Beyond Ewing: Intraosseous Synovial Sarcoma of the the Femur in an Adolescent with Overlapping Imaging Features

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Abstract

Introduction: Primary intraosseous synovial sarcoma is an exceptionally rare malignant tumor of bone and may closely mimic other aggressive primary bone malignancies on imaging, particularly Ewing sarcoma, thereby posing a significant diagnostic challenge for radiologists.

Case Report: We report the case of a 15-year-old female adolescent who presented with a rapidly enlarging painful mass of the left proximal femur associated with limping and functional limitation following a minor fall, for which she initially did not seek medical care and instead underwent traditional massage therapy. Plain radiographs demonstrated a mixed lytic-blastic lesion of the proximal femur with permeative bone destruction and an associated soft tissue mass, suggesting an aggressive primary bone tumor. Magnetic resonance imaging revealed extensive bone marrow replacement of the proximal femur with a large extraosseous soft tissue component, showing heterogeneous signal intensity, intralesional hemorrhage, marked diffusion restriction with low apparent diffusion coefficient values, and an early wash-in–wash-out enhancement pattern on dynamic contrast-enhanced imaging, reflecting high tumor cellularity and neovascularity. The lesion infiltrated adjacent muscle compartments and encased major femoral vessels. Chest imaging demonstrated bilateral pulmonary metastases with pleural involvement, consistent with advanced-stage disease. Histopathological examination and immunohistochemical analysis confirmed the diagnosis of primary intraosseous synovial sarcoma.

Discussion: This case highlights the substantial overlap in imaging features between primary intraosseous synovial sarcoma and Ewing sarcoma and underscores the pivotal role of advanced multimodal MRI in refining the differential diagnosis and guiding definitive histopathological confirmation.

Conclusion: Recognition of this rare entity is essential for accurate diagnosis, staging, and optimal management planning in adolescent patients presenting with aggressive malignant bone tumors.

Keyword: Primary Synovial Sarcoma of Bone, Bone Neoplasms, Ewing Sarcoma Mimicker, Pediatric Oncology

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1. INTRODUCTION

Primary intraosseous synovial sarcoma is an exceptionally rare malignant tumor of bone and may closely mimic other aggressive primary bone malignancies on imaging, particularly Ewing sarcoma, thereby posing a significant diagnostic challenge for radiologists. [1,2]

Despite their designation, synovial sarcomas do not arise from synovial tissue. Rather, they are classified as mesenchymal spindle cell neoplasms that exhibit variable epithelial differentiation. These tumors are characterized by a distinctive chromosomal translocation between the SS18 and SSX1 genes, producing the SS18–SSX fusion oncogene.[3] The resulting fusion protein interferes with the normal regulation of multipotent mesenchymal stem cells, which are thought to represent the cell of origin for synovial sarcoma.[4]

Only a limited number of radiologically documented cases of primary intraosseous synovial sarcoma have been described, most of which appear as isolated case reports. [5] Synovial sarcoma most commonly affecting adolescents and young to middle-aged adults. It accounts for approximately 5–10% of all soft tissue sarcomas and typically develops in close proximity to joint spaces, while primary involvement of visceral organs or bone is exceedingly rare.[6] Awareness of this rare entity is crucial for accurate diagnosis and management.

This study was approved by Medical Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, East Java, Indonesia. The patient's guardians have given their written informed consent to participate in this study.

2. CASE REPORT

We report the case of a 15-year-old female adolescent who presented with a rapidly enlarging painful mass of the left proximal femur associated with limping and functional limitation following a minor fall, for which she initially did not seek medical care and instead underwent traditional massage therapy. There was no significant past medical history, no family history of tumors, and no prior exposure to chemotherapy or radiotherapy.

Physical examination revealed a firm, immobile, skin-colored mass in the left femoral region measuring approximately 10 × 16 cm, with tenderness on palpation, with ill-defined borders and irregular edges, no overlying skin changes or venous ectasia, and markedly limited left hip range of motion due to pain (Fig.1).

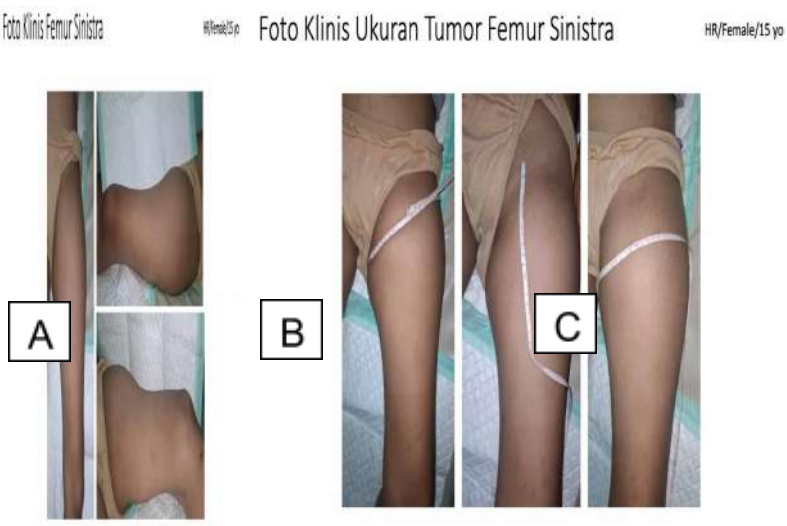

Figure 1. A. Clinical photographs of the left thigh showing asymmetric proximal thigh enlargement with **(B,C)** longitudinal and circumferential measurements.

Plain radiographs was taken to rule out fracture, but instead demonstrated a mixed lytic–blastic lesion of the proximal femur with permeative bone destruction and an associated soft tissue mass, suggesting an aggressive primary bone tumor such as Osteosarcoma or Ewing's Sarcoma (Fig.2).

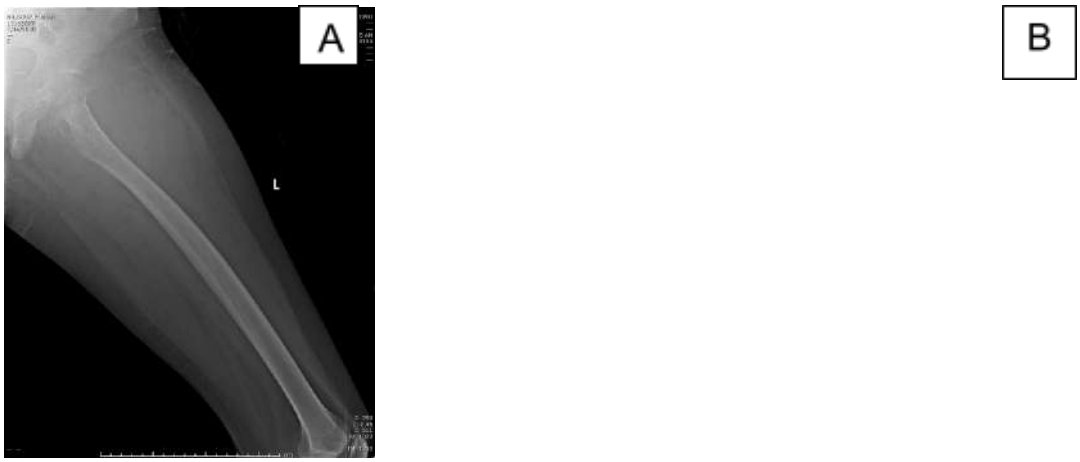

Figure 2. Plain radiographs of the left femur **(A)** AP view **(B)** Magnified view demonstrating (arrows)

MRI revealed extensive bone marrow replacement with ill-defined and irregular margins involving the proximal epimetadiaphysis of the left femur, extending approximately 10.3 cm. The lesion appeared isointense on T1-weighted images and hyperintense on T2-weighted images and STIR sequences. Diffusion-weighted imaging showed marked restricted diffusion with low ADC values ($0.7–0.8 \times 10^{-3}$ mm^2/s), consistent with a highly cellular malignant tumor. Post-contrast images demonstrated heterogeneous enhancement with areas of necrosis and a type IV (washout) dynamic enhancement pattern, suggestive of aggressive tumor vascularity.

There was associated cortical destruction of the proximal metadiaphysis with epiphyseal sparing. A bulging soft tissue mass with solid components demonstrated similar signal characteristics and enhancement patterns. Tumor infiltration was noted in the anterior muscle compartment (vastus lateralis, intermedius, and medialis) and the medial compartment (adductor longus). The mass displaced the left common femoral artery, vein, and nerve anteromedially without extension into the left hip joint. The lesion also infiltrated adjacent muscle compartments.

The combined size of the bone lesion and surrounding soft tissue mass measured approximately 13.1 × 12.0 × 16.2 cm. Overall imaging findings were highly suggestive of an aggressive primary malignant bone tumor with extensive soft tissue involvement. (Fig 3).

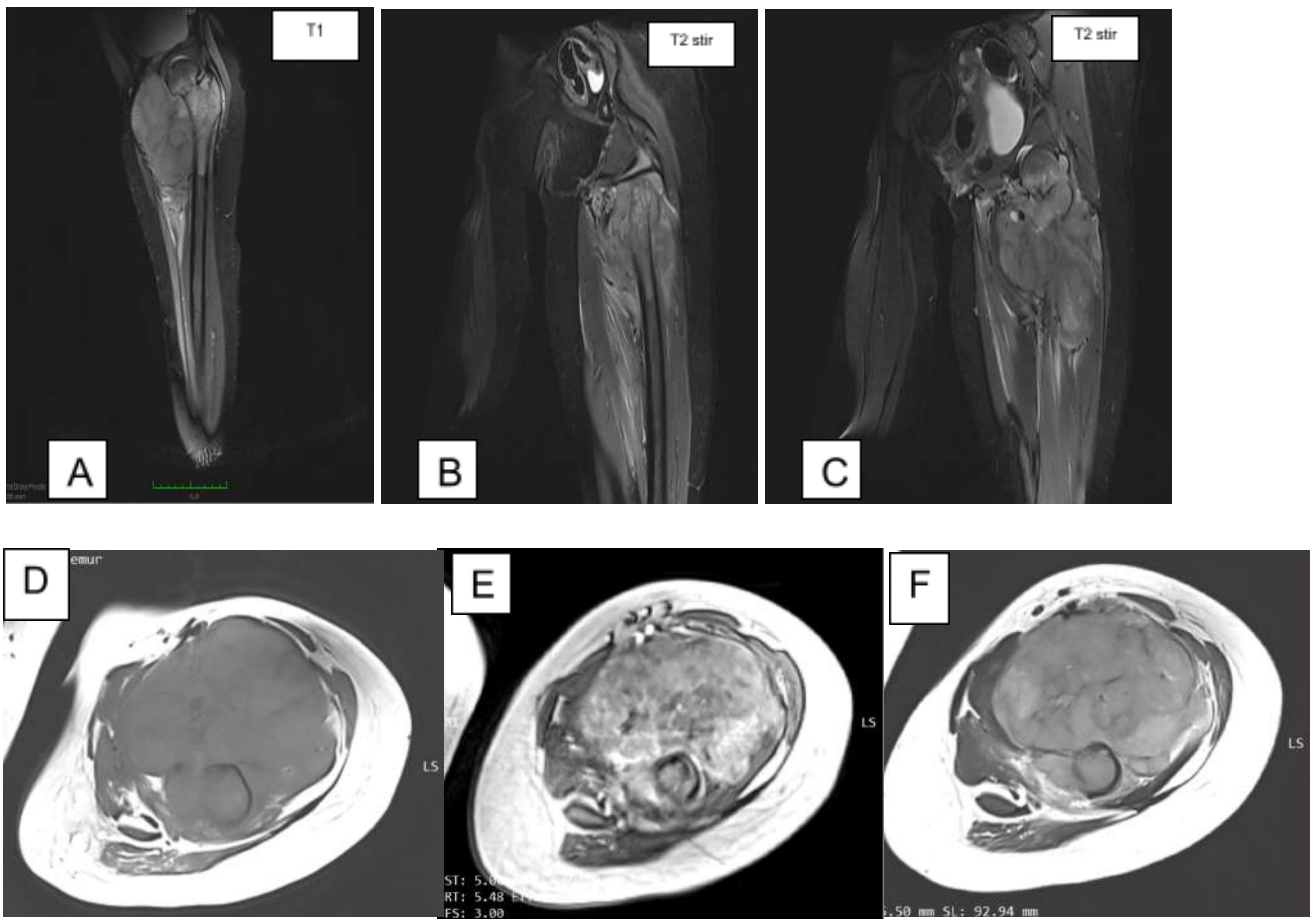

Figure 3. MRI of the left femur demonstrating an aggressive bone tumor with extensive soft tissue involvement, **(A)** T1 sagittal , **(B,C)** Coronal Short-Tau Inversion Recovery (STIR) T2. **(D)** T1 Axial, **(E)** T1 Axial + Contrast, **(F)** T2 Axial

Chest imaging demonstrated bilateral pulmonary metastases with pleural involvement, consistent with advanced-stage disease (Fig 4).

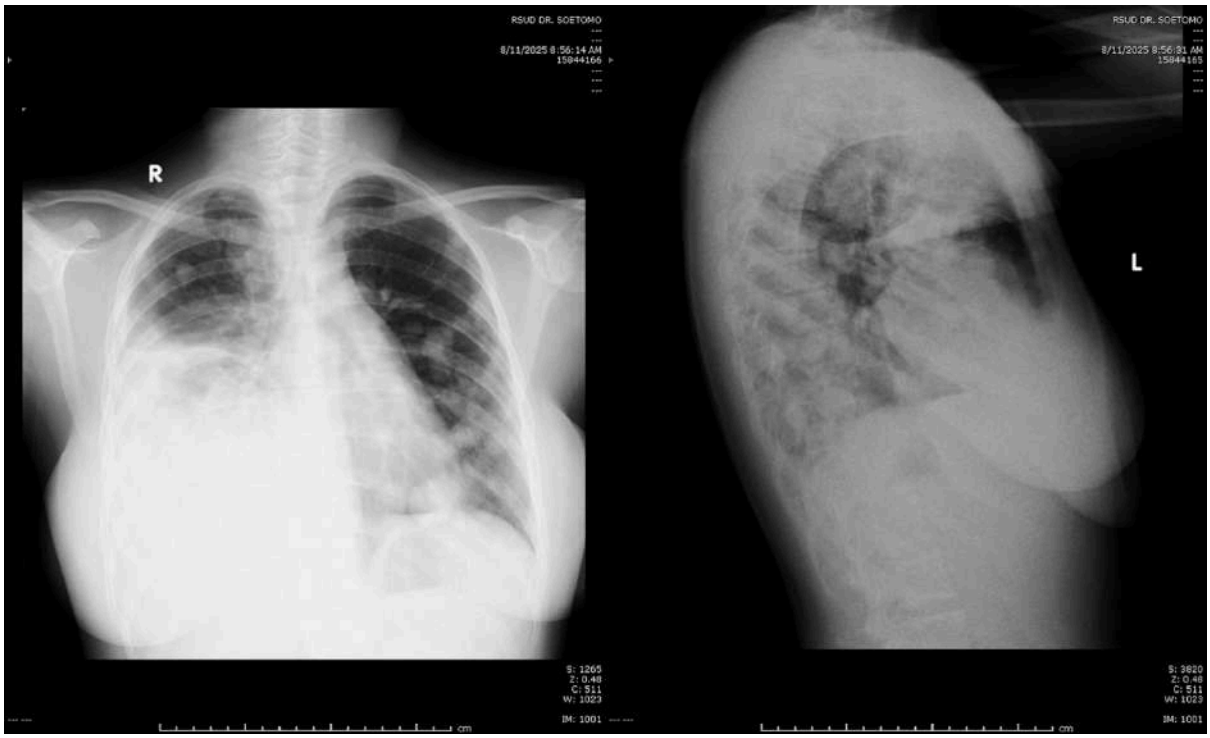

Figure 4. Chest X-ray AP & Lateral View

Fine-needle aspiration biopsy (FNAB) revealed anaplastic tumor cells with oval to spindle-shaped nuclei showing marked pleomorphism and hyperchromasia, consistent with a high-grade malignant neoplasm. (Figure 5) However, the sarcoma subtype could not be determined based on cytological findings alone, and histopathological examination was therefore warranted for definitive diagnosis.

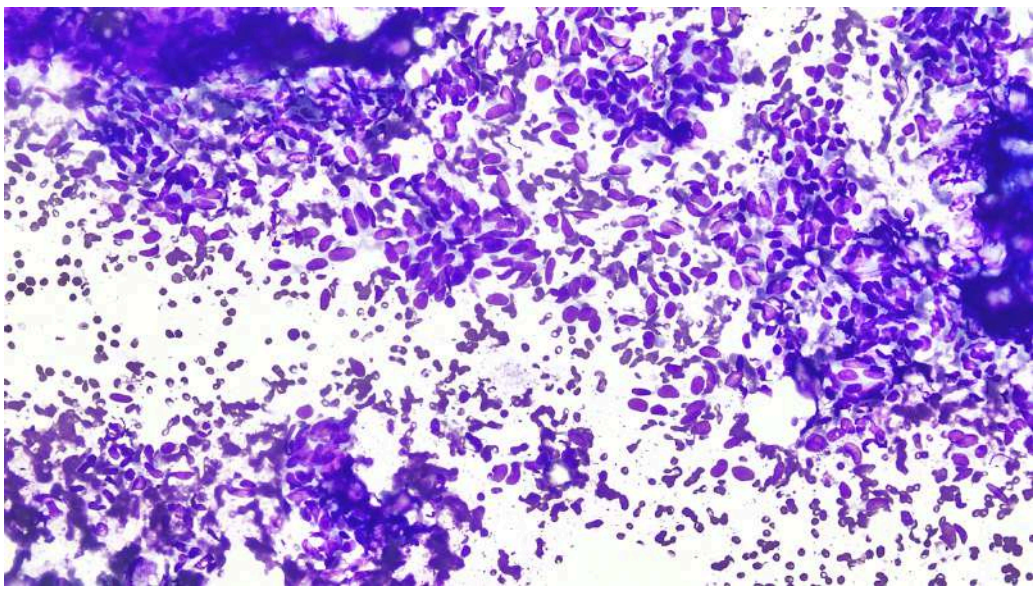

Figure 5. FNAB of the Tumor (400x Magnification)

Core biopsy of the femoral lesion demonstrated a proliferative spindle cell tumor composed of oval to spindle-shaped hyperchromatic nuclei, with increased mitotic activity (12 per 10 high-power fields). Focal areas showed tumor cell groupings with a gland-like pattern. (Figure 6) These features favored a working diagnosis of synovial sarcoma of bone, with malignant peripheral nerve sheath tumor (MPNST) of bone as a key differential diagnosis. Immunohistochemical studies are required to confirm the final diagnosis.

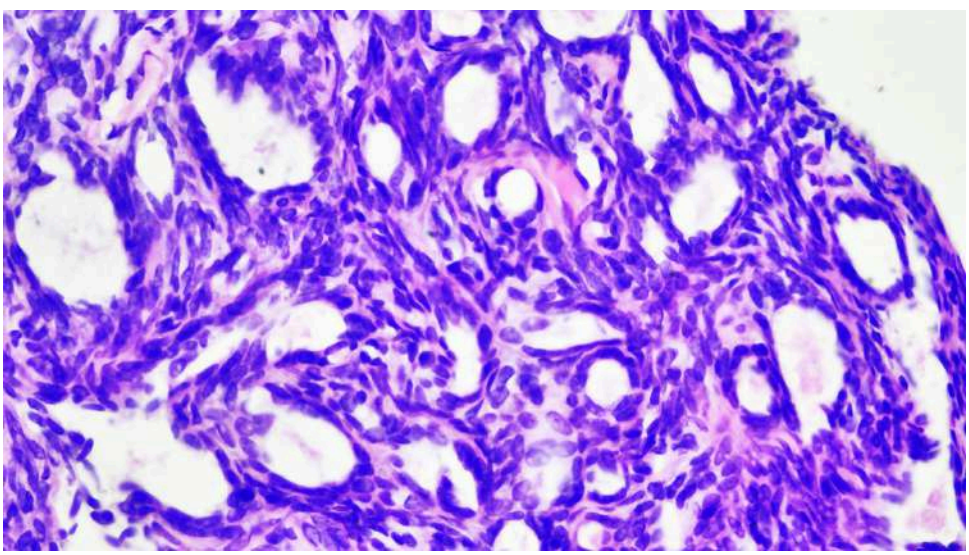

Figure 6. Core Biopsy of the Tumor

The immunohistochemical profile shows strong support for a diagnosis of synovial sarcoma of bone. Tumor cells demonstrate cytoplasmic positivity for epithelial membrane antigen (EMA) in the glandular components, along with diffuse nuclear positivity for TLE-1 and strong expression of BCL-2 and CD99. These findings are characteristic of synovial sarcoma. The absence of S100 expression argues against malignant peripheral nerve sheath tumor (MPNST), while negative SATB2 staining excludes an osteoblastic lineage. Taken together, the histomorphology and immunohistochemical results are consistent with synovial sarcoma of bone, confirming the working diagnosis. (Figure 7)

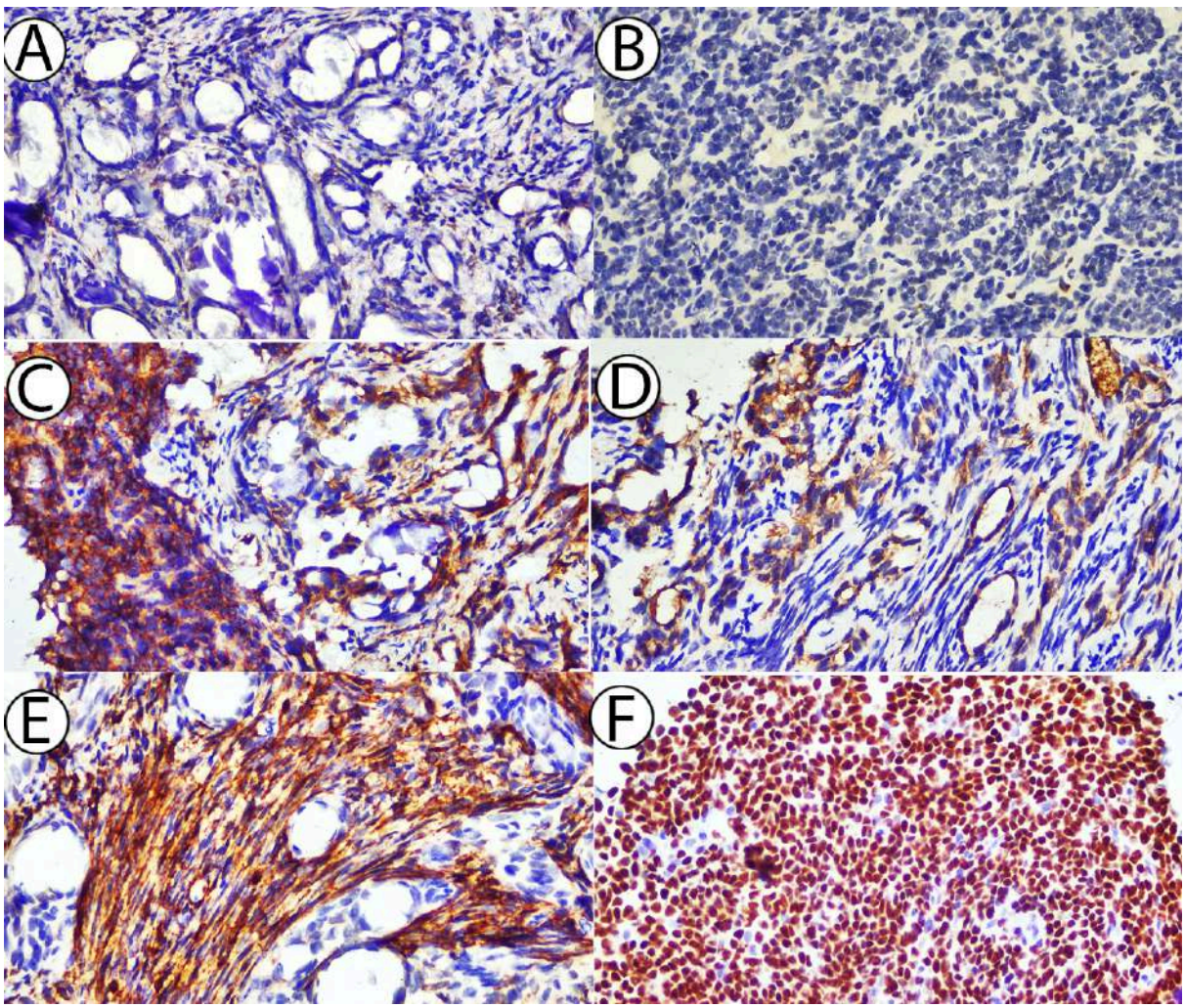

Figure 7. Immunohistochemistry slides (400x Magnification). **(A)** SAT B2 **(B)** S100 **(C)** CD99 **(D)**EMA

(E)BCL2 (F)TLE1

3. DISCUSSION

Synovial sarcoma is an uncommon malignant mesenchymal tumor, accounting for approximately 5–10% of all soft tissue sarcomas, with an estimated annual incidence of approximately 1.3–1.6 cases per million individuals.[5] Primary synovial sarcoma arising within bone is an even more exceptionally rare entity, particularly in the pediatric and adolescent population. Because synovial sarcoma typically originates in deep soft tissues, primary intraosseous involvement is often not initially considered.[7] Consequently, its clinical and radiologic presentation frequently overlaps with more prevalent malignant bone tumors such as Ewing sarcoma and osteosarcoma, resulting in significant diagnostic challenges.[8] In the present case, features including aggressive osteolysis, a prominent extraosseous soft-tissue mass, spindle-cell morphology, and early pulmonary metastases supported the presence of a high-grade sarcoma and underscored the aggressive biological behavior of this neoplasm.

A history of antecedent trauma has been described in a subset of synovial sarcoma cases; however, current evidence suggests that trauma is more likely coincidental and serves to draw clinical attention to an already existing lesion rather than acting as an etiologic factor [9]. This case highlights the importance of maintaining a high index of suspicion when evaluating persistent pain, swelling, or functional limitation in adolescents, particularly when symptoms fail to resolve with conservative management. Early imaging and tissue diagnosis are critical to avoid delays in appropriate treatment.

The histogenesis of synovial sarcoma remains controversial; proposed cells of origin include multipotent mesenchymal stem cells with the capacity for epithelial and mesenchymal differentiation. Histologically, synovial sarcoma is classified into monophasic, biphasic, and poorly differentiated subtypes. The poorly differentiated variant, in particular, may closely resemble other small round-cell malignancies, including Ewing sarcoma, lymphoma, and rhabdomyosarcoma, thereby increasing the risk of misdiagnosis. [3]

Synovial sarcoma exhibits a wide range of radiographic features across X-ray, CT, and MRI modalities, reflecting its heterogeneous composition and variable growth behavior. On plain radiographs, early or small lesions often present as nonspecific soft-tissue masses; however, calcifications are observed in up to 30% of cases. These calcifications are typically punctate, stippled, or peripheral and may prompt suspicion of synovial sarcoma, particularly in young patients with deep-seated soft-tissue lesions. In some cases, radiographs may also demonstrate bone erosion or pressure-related changes when the tumor is in close proximity to adjacent osseous structures.[10]

MRI represents the gold standard for imaging soft tissue masses and is the optimal technique for evaluating the extent and internal characteristics of synovial sarcomas. It also contributes significantly to staging and treatment planning and is therefore integral to patient assessment. However, SS is often misdiagnosed as benign on MRI, most commonly as neurogenic tumors in the upper extremities and as cystic lesions in the lower extremities. Smaller tumors usually appear homogeneous and therefor misdiagnosed as neurogenic tumor. Larger lesions (>5 cm) tend to be heterogeneous with cystic or necrotic components, leading to frequent misinterpretation as cystic masses [8].

MRI remains the modality of choice for evaluating synovial sarcoma due to its superior soft tissue contrast and detailed signal characterization. On MRI, synovial sarcomas typically present as multilobulated, heterogeneous masses with T1 signal that is isointense or slightly hypointense to muscle and marked T2 hyperintensity, reflecting a mixture of solid tumor, cystic areas, hemorrhage, and myxoid stroma. Distinctive patterns such as the “triple sign” — co-existence of high, intermediate, and low signal intensities on T2 — and the “bowl of grapes” appearance due to fluid-fluid levels and septations, are suggestive, though not pathognomonic, features of synovial sarcoma [11]. These MRI characteristics assist in differentiating synovial sarcoma from benign soft-tissue lesions and inform surgical planning and staging.

The chromosomal abnormality underlying SS can be identified using fluorescence in situ hybridization (FISH) or reverse transcription polymerase chain reaction (RT-PCR). Nevertheless, factors such as expense, specialized instrumentation, and limited access hinder the widespread use of these techniques[12]. Most center pivot to Immunohistochemistry as a more efficient confirmation test.

Diagnosis in the majority of cases relied on a combination of IHC markers, most commonly TLE1, CD56, CD99, BCL2, and EMA Among the commonly used immunohistochemical markers, TLE1 showed the highest specificity. SS18–SSX immunostaining was also useful and highly sensitive if the translocation is positive. [12]

This case highlights the importance of considering rare diagnoses such as intraosseous synovial sarcoma in adolescents presenting with aggressive bone tumors, particularly when imaging findings are not entirely typical for more common entities such as Ewing sarcoma or osteosarcoma.

4. CONCLUSION

Primary synovial sarcoma of the bone should be considered in the differential diagnosis of aggressive primary bone tumors in adolescents. Early suspicion, timely diagnostic workup, and multidisciplinary

management are essential due to the tumor's aggressive behavior and high metastatic potential.

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