving and communication system was used for the radiological evaluation of the primary lesion and the radiological classification of STRs. As part of the routine follow-up protocol, plain radiographs were obtained. If a soft tissue lesion was suspected based on these radiographs, further imaging with magnetic resonance imaging (MRI) or computed tomography (CT) was performed to assess the lesion in detail. All suspected lesions were confirmed by surgical excision and histopathological examination. Primary bone lesions were graded according to the Campanacci classification (Table 1).[11] Soft tissue lesions were categorized separately according to the classification systems described by Xu et al[7] and Cui et al.[8] In the Xu system, lesions are classified as Type I (peripheral ossification), Type II (central ossification), or Type III (no ossification). The Cui system further subdivides Types I and II into I-1 (<50% of the rim with peripheral ossification), I-2 (≥50% to complete 'egg-shell' rim ossification), II-1 (<50% of the lesion with central ossification), and II-2 (≥50% to complete central ossification), with Type III indicating no ossification (Table 2).

All suspected STRs were managed by excisional biopsy when the lesion was clinically and radiologically consistent with GCTB, superficial in location, and smaller than 5 cm in diameter. In cases where the lesion was larger, deep-seated, or demonstrated atypical radiological features suggesting possible sarcoma or malignant transformation, a closed biopsy was performed prior to definitive surgery. Pathological specimens were evaluated by a pathologist who was blinded to patient identity. The lesions were primarily stained with hematoxylin and eosin. The classical histological appearance of the tumor, characterized by rounded mononuclear mesenchymal stromal cells and multinucleated giant cells, is considered the hallmark of GCTB.[12,13] Due to the possibility of secondary malignancies and the need to differentiate GCTB from histologically similar lesions such as giant cell tumor of soft tissue and tenosynovial giant cell lesions, additional immunohistochemical staining for H3F3A was performed to confirm the diagnosis. Staining was first performed on STR specimens, followed by analysis of the corresponding primary tumors from the same patients to assess concordance.

### Statistical analysis

All statistical analyses were performed using Python (pandas, scipy, and statsmodels libraries).[14] Categorical variables were analyzed using chi-square or Fisher's exact tests, as appropriate. Continuous variables were evaluated with the Mann–Whitney *U*-test due to non-normal distribution. A *P*-value <.05 was considered statistically significant.

## Results

A total of 69 patients diagnosed with GCTB were evaluated. The mean age at the time of initial treatment was 36.2 years (range: 14-67 years), comprising 32 females (46.4%) and 37 males (53.6%). Total follow-up duration ranged from 12.5 to 240 months (median: 65.2 months). Radiographically, Campanacci classification was Grade 1 in 15 patients (21.7%), Grade 2 in 27 (39.1%), and Grade 3 in 27 (39.1%). Tumors were most commonly located in the lower extremity

**HIGHLIGHTS**

- Soft tissue recurrence (STR) of giant cell tumor of the bone (GCTB) should be considered in the differential diagnosis; it typically presents as a firm, immobile mass in the previously operated area.
- Soft tissue recurrences could be expected in patients who had previously undergone surgery for a bone recurrence.
- En bloc excision is a wise selection of treatment since it is easy and reliable.
- In contrast to its bony counterpart, H3F3A mutation could not be an accurate marker for STR.
- Pulmonary metastasis of GCTB is more likely in patients with STR, indicating a potential link between STR and distant spread.

**Table 2.** Radiographic classification of soft tissue recurrence in giant cell tumor of bone

| Classification | Types | Definition |
|---|---|---|
| Xu et al[7] classification | Type I | Soft tissue recurrence with peripheral ossification |
| | Type II | Soft tissue recurrence with central ossification |
| | Type III | Pure soft tissue recurrence without ossification |
| Cui et al[8] classification | Type I-1 | Peripheral ossification, less than 1/2 of the mass rim |
| | Type I-2 | Peripheral ossification, 1/2 of the rim to an "egg-shell" like ossification rim |
| | Type II-1 | Central ossification, less than 1/2 of the soft tissue lesion |
| | Type II-2 | Central ossification, 1/2 to the whole area of soft tissue lesion |
| | Type III | No ossification within the soft tissue recurrence mass |

**Table 3.** Tumor localizations and recurrence data

| Variable | Value | Median (min-max) | n (%) |
|---|---|---|---|
| Follow-up duration (months) | | 65.2 (12.5-240) | |
| Tumor location (N=69) | Upper extremity | | 15 (21.7) |
| | Proximal humerus | | 4 (5.8) |
| | Proximal ulna | | 1 (1.4) |
| | Distal radius | | 9 (13) |
| | Metacarpus | | 1 (1.4) |
| | Lower extremity | | 52 (75.4) |
| | Ilium | | 2 (2.9) |
| | Proximal femur | | 3 (4.3) |
| | Distal femur | | 27 (39.1) |
| | Proximal tibia | | 14 (20.3) |
| | Proximal fibula | | 4 (5.8) |
| | Distal tibia | | 2 (2.9) |
| | Axial skeleton (sacrum) | | 2 (2.9) |
| Patients with metastasis | | | 8 (11.6) |
| Patients with recurrence | | | 24 (34.8) |
| Recurrence counts, (N=69) | 1 | | 17 (24.6) |
| | 2 | | 4 (5.7) |
| | 3 | | 1 (1.4) |
| | 4 | | 2 (2.9) |
| Involved tissues, (N=36) | Bone | | 29 (80.6) |
| | Soft tissue | | 7 (19.4) |
| Time interval to soft tissue recurrence (months) | | 12 (3-70) | |

(52 patients, 75.4%), followed by the upper extremity (15, 21.7%) and sacrum (2, 2.9%). Detailed characteristics of these patients are presented in Tables 3 and 4.

The initial surgical approach was curettage in 55 patients (79.7%), resection in 14 (20.3%). Local adjuvant therapy, consisting of phenol application, hydrogen peroxide irrigation, and/or alcohol application following curettage, was used in 40 patients (58.0%), and neoadjuvant denosumab was administered in 17 patients (24.6%).

Recurrence was observed in 24 patients (34.8%), with STR developing in 7 patients (10.1%). The median time to STR was 12 months (range 3 to 70 months). Soft tissue recurrence most frequently occurred in lesions located at the distal femur in 3 cases, followed by the distal tibia, proximal fibula, proximal ulna, and distal radius, each observed in 1 case. The presence of previous bone recurrence was noted in 4 of the 7 cases (57.1%). Regarding the last treatment method applied before recurrence, 4 patients had previously undergone curettage, and 3 had undergone resection. Based on the Xu et al[7] classification, 4 lesions were Type III and 3 were Type I, whereas according to the Cui et al[8] classification, 4 lesions were Type III, 2 were Type I-2, and 1 was Type I-1. H3F3A analysis was performed in 6 of the 7 patients with STR whose tissue specimens were suitable for molecular and pathological evaluation, and positivity was detected in 3 of them. Importantly, in all cases where analysis was available, the corresponding primary tumors demonstrated the same immunohistochemical staining pattern as the STR specimens (Figures 1 and 2). Campanacci grade was determined as grade 3 in 5 patients and grade 2 in 2 patients. Neoadjuvant denosumab therapy had been administered to 3 of the 7 patients.

In 1 patient who had undergone distal femoral resection and endoprosthetic reconstruction for GCTB in the distal femur, a STR was detected at 12 months, and the diagnosis was histologically verified after an excisional biopsy. Despite surgical removal with negative

**Table 4.** Potential factors, values, and their relationships with recurrence rates

| Variable | Value | Mean (min-max) | N=69, n (%) | *P* (recurrence) | *P* (soft tissue recurrence) |
|---|---|---|---|---|---|
| Age (years) | | 36.2 (14-67) | | .99 | .54 |
| Gender | | | | 1.00 | .70 |
| | Male | | 37 (53.6) | | |
| | Female | | 32 (46.4) | | |
| Tumor grade (Campanacci) | | | | .38 | .14 |
| | Grade 1 | | 15 (21.7) | | |
| | Grade 2 | | 27 (39.1) | | |
| | Grade 3 | | 27 (39.1) | | |
| Tumor volume ($cm^3$) | | 182.8 (4.5-1205.4) | | 1.00 | .45 |
| Neo-adjuvant denosumab treatment | | | | .09 | .35 |
| | Yes | | 17 (24.6) | | |
| | No | | 52 (75.4) | | |
| Initial surgery | | | | .12 | 1.00 |
| | Curettage | | 55 (79.7) | | |
| | Resection | | 14 (20.3) | | |
| Local adjuvant | | | | .35 | 1.00 |
| | Yes | | 40 (58) | | |
| | No | | 15 (21.7) | | |
| | n/a | | 14 (20.3) | | |
| Tumor thrombus | | | | 1.00 | 1.00 |
| | Yes | | 7 (10.1) | | |
| | No | | 62 (89.9) | | |
| Presence of recurrence | | | | – | – |
| | Yes | | 24 (34.8) | | |
| | No | | 45 (65.2) | | |
| Tumor location | | | | .23 | .72 |
| | Upper extremity | | 15 (21.7) | | |
| | Lower extremity | | 52 (75.4) | | |
| | Axial skeleton | | 2 (2.9) | | |

n/a, not applicable.

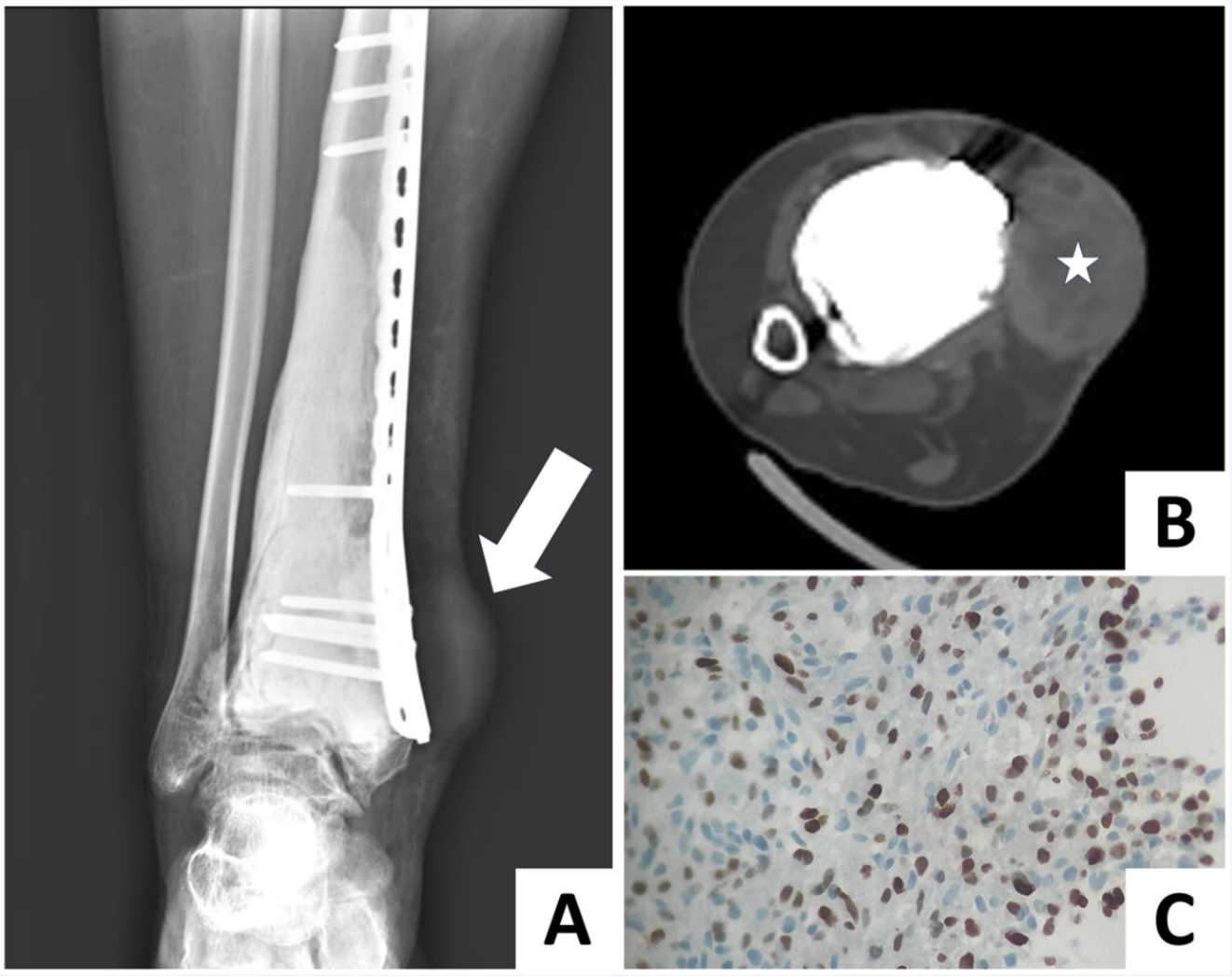


**Figure 1.** A 16-year-old female patient with a giant cell tumor of the distal tibia underwent curettage and cementation as the initial treatment. Intraosseous recurrence developed at 26 months and was treated with repeat curettage and cementation. A soft tissue recurrence occurred 55 months after this surgery and was classified as Type III according to Xu et al[7] and Cui et al.[8] (A) X-ray shows the soft tissue mass (arrow). (B) Computed tomography image highlights the lesion (star). (C) H3F3A staining reveals nuclear positivity.

margins, the patient developed a second STR 6 months later, presenting as a large, deep-seated mass. Closed biopsy demonstrated giant cell malignant fibrous histiocytoma, and due to the lesion's rapid enlargement with vascular involvement, high transfemoral amputation was performed. Histopathological evaluation of the amputation specimen revealed secondary malignant transformation with fibrosarcomatous features. Therefore, while the earlier benign recurrences were included in the analysis, the malignant lesion was excluded from the benign STR cohort (Figure 3). Additionally, 1 patient with STR developed a metachronous calvarial lesion 13 months after the initial diagnosis, which was histopathologically confirmed as GCTB. In terms of systemic progression, metastasis was documented in 8 patients overall. Notably, 3 of the 7 patients with STR (42.9%) developed pulmonary metastases, whereas only 5 of the remaining 62 patients without STR (8.1%) developed metastases. This difference was statistically significant (odds ratio=8.55, $P$=.029). No cases of tumor thrombus were observed in the STR group. The median follow-up duration after STR was 67.1 months (range: 14.1-229 months). Detailed clinical, radiological, and molecular characteristics of the 7 patients with STR are presented individually in Table 5.

Statistical analysis demonstrated that neither overall recurrence nor STR showed a significant association with age, gender, Campanacci grade, tumor volume, tumor localization, use of neoadjuvant denosumab, or local adjuvant use (all $P > .05$). Similarly, H3F3A mutation status, presence of metastasis, and tumor thrombus were not associated with STR. The type of treatment applied prior to recurrence also did not reach statistical significance. A detailed summary of these findings is provided in Table 4.

## Discussion

Soft tissue recurrence of bone-originated tumors is considered an inevitable consequence of prior contamination during the initial surgical intervention.[15] Although initially limited to case reports, recent years have seen a growing number of published case series focusing on this entity. In the study of Cooper et al[6] involving 1100 patients with GCT, 17 were identified with STR, with recurrence intervals ranging from 1 year to over 5 years. Histologically, these lesions resembled typical GCTB, while radiographically, they were similar to myositis ossificans, which is characterized by a peripheral calcified rim and a central radiolucent area. However, spontaneous regression,

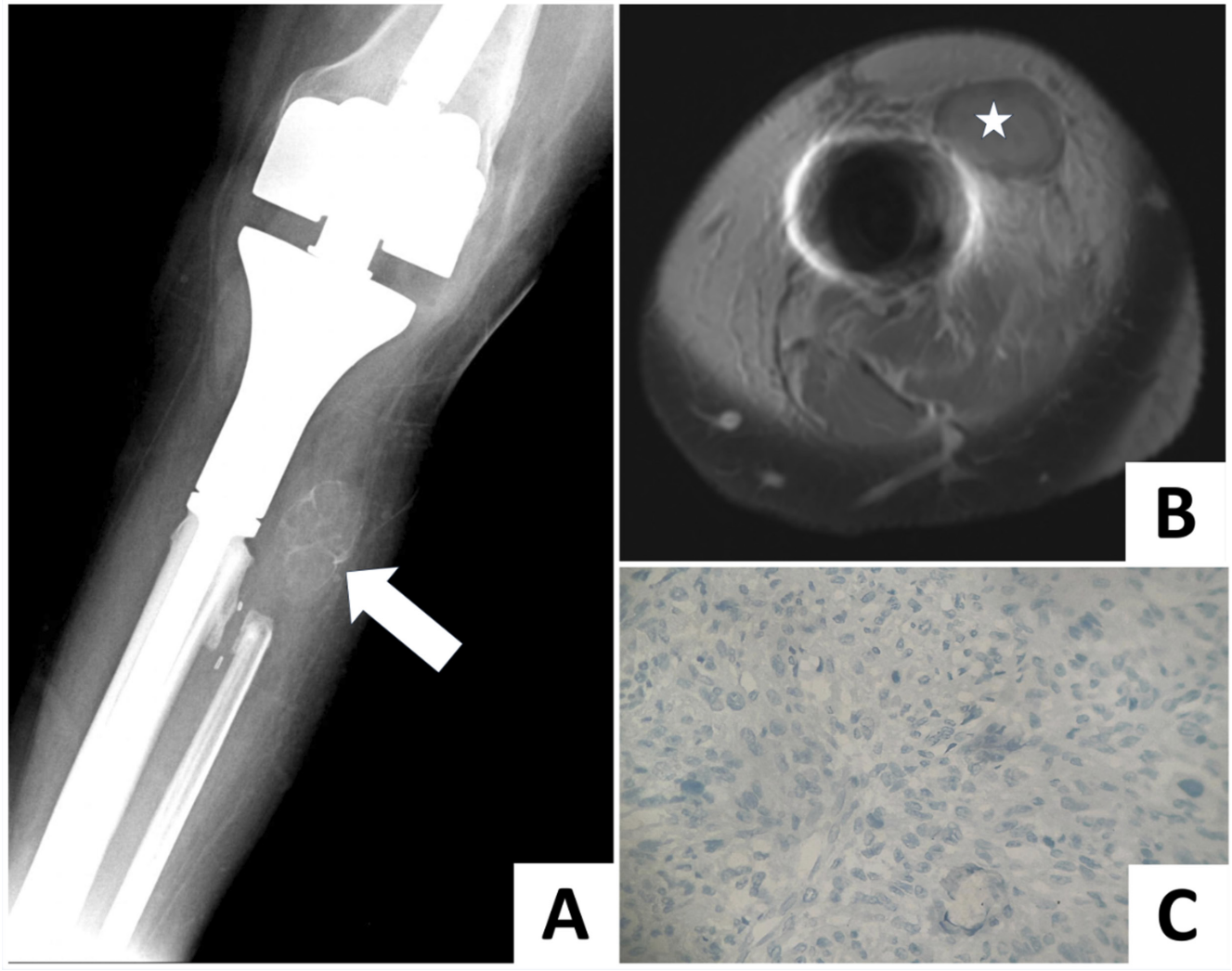


**Figure 2.** A 24-year-old female patient with a giant cell tumor of the proximal fibula was treated with resection and reconstruction using a knee megaprosthesis. Following 2 intraosseous recurrences, a soft tissue recurrence was detected at 38 months. The lesion was classified as Type I by Xu et al[7] and as Type I-2 by Cui et al.[8] (A) Radiograph shows peripheral soft tissue calcifications. (B) Axial magnetic resonance imaging demonstrates the lesion adjacent to the prosthesis. (C) H3F3A immunostaining is negative.

which is a key distinguishing feature of myositis ossificans, was not observed in cases of STR. In this study, the observed STR rate of 10.1% was notably higher than those reported by Xu et al[7] (2.1%) and Cui et al[8] (1.59%). This discrepancy may be attributed in part to the systematic use of advanced imaging modalities—particularly MRI and CT—which facilitate the detection of non-ossified lesions (Type III) that may be missed on plain radiographs. While the classification systems proposed by Xu and modified by Cui provide a practical framework for radiologic evaluation, the absence of Type II lesions in this series suggests that centrally ossified patterns are rare. The predominance of Type III lesions across all 3 studies further underscores the limitations of imaging protocols focused solely on mineralized tissue. Additionally, incorporating routine ultrasonography, especially for anatomically superficial regions, may improve early detection and provide a more accurate estimation of true STR incidence. Notably, although no statistically significant association was found between Campanacci grade and overall recurrence, Grade 3 lesions accounted for 39.1% of the cases, a proportion higher than those reported in comparable studies, which may also contribute to the elevated STR rate observed in this cohort by reflecting a more aggressive tumor phenotype prone to extraosseous dissemination.[16-18] One patient developed a metachronous lesion in the calvarium, and 3 patients developed pulmonary metastases. Pulmonary metastasis is a well-recognized event in GCTB, particularly in cases with recurrence.[19] In this series, metastatic disease was more frequently observed in patients with STR, suggesting that the presence of STR may be associated with a higher risk of systemic spread. This underscores the importance of vigilant pulmonary surveillance once STR is detected, as timely identification of metastasis could impact both prognosis and treatment planning. Since the literature recommends metastatic screening every 6 months and favors thorax CT over radiography, strict adherence to follow-up protocols is particularly crucial in this subgroup.[19] Another patient, who was ultimately diagnosed with secondary malignant transformation with fibrosarcomatous differentiation, underwent high transfemoral amputation and died of disease within 2 years.

Soft tissue recurrence was also identified in anatomical regions with limited soft tissue coverage, suggesting that such areas may be predisposed to this pattern of recurrence. Notably, 4 out of 7 patients with STR had primary tumors located in the distal medial tibia, proximal ulna, distal radius, and proximal fibula, consistent with previous studies reporting a higher likelihood of STR in anatomically superficial locations.[20] Among the 7 patients with STR in this cohort, 4 had

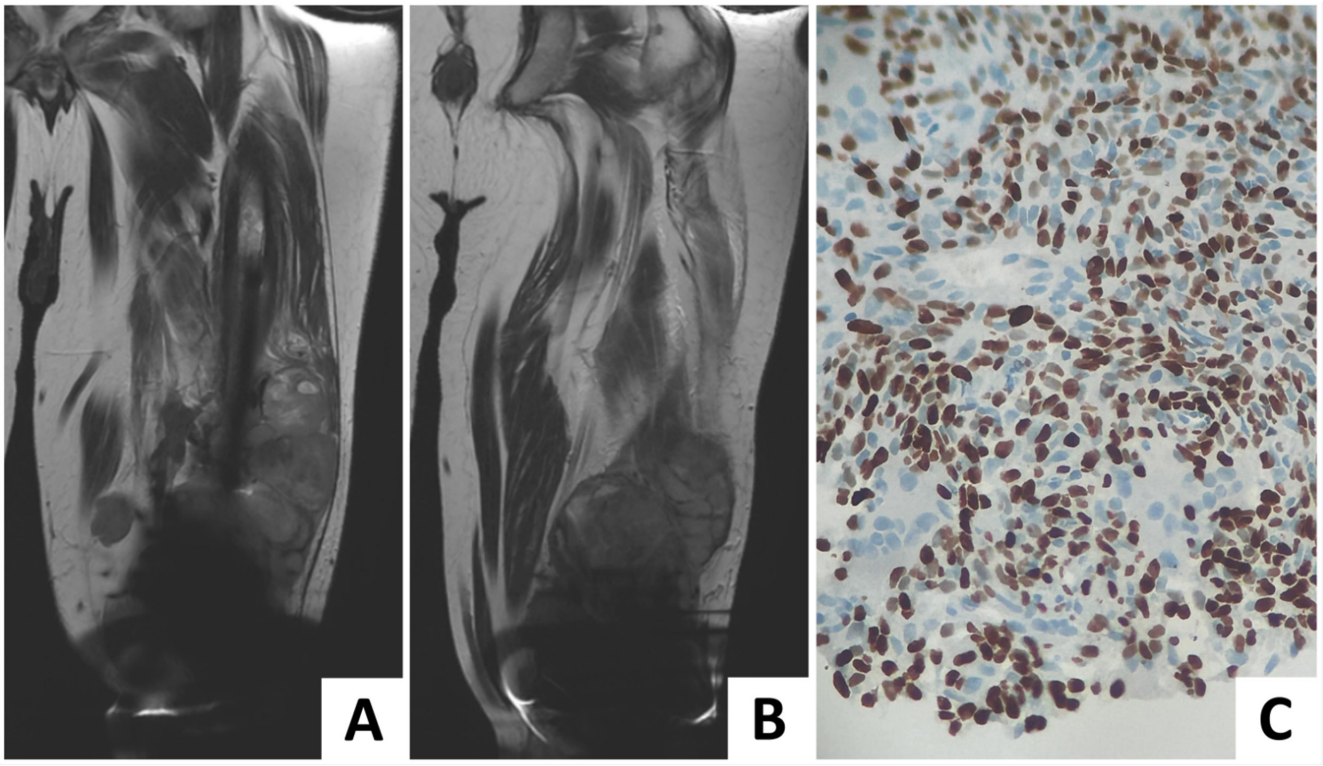


**Figure 3.** A 51-year-old male with a distal femoral giant cell tumor of the bone (GCTB) underwent resection and prosthesis. At 12 months, a soft tissue recurrence was excised and confirmed as GCTB. Six months later, the patient presented with a deep-seated mass larger than 5 cm, and biopsy demonstrated giant cell malignant fibrous histiocytoma. Due to rapid progression and vascular invasion, a high transfemoral amputation was required. Pathology revealed secondary malignant GCTB with fibrosarcomatous differentiation. (A and B) Coronal magnetic resonance imaging showing a multilobulated soft tissue mass. (C) H3F3A immunostaining with strong nuclear positivity.

a history of prior intraosseous recurrence, consistent with previous studies indicating that STR frequently occurs in the setting of preceding intraosseous relapse.[6,8] However, unlike earlier reports describing multiple relapses after excision of STRs, no further recurrence was observed in the patients after surgical removal of the STR.[20]

Although the H3F3A mutation has been well established as a diagnostic marker for primary and recurrent GCTB in previous studies,[9,10] this study first investigated its status in STR specimens. None of the patients had received denosumab prior to the development of STR; immunohistochemical staining was positive in 3 out of 6 STRs, indicating a suboptimal diagnostic yield. To further clarify these findings, the corresponding primary tumors of the same patients were subsequently analyzed, revealing the same staining pattern. This concordance demonstrates that H3F3A status was preserved in STRs, supporting its stability throughout disease progression. Nevertheless, the limited positivity highlights the need for larger comparative studies to better assess the diagnostic reliability of H3F3A in extraosseous lesions.

**Table 5.** Demographic, clinical, and pathological characteristics of patients with soft tissue recurrence

| Patient | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Age, years | 35 | 41 | 51 | 16 | 24 | 37 | 27 |
| Gender | Male | Male | Male | Female | Female | Female | Female |
| Localization | Distal femur | Distal femur | Distal femur | Distal tibia | Proximal fibula | Proximal ulna | Distal radius |
| Campanacci grade | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| Neoadjuvant denosumab use | No | No | No | Yes | Yes | No | Yes |
| Total recurrence count | 1 | 4 | 2 | 2 | 3 | 1 | 1 |
| Presence of previous bone recurrence | No | Yes | Yes | Yes | Yes | No | No |
| Time to soft tissue recurrence (mo) | 6.5 | 3 | 12 | 54.9 | 24 | 70 | 11 |
| Follow-up after soft tissue recurrence (mo) | 100.4 | 198.2 | 18.3 | 35 | 67.1 | 14.1 | 229 |
| Total follow-up (mo) | 106.9 | 217.2 | 30.3 | 115.9 | 105.1 | 84.1 | 240 |
| Xu et al[7] classification | Type III | Type I | Type III | Type III | Type I | Type I | Type III |
| Cui et al[8] classification | Type III | Type I-2 | Type III | Type III | Type I-2 | Type I-1 | Type III |
| H3F3A mutation | Yes | No | Yes | Yes | No | No | – |
| Treatment of recurrence | Excision | Excision | Excision | Excision | Excision | Excision | Excision |
| Malign transformation | No | No | Yes | No | No | No | No |
| Tumor thrombus | No | No | No | No | No | No | No |
| Metastasis | Yes | Yes | No | No | Yes | No | No |

mo, months.

Previous studies have suggested that tumor embolism may be associated with pulmonary nodules and that repeated surgical interventions could increase the risk of tumor embolism and subsequent metastasis.[21] In this study, the potential association between vascular thrombus formation and STR was evaluated; however, no positive correlation was identified.

This study has limitations. H3F3A immunohistochemistry was not assessed in all patients, including those without recurrence, which limits conclusions on its prognostic role and importance in STR. In addition, the retrospective design, small sample size, and particularly the low number of STR cases reduce the statistical power and generalizability of the results.

In conclusion, STR of GCTB is an underrecognized yet clinically significant phenomenon. This study demonstrates that such recurrences may occur even in the absence of prior intraosseous recurrence and may be influenced by anatomical factors such as soft tissue coverage. While en bloc excision appears to offer definitive treatment with no observed re-recurrence, the role of H3F3A mutation as a reliable diagnostic marker in STRs remains questionable. Importantly, clinicians should also be aware that lesions presenting as STRs may, in some cases, represent malignant transformation. Moreover, STR appears to be associated with a higher risk of pulmonary metastasis, underscoring the need for strict thoracic surveillance with periodic CT imaging. The relatively high rate of STR observed in this cohort highlights the need for heightened vigilance during long-term follow-up, particularly in anatomically predisposed regions. Further research is warranted to clarify the pathophysiology, refine diagnostic strategies, and optimize management protocols for this unique recurrence pattern in GCTB.

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

**Ethics Committee Approval:** Ethical committee approval was received from the Ethics Committee of Çukurova University Faculty of Medicine (Approval No.: 152/54; Date: February 7,2025).

**Informed Consent:** Written informed consent was obtained from the patients/patient who agreed to take part in the study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – A.M., K.E.E., M.A.D.; Design – A.M., K.A.D., B.K., K.E.E.; Supervision – M.B., K.E.E., M.A.D.; Materials – A.M., K.E.E., M.A.D.; Data Collection and/or Processing – K.A.D., H.C.O., B.K.; Analysis and/or Interpretation – K.A.D., H.C.O.; Literature Search – A.M., H.C.O., B.K., M.B.; Writing – A.M., K.A.D., H.C.O.; Critical Review – K.E.E., M.A.D.

**Declaration of Interests:** Mehmet Ali Deveci is an Associate Editor at Acta Orthopaedica et Traumatologica Turcica, however; his involvement in the peer review process was solely as an author. The other authors have no conflict of interest to declare.

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