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Case Report

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Intramuscular Venous Malformation: A Case Report

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ABSTRACT

Intramuscular venous malformation (IVM) is a rare, benign vascular disorder characterized by dilated venous channels within muscle tissue, slow-flow hemodynamics, and a tendency to be overlooked because the lesions are not visible on physical inspection [1,2]. Accurate diagnosis relies on ultrasonography and magnetic resonance imaging (MRI), which allow precise lesion characterization and differentiation from soft-tissue tumors, thereby guiding appropriate treatment selection.

The International Society for the Study of Vascular Anomalies (ISSVA) has adopted the classification system first described by Mulliken and Glowacki in 1982, which has become the international standard for nomenclature. This system provides a unified framework for diagnosis, treatment, epidemiological research, prognosis, and evaluation of therapeutic outcomes. Within this classification, intramuscular venous malformations are categorized as slow-flow vascular anomalies [3].

Introduction

Venous malformation (VM) is one of the most common types of congenital vascular malformations, accounting for approximately two-thirds of all vascular malformations, with an estimated prevalence of 0.3–0.5% in the general population [1]. Intramuscular venous malformation represents a distinct subtype in which the lesion is predominantly confined to skeletal muscle. Approximately two-thirds of intramuscular VMs are present at birth, whereas the remainder become clinically apparent during childhood or adolescence.

Clinically, intramuscular VMs typically present as soft, nonpulsatile masses that may increase in size with physical exertion or dependent positioning and can be associated with chronic pain or functional limitation.

Imaging, particularly Doppler ultrasonography and magnetic resonance imaging (MRI), plays a pivotal role in confirming the venous nature of the lesion, assessing disease extent, and planning treatment [3,4].

This report describes a case of intramuscular venous malformation diagnosed using ultrasonography, MRI, and digital subtraction angiography (DSA) in conjunction with interventional treatment, highlighting the critical role of imaging in lesion recognition and management planning [4,5].

Case Presentation

A 15-year-old female patient presented with a gradually progressive painful swelling of the left forearm for approximately three years, without a history of trauma. The pain worsened with activity and improved with rest.

Clinical Examination

- A soft mass was palpated in the left forearm, measuring approximately 3 × 2 cm, with ill-defined margins.
- The lesion was nonpulsatile, nonerythematous, non-warm, and mildly tender on palpation.
- No signs of inflammation or limb deformity were observed.

Imaging Findings

Ultrasonography

Ultrasonography demonstrated a lesion located within the muscular layer, likely involving the deep flexor compartment of the forearm. The lesion extended deep to the ulnar neurovascular bundle and was adjacent to the ulnar cortex. Multiple interconnected, well-defined, heterogeneous structures with discernible walls were identified.

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At the level near the ulnar styloid process, the lesion measured approximately 33 × 13 mm and showed mild hypervascularity with scattered low-velocity venous flow signals on Doppler imaging, containing minimal internal fluid. In the mid-forearm, the lesion extended deeper along the ulnar neurovascular bundle, measuring approximately 12 × 66 mm, with coarse internal calcifications. Near the elbow, the lesion became more superficial, measuring approximately 12 × 55 mm, with an additional heterogeneous mass superior to the elbow composed of mixed hypoechoic and hyperechoic components, poor detectable vascular signals, and coarse calcifications.

Multiple cystic structures with interconnected tubular components were observed, containing anechoic fluid interspersed with fibrous septa, without detectable internal flow. Several coarse calcifications consistent with phleboliths were noted, suggestive of venous malformation.

Magnetic Resonance Imaging

MRI of the forearm revealed a multilobulated soft-tissue lesion extending from the elbow to the wrist, predominantly located in the anteromedial aspect of the forearm. The lesion infiltrated between muscle groups and muscle fibers and extended into the medullary cavity of the ulna without cortical destruction. The margins were well defined.

The lesion demonstrated mildly heterogeneous hyperintensity on T1-weighted images and marked hyperintensity on T2-weighted fat-suppressed and proton density fat-suppressed sequences. Two-dimensional and three-dimensional time-of-flight sequences showed dilated venous structures with scattered areas of slow flow, correlating with Doppler findings. Multiple internal phleboliths were present. Following contrast administration, the lesion exhibited delayed, progressive, and heterogeneous enhancement. No invasion of the skin or adjacent osseous structures was observed.

Digital subtraction angiography. Diagnostic digital subtraction angiography was performed, followed by endovascular intervention.

Imaging diagnosis: Intramuscular venous malformation of the left forearm.

Definitive diagnosis: Intramuscular venous malformation of the anterior compartment of the forearm. ISSVA classification: Slow-flow vascular malformation (venous malformation).

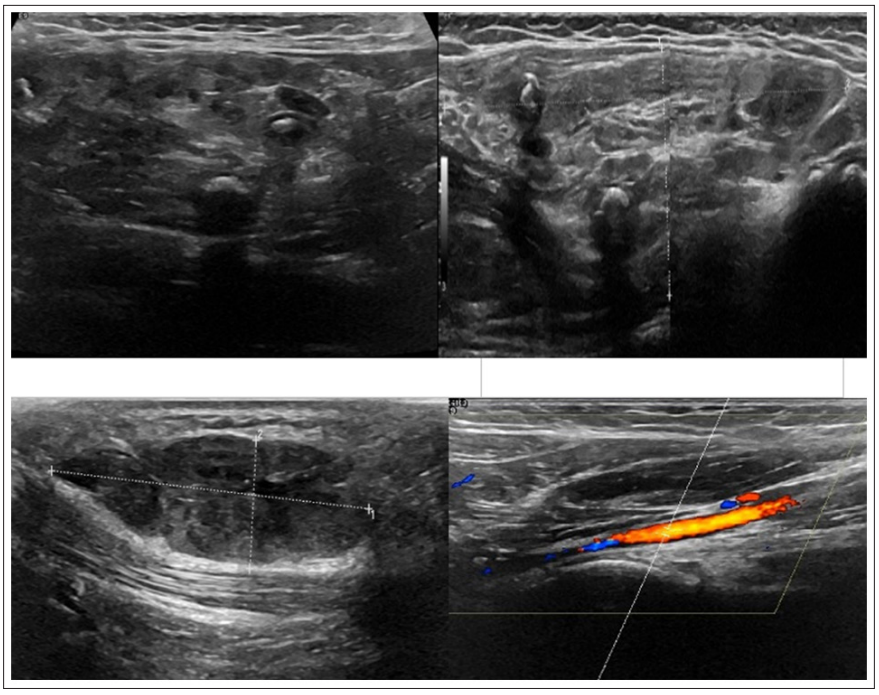

Figure 1: Ultrasonography Shows a Heterogeneous Intramuscular Lesion with Interconnected Venous Spaces, Internal Phleboliths, and Low-Velocity Flow on Color Doppler, Consistent with Venous Malformation.

Treatment

- Treatment performed: Image-guided sclerotherapy under digital subtraction angiography (DSA) guidance.
- Follow-up: Scheduled clinical and imaging follow-up at 3 months and subsequently every 6 months.

Discussion

Intramuscular venous malformation (IVM) is a congenital vascular malformation that most commonly involves the lower extremities, gluteal muscles, masseter muscles, and upper limb muscles. Lesions that are entirely confined within skeletal muscle pose a diagnostic challenge for both clinical evaluation and imaging assessment [6].

In contrast to superficial venous malformations, intramuscular VMs often present later in life. Their deep location and the contractile function of muscle, which reduces venous stasis, may delay symptom onset. However, owing to an increased risk of localized thrombosis and intravascular coagulation, intramuscular VMs are associated with a higher rate of complications. Consequently, these lesions are frequently misdiagnosed as malignant soft-tissue tumors. Their close relationship with neurovascular bundles further contributes to diagnostic confusion, particularly with peripheral nerve sheath tumors or soft-tissue sarcomas.

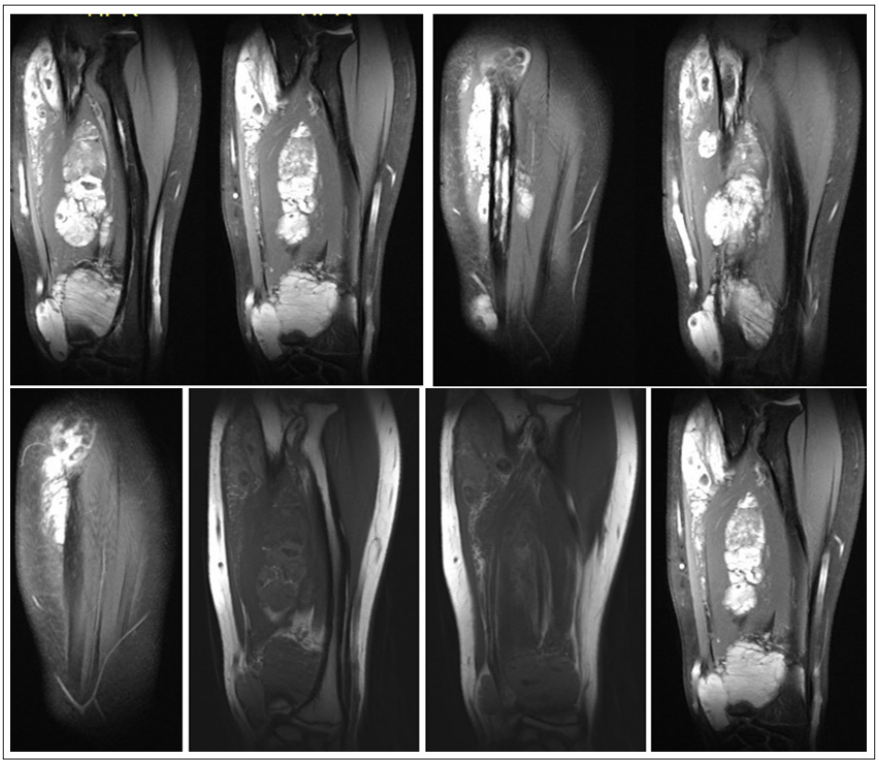

Figure 2: Mri Demonstrates a Multilobulated Intramuscular Slow-Flow Vascular Lesion with Internal Phleboliths and Delayed Enhancement, Consistent with Venous Malformation.

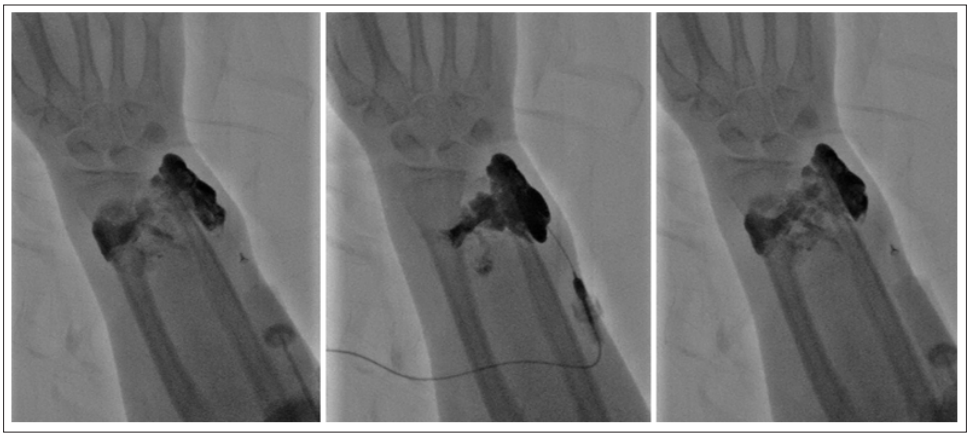

Figure 3: Digital Subtraction Angiography of the Left Forearm Demonstrates Dilated Venous Channels with Slow-Flow Characteristics.

Clinical examination remains fundamental in the initial assessment of vascular anomalies. A thorough medical history and direct inspection may allow differentiation between vascular tumors and venous malformations in typical cases. However, in neonates or in deeply located lesions, clinical manifestations may be subtle or atypical, limiting the accuracy of diagnosis based solely on physical examination [7]. In such cases, ultrasonography—including gray-scale imaging, color Doppler, and elastography—along with other imaging modalities plays a critical complementary role by providing information on lesion architecture, depth, vascular density, and tissue compliance, thereby supporting diagnostic confidence and treatment planning. On ultrasonography and MRI, venous channels are typically confined within muscle and oriented parallel to the muscle fibers. The incidence of calcifications is higher than in superficial VMs, further complicating differential diagnosis [5].

Ultrasonography, particularly when combined with color and power Doppler techniques, is the first-line and most widely used imaging modality for evaluating intramuscular venous malformations. It allows early detection of intramuscular lesions and enables assessment of lesion location, size, margins, and relationships with adjacent structures. Characteristic sonographic features include hypoechoic or heterogeneous masses composed of dilated venous spaces, slow venous flow, and, in some cases, small echogenic foci with posterior acoustic shadowing corresponding to phleboliths—an important diagnostic clue—representing calcified thrombi or chronic intravascular thrombosis. Additional techniques such as elastography and microvascular imaging may provide supplementary diagnostic information.

Doppler ultrasonography is particularly valuable in assessing flow characteristics, allowing differentiation between

venous malformations (slow-flow lesions) and arteriovenous malformations (high-flow lesions), which is essential for appropriate treatment selection. Ultrasonography is also useful for guiding sclerotherapy, monitoring post-treatment response, and detecting recurrence. Nevertheless, its diagnostic performance may be limited in deeply located or extensive lesions, in which case MRI plays a crucial complementary role by providing comprehensive anatomical and tissue characterization. Overall, ultrasonography remains an effective, safe, and highly valuable initial imaging modality in the management of intramuscular venous malformations.

The sonographic appearance of intramuscular venous malformations may overlap with that of other intramuscular lesions, particularly hypoechoic or mixed-echogenic masses with vascular components. Major differential diagnoses include intramuscular hemangioma, arteriovenous malformation, benign muscle tumors, soft-tissue sarcoma, and intramuscular cystic lesions [7]. Several imaging features favor the diagnosis of IVM, including the presence of dilated venous channels, absence of dominant arterial flow (distinguishing it from hemangioma or AVM), lack of arterial flow voids on Doppler imaging, and longitudinal extension along muscle fibers. Awareness of potential pitfalls is essential, as chronic intravascular thrombosis may form intraluminal projections mimicking solid masses, and cystic components may lead to confusion with lymphatic malformations.

Importantly, ultrasonography plays a central role in image-guided intervention, particularly sclerotherapy. Assessment of lesion compressibility, degree of venous stasis, and identification of dominant venous spaces allows optimal selection of injection sites, thereby reducing the risk of sclerosant extravasation or inadvertent injection into draining veins.

Conclusion

Intramuscular venous malformation is a benign congenital slow-flow vascular anomaly that is often diagnosed late because of its indolent clinical course. If unrecognized or improperly managed, these lesions may cause chronic pain, deformity, or functional limitation, adversely affecting quality of life.

Doppler ultrasonography serves as a valuable initial imaging modality for identifying the venous nature of the lesion and assessing flow characteristics. However, magnetic resonance imaging remains the reference standard for comprehensive lesion characterization. The combined use of clinical evaluation, ultrasonography, and MRI enables early and accurate diagnosis, helps avoid misinterpretation as other soft-tissue tumors, and facilitates appropriate treatment selection, including sclerotherapy, surgical intervention, or conservative management.

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