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Imaging Characteristics of Tenosynovial Giant Cell Tumor of The Knee: A Multimodal Approach Integrating MRI and Ultrasound

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Abstract | **Case Report**

Tenosynovial Giant Cell Tumor (TGCT), formally known as pigmented villonodular synovitis (PVNS) is a rare, benign yet locally aggressive proliferative disorder of the synovial membrane, primarily affecting large joints such as the knee [1]. It presents with nonspecific symptoms, often leading to delayed diagnosis [2]. Imaging, particularly MRI, plays a crucial role in detecting characteristic features such as joint effusion, synovial hypertrophy, and hemosiderin deposition [3]. This case study reports a 55-year-old male presenting with chronic knee swelling, confirmed as pigmented villonodular synovitis through imaging and histopathology. Management strategies include surgical synovectomy, adjunctive radiation, and emerging systemic therapies targeting CSF-1. This article highlights the diagnostic approach, treatment modalities, and prognostic considerations based on current literature.

Keywords: MRI, Ultrasound, Tenosynovial Giant Cell Tumor, pigmented villonodular synovitis.

INTRODUCTION

Tenosynovial Giant Cell Tumor (TGCT) is a rare proliferative disorder of the synovial membrane, characterized by synovial hyperplasia, hemosiderin deposition, and chronic inflammation. It predominantly affects large joints, with the knee being the most common site. TGCT can be classified into localized and diffuse forms, with the latter being more aggressive and prone to recurrence. Due to its nonspecific clinical presentation, TGCT is often misdiagnosed as inflammatory arthritis or other synovial pathologies. Imaging modalities such as MRI play a crucial role in differentiating it from other joint disorders. Histopathological confirmation remains essential for definitive diagnosis. This article presents a case of Tenosynovial giant cell tumour in a 55-year-old male and discusses its pathophysiology, diagnostic considerations, treatment options, and long-term prognosis.

CASE REPORT

A 55-year-old male presents with a knee mass evolving over the past year. A knee ultrasound was performed, revealing a large joint effusion along with synovial proliferation suggestive of Tenosynovial Giant Cell Tumor (TGCT).

To further evaluate these findings, an MRI was performed with the following sequences:

- T1-weighted axial and coronal
- T2 and T2* axial and coronal
- STIR coronal and sagittal
- T1 FS sagittal before and after gadolinium injection

MRI findings revealed a large-volume joint effusion in the left knee, appearing hypointense on T1-weighted images, hyperintense on T2-weighted, with septations. There was diffuse and irregular thickening of the synovial membrane, exhibiting a frond-like appearance in certain areas. The synovial thickening appeared isointense on both T1 and T2-weighted images, with some focal hyperintense areas on T1 and signal voids on T2* sequences. This thickening showed intense contrast enhancement and measured a maximum thickness of 31 mm, strongly suggestive of pigmented villonodular synovitis (PVNS). Additionally, tricompartmental knee osteoarthritis with grade IV chondropathy was observed.

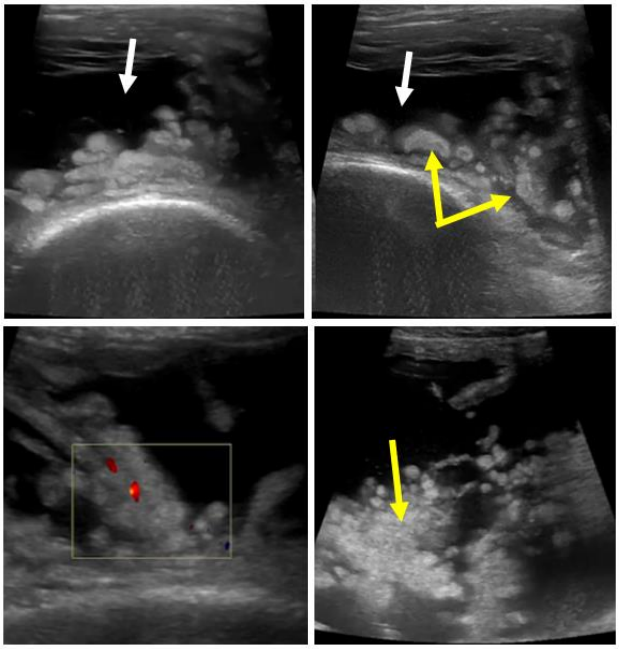

Figure 1: Ultrasound image of the left knee showing a significant joint effusion (white arrow) and synovial thickening (yellow arrow) with increased vascularity on color Doppler

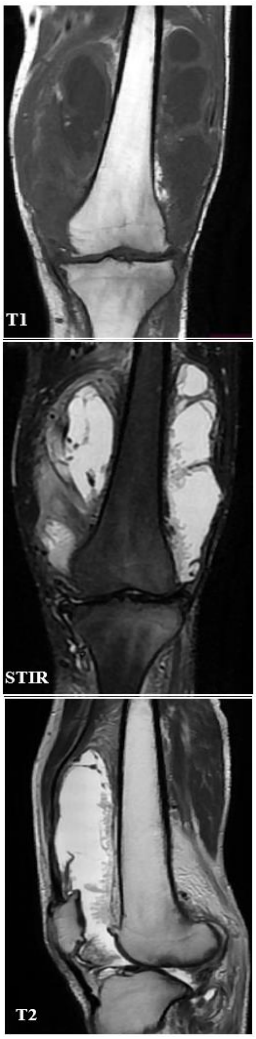

Figure 2: coronal and sagittal Knee MRI showing a large-volume joint effusion in the left knee, appearing hypointense on T1, hyperintense on T2 and STIR, with septations

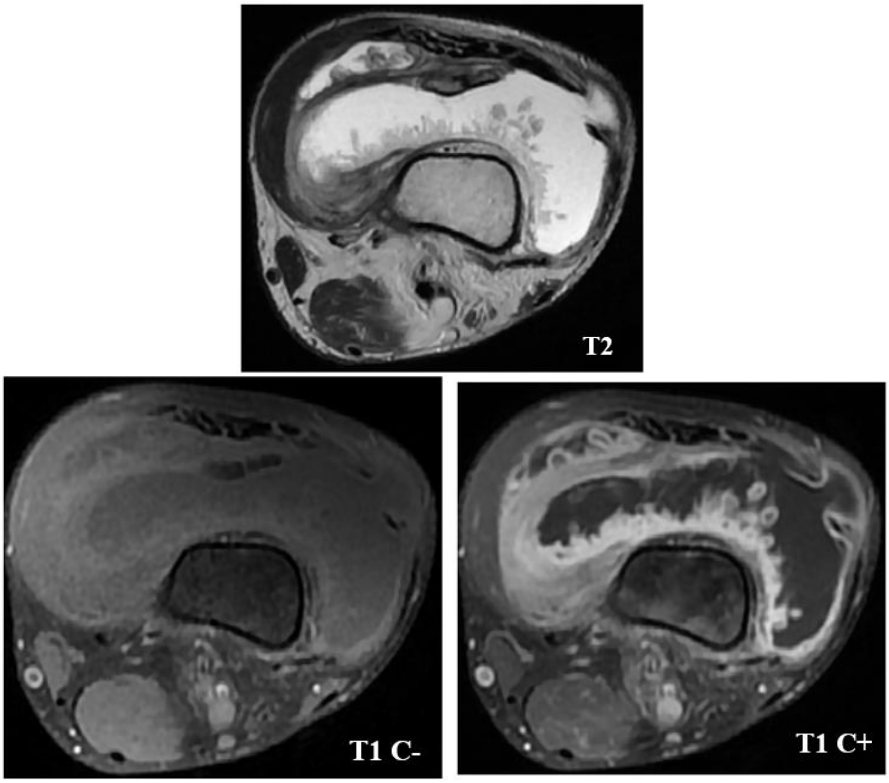

Figure 3: Axial Knee MRI showing diffuse and irregular thickening of the synovial membrane, exhibiting a frond-like appearance. The synovial thickening appeared isointense on both T2 and T1-weighted without contrast enhancement, and showed intense contrast enhancement in T1-weighted post-contrast

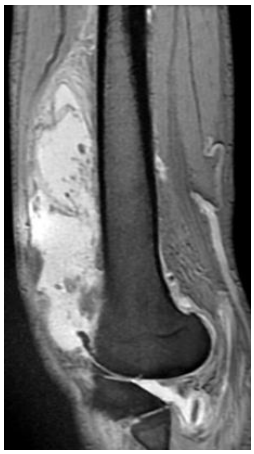

Figure 4: Sagittal Knee MRI acquired with a MERGE sequence (T2* weighted) showing signal voids within the irregularly thickened synovial membrane

DISCUSSION

Tenosynovial giant cell tumor (TGCT), formerly known as pigmented villonodular synovitis is a rare, locally aggressive proliferative disorder of the synovial membrane, often affecting large joints such as the knee [1]. The current case highlights a 55-year-old male presenting with a chronic knee mass, confirmed by imaging studies to be consistent with PVNS. The discussion aims to contextualize these findings within the existing literature while addressing diagnosis, pathophysiology, treatment, and prognosis.

TGCT is characterized by abnormal proliferation of synovial tissue with hemosiderin deposition, leading to chronic inflammation and joint destruction [2]. MRI findings play a pivotal role in diagnosis, with classical features including joint effusion, synovial hypertrophy, and characteristic blooming artifacts on T2*sequences due to hemosiderin deposition [3]. In this case, MRI revealed extensive synovial thickening with signal voids on T2*, aligning with the classical imaging criteria. The presence of hypervascularity on Doppler ultrasound further supports the diagnosis [2,5].

The clinical presentation of TGCT is often insidious, with symptoms overlapping with other intra-articular pathologies, such as inflammatory arthritis and synovial chondromatosis [2,4]. Although MRI remains

the gold standard, histopathological confirmation is essential to differentiate TGCT from malignant synovial pathologies, such as synovial sarcoma [6]. The observed histological pattern "diffuse synovial thickening with hemosiderin-laden macrophages" remains a key diagnostic hallmark [2,7].

Management of TGCT is challenging due to its high recurrence rate. Surgical resection via **a**rthroscopic or open synovectomy remains the mainstay of treatment [3]. However, diffuse TGCT has been associated with high recurrence rates following surgery alone, necessitating adjunctive therapies such as radiation therapy and targeted molecular treatments. Recent advances in CSF-1 inhibition therapy have shown promise in mitigating disease progression, particularly in cases with extensive synovial involvement [1,7].

Despite advances in treatment, TGCT remains associated with a high risk of recurrence and joint degeneration, often leading to secondary osteoarthritis, as observed in this case [3,5]. Long-term follow-up is crucial to monitor for recurrence, particularly in patients with extensive synovial proliferation. Given the presence of grade IV chondropathy in our patient, joint-preserving strategies, including early surgical intervention and possible disease-modifying treatments, are warranted to prevent further functional decline.

CONCLUSION

This case underscores the importance of a multimodal diagnostic approach, integrating clinical evaluation, advanced imaging. While surgical synovectomy remains the cornerstone of treatment, emerging systemic therapies provide new avenues for managing recurrent and diffuse TGCT. Further research into targeted therapies and optimal treatment sequencing is essential to improve long-term patient outcomes.

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