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CASE REPORT

Intramuscular Veins: The Most Neglected Source of Thrombosis

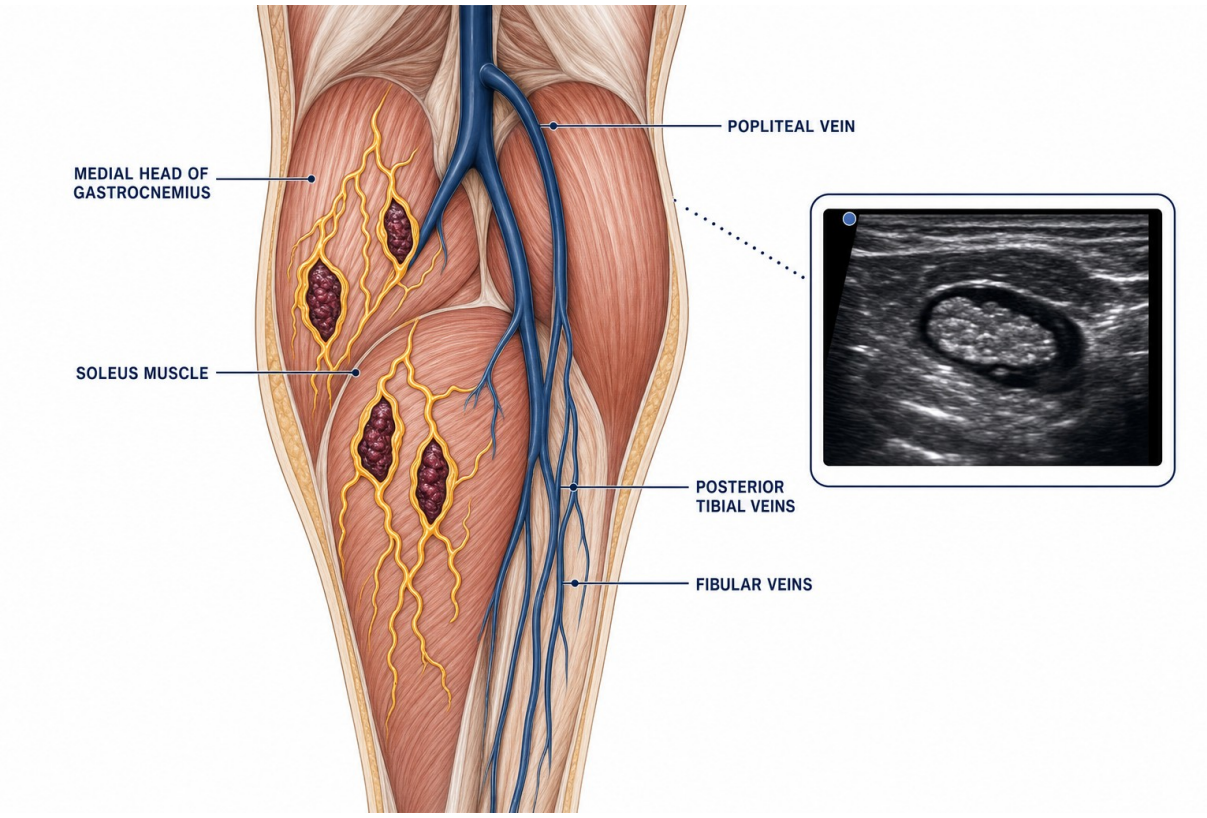
a case report

HIGHLIGHTS

- Intramuscular calf-vein thrombosis is an under-recognised manifestation of venous thromboembolism, easily missed by a routine examination limited to popliteal and deep axial veins.
- Persistent post-traumatic calf swelling — even with normal MRI and an unremarkable initial Doppler — warrants targeted ultrasound of the soleal and gastrocnemius veins.
- Diagnostic criteria on Doppler ultrasound include non-compressibility, intraluminal echogenic material, vein dilatation and the absence of colour flow.
- Although progression risk is lower than in proximal DVT, isolated intramuscular thrombosis can extend proximally and embolise to the pulmonary circulation.
- A comprehensive evaluation of superficial, deep, and intramuscular veins should be the standard of

care in post-traumatic patients with unexplained limb oedema.

GRAPHICAL ABSTRACT



Graphical Abstract. *Posterior view of the calf showing thrombotic involvement of the intramuscular venous network of the soleal and medial gastrocnemius muscles (highlighted in gold), with preserved patency of the popliteal, posterior tibial and fibular veins. The inset illustrates the corresponding Doppler-ultrasound appearance — a non-compressible, dilated vessel containing echogenic intraluminal material consistent with thrombosis. Routine venous Doppler limited to popliteal and deep axial veins may overlook these clinically significant intramuscular thrombi.*

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ABSTRACT

BACKGROUND: Venous thromboembolism is a common clinical problem and a frequent cause of post-traumatic morbidity. Its diagnosis in trauma patients can be difficult due to non-specific symptoms and the absence of characteristic findings on imaging. Thrombosis of the intramuscular veins of the calf is an uncommon and frequently overlooked manifestation of thrombotic disease that may underlie persistent, painful lower-limb oedema.

CASE PRESENTATION: A 36-year-old physically active man who had sustained a knee injury while skiing presented with persistent swelling of the knee and shin lasting three weeks. Magnetic-resonance imaging and an initial ultrasound revealed no significant intra-articular pathology, ligamentous or meniscal damage, or cartilage lesions; an initial assessment of the popliteal venous system disclosed no signs of thrombosis. Because of progressive pain, tenderness and persistent oedema, the work-up was extended to a comprehensive Doppler ultrasound of the lower limb, which revealed extensive thrombosis of the soleal and gastrocnemius muscle veins, with preserved patency of the larger superficial and deep venous trunks.

CONCLUSIONS: This case highlights the importance of intramuscular veins as a potential starting point for thromboembolic disease, with a real risk of serious complications. Targeted assessment of intramuscular veins is essential in patients with persistent post-traumatic limb oedema. A cursory examination of the venous system may delay diagnosis and allow complications to develop. A comprehensive evaluation of the superficial, deep, and intramuscular venous systems should be standard practice in trauma patients with unexplained calf swelling.

KEYWORDS venous thromboembolism; intramuscular vein thrombosis; calf muscle veins; soleal vein; gastrocnemius vein; Doppler ultrasound; post-traumatic oedema

PLAIN LANGUAGE SUMMARY

Blood clots in the deep veins of the leg are a well-known complication of injury and prolonged immobility. Most often clinicians look only at the larger deep veins behind the knee and along the shin. Inside the calf muscles there is another set of smaller veins — the soleal and gastrocnemius veins — which are easy to miss but can also be the starting point of a dangerous clot. We describe a 36-year-old skier whose knee MRI and standard Doppler examination were normal, yet whose calf kept swelling for three weeks. A focused ultrasound of the calf-muscle veins revealed extensive thrombosis confined to those small intramuscular vessels. Anticoagulant treatment led to full recovery. The case is a reminder that any leg-trauma patient with unexplained, lasting swelling deserves a thorough scan that includes the deep, superficial, and intramuscular veins together.

1. INTRODUCTION

Venous thromboembolism (VTE) is a significant and relatively common clinical condition, primarily affecting the venous system of the lower limbs, although in selected cases it can also involve other vascular territories, such as the upper limbs or the inferior vena cava [1]. The disease comprises two core clinical entities: deep vein thrombosis (DVT) and pulmonary embolism (PE). Thrombus formation in the deep veins and their tributaries is driven by the components of Virchow's triad — venous stasis (typically related to immobilisation), an imbalance between procoagulant and anticoagulant factors (hypercoagulability), and endothelial injury (most often traumatic in origin) [2].

The annual incidence of VTE in European populations is approximately 150 per 100,000 people, i.e., 1–2 per 1,000 people per year [3]. Recognised risk factors include female sex (especially after the age of 40), advanced age, hospitalisation, prolonged immobilisation, major surgery, malignancy, hormonal contraception, and trauma [4]. Lower-limb injuries are particularly important: they increase the risk of VTE even when imaging does not reveal overt bone, joint, or ligament damage, because soft-tissue inflammation, reduced activity, and short-term immobilisation collectively favour the development of thrombosis [5].

Calf-muscle vein thrombosis may present as persistent lower-leg swelling without accompanying pain or joint instability, which by itself does not exclude significant vascular pathology [6]. Distal lower-limb thrombosis involves the tibial and fibular veins as well as the intramuscular vessels of the calf — including the soleal and gastrocnemius veins — and may be isolated or coexist with proximal (axial) thrombosis [7]. Because of their connections with the tibial venous system and their direct drainage into the popliteal vein, intramuscular thrombi may propagate proximally and, in some cases, embolise to the pulmonary circulation [6].

Series describing thrombosis in the calf-muscle veins show that these lesions occur relatively frequently, and that omitting them during an ultrasound examination may result in the failure to detect clinically significant pathology. For this reason, the authors emphasise that intramuscular veins should be systematically included in ultrasound examinations of patients with symptoms suggestive of calf thrombosis, especially because changes in this area may be the starting point for further DVT progression [6]. Furthermore, because pulmonary embolism is a life-threatening condition, the earliest possible diagnosis and the prompt introduction of appropriate anticoagulant therapy — and, in selected cases, thrombolytic or interventional management — are crucial. If left untreated or diagnosed late, VTE may lead to acute right-ventricular failure, haemodynamic instability, and even sudden cardiac death [8,9].

2. CASE REPORT

A 36-year-old physically active man sustained a knee injury while skiing. He presented with swelling of the knee and shin that had persisted for three weeks, without obvious signs of joint instability or severe pain. Laboratory work-up included a D-dimer assay, a complete blood count, prothrombin time (PT), activated partial thromboplastin time (aPTT), and selected coagulation factors. D-dimer levels were significantly elevated (greater than twice the upper limit of normal). The patient was referred for ultrasound examination of the knee joint, followed by magnetic-resonance imaging (MRI). Both examinations showed no significant damage to intra-articular or periarticular structures: no lesions of the ligaments, menisci, or cartilage were identified. The imaging picture was limited to soft-tissue swelling and minor post-traumatic contusions, with no signs of haematoma or effusion requiring intervention. During the knee ultrasound, a limited evaluation of the popliteal venous system was also performed, confirming patency of the popliteal vein and the absence of thrombotic features within it.

Despite the negative work-up and the absence of significant structural changes on imaging, the calf swelling persisted, prompting further differential diagnosis and a repeat, focused ultrasound examination of the lower limb.

This examination disclosed extensive thrombosis of the intramuscular veins of the calf, involving the veins of the soleus muscle (Figure 1) and the veins of the medial head of the gastrocnemius muscle (Figures 2, 3 and 4), with preserved patency of the principal superficial and deep venous trunks. These findings explained the

persistent clinical picture and provided the basis for further therapy. Treatment consisted of low-molecular-weight heparin at a dose of 150 IU/kg administered subcutaneously once daily for 10 days (body weight approximately 75 kg), which produced adequate anticoagulation. During therapy, monitoring for possible haemorrhagic complications and surveillance of clinical parameters were recommended. After completion of treatment, continued follow-up at the primary-care level and a planned repeat Doppler ultrasound of the lower-limb veins were advised in order to assess therapeutic efficacy and to monitor for symptoms of progression or recurrence of thrombosis.

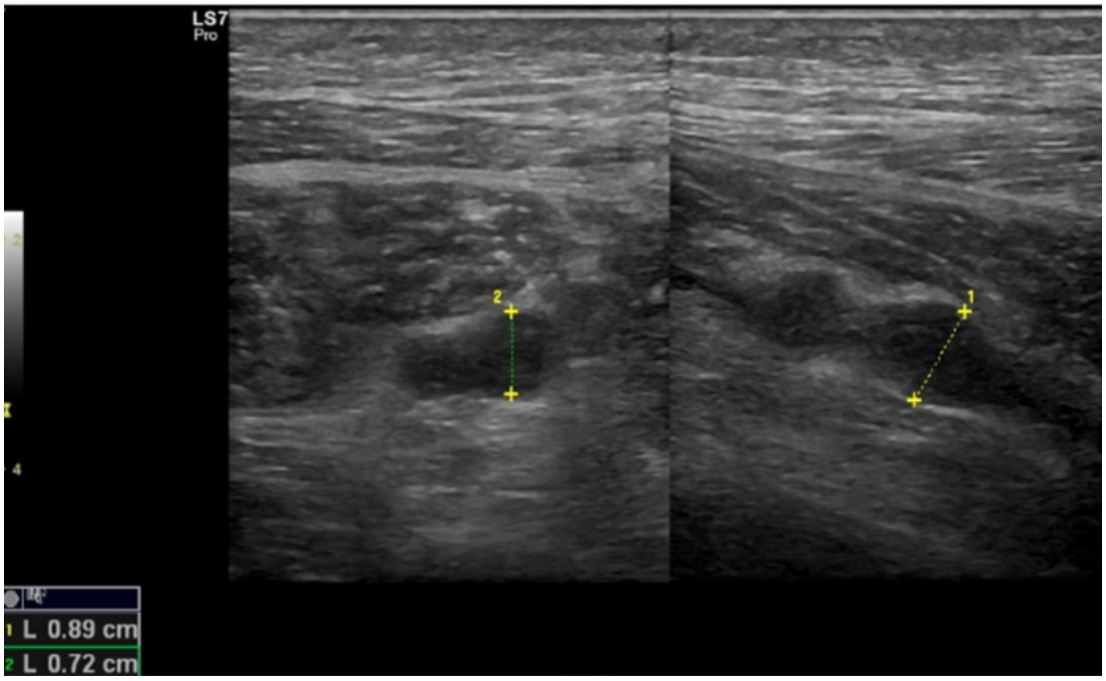

Figure 1. *Non-compressible, dilated (to 9 mm) soleal-muscle veins — ultrasound features of intramuscular venous thrombosis.*

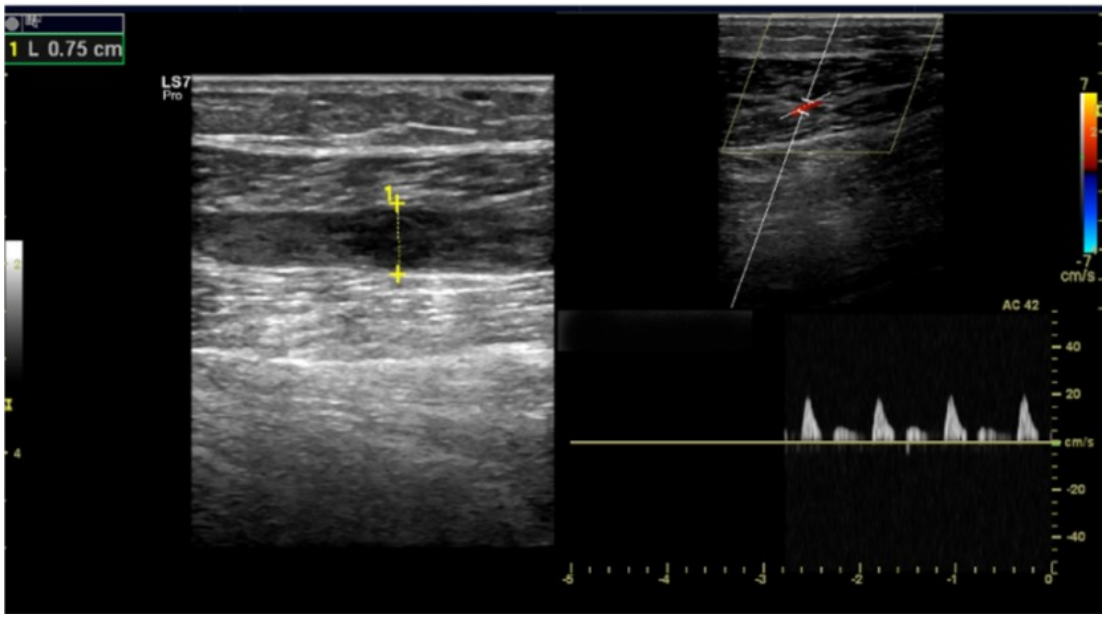

Figure 2. *Vein of the medial head of the gastrocnemius muscle, widened to 7.5 mm, showing no colour-Doppler filling and absence of compressibility — ultrasound features of thrombosis.*

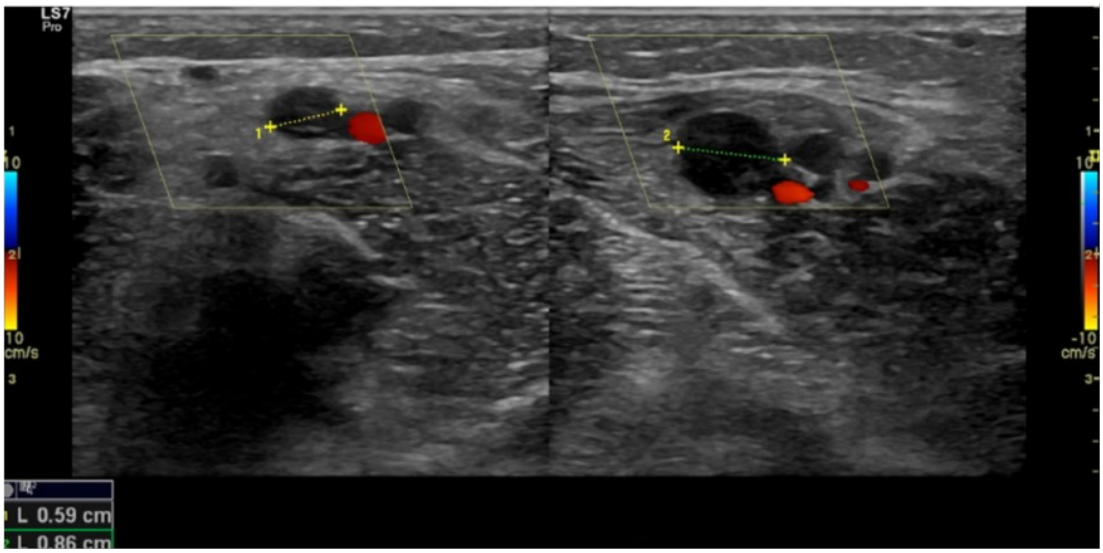

Figure 3. *Enlarged (5.9 mm and 8.6 mm) veins of the medial head of the gastrocnemius muscle, with no colour-Doppler filling and no compressibility — features consistent with thrombosis on ultrasound.*

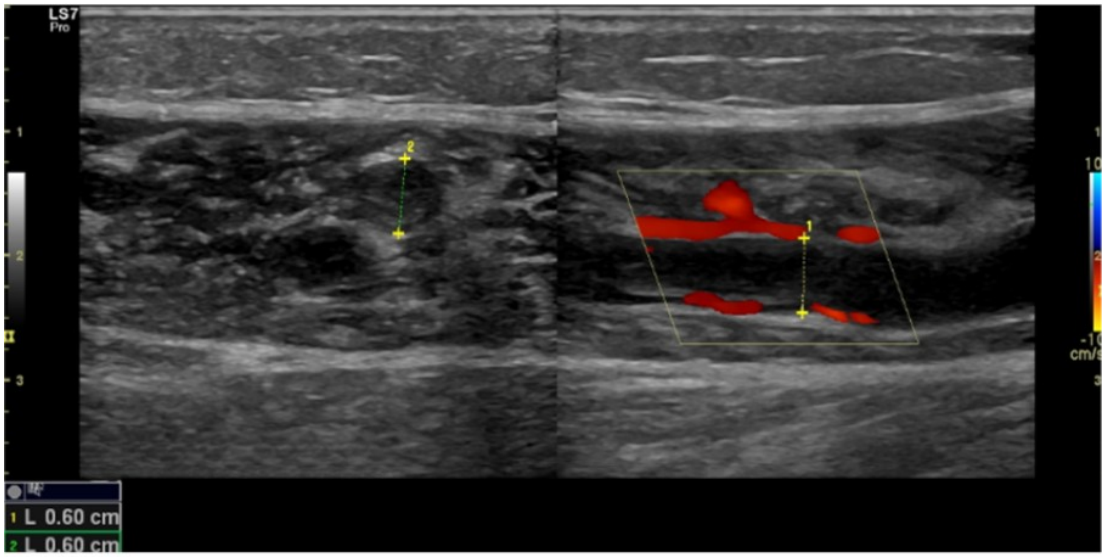

Figure 4. *Enlarged vein (up to 6 mm) within the medial head of the gastrocnemius muscle of the calf; no colour flow on Doppler imaging and non-compressible — findings consistent with thrombosis.*

3. DISCUSSION

Intramuscular vein thrombosis is a relatively rare form of DVT, and its assessment is often overlooked, particularly in trauma patients in whom orthopaedic injuries to joint structures usually dominate the initial diagnostic work-up. Physicians not infrequently evaluate the venous system in a cursory manner, restricting attention to the larger deep and superficial veins and neglecting the intramuscular component.

The differential diagnosis of lower-limb venous thrombosis involves excluding such conditions as occult bony injury or rupture of a popliteal (Baker's) cyst by means of imaging — particularly MRI and ultrasound [10,11]. Because of overlapping clinical features, alternative pathologies should always be considered, and the clinical picture clarified by a thorough ultrasound examination of the lower limb, especially in patients with a paucisymptomatic course such as the one reported here [12].

Currently, the gold standard for the evaluation of intramuscular calf veins is Doppler ultrasound with compression assessment. The technique is non-invasive and allows assessment of both proximal and distal venous segments [13]. A skilled sonographer and adequate vein compression at more than three levels are prerequisites for reliable results [13]. The key sonographic criteria for the diagnosis of intramuscular thrombosis are the absence of vein compressibility, visualisation of intraluminal material consistent with

thrombus, and the presence of flow disturbances within the vessel — all of which were demonstrated in our patient [14]. Among alternative imaging methods, contrast phlebography is an invasive technique, now largely obsolete, associated with the risk of complications related to intravenous contrast administration; before the widespread introduction of ultrasound this method represented the diagnostic gold standard for venous thrombosis [15]. The advantage of MRI is that it can differentiate acute from chronic thrombotic lesions in the veins of the lower limb and is particularly useful in cases of inconclusive ultrasound findings [16]; characteristic MRI features include a hyperintense signal of thrombus on T1-weighted sequences. Computed tomography is another option, but it is less appropriate in cases similar to the present one because of radiation exposure and the need for iodinated contrast; CT is preferred when thrombosis is localised to the iliac or pelvic veins [17].

The treatment of intramuscular vein thrombosis remains a matter of debate. Because of its relatively low risk of progression and enlargement, the dominant strategy is active surveillance with follow-up Doppler ultrasound and the initiation of treatment in the event of clot extension [18]. However, several authors have noted that isolated intramuscular vein thrombosis may carry a non-negligible risk of progression to proximal DVT and subsequent pulmonary embolism, so that early anticoagulation may reduce this risk and provide measurable clinical benefit [19]. The 2021 European Society for Vascular Surgery (ESVS) recommendations support the use of a standard anticoagulant regimen and control of modifiable risk factors, including avoidance of prolonged immobilisation [10]. Throughout the treatment period, clinicians should remain alert to symptoms suggestive of pulmonary embolism — the most serious complication of this disease. The selection of pharmacological therapy must additionally take into account potential drug–drug interactions and the patient's overall clinical condition.

Table 1. Doppler-ultrasound criteria of intramuscular vein thrombosis

Feature	Finding consistent with thrombosis
Compressibility	Non-compressible vein under controlled probe pressure
Vein diameter	Dilatation above the upper limit of normal (typically > 4–5 mm for soleal/gastrocnemius branches)
Intraluminal echoes	Echogenic intraluminal material partially or completely filling the vessel
Colour Doppler	Absent or markedly reduced colour-flow filling of the affected segment
Surroundings	Possible perivenous soft-tissue oedema; preserved patency of adjacent deep/superficial trunks

4. CONCLUSIONS

Intramuscular veins can be the starting point for lower-limb thrombosis and, in terms of thromboembolic complications, should be regarded as deep veins. Under favourable conditions (such as immobilisation) and in the presence of additional risk factors (such as trauma), they may become the site of clinically significant thrombus formation.

Ultrasound is the gold standard for imaging, identification, and extent assessment of such thrombi. On the basis of the sonographic extent of the clot, clinicians can choose between anticoagulant treatment and active surveillance. Unfortunately, when symptoms of thrombosis prompt only a routine examination of superficial and deep veins, the intramuscular compartment is often missed, and this omission may have serious consequences — including pulmonary embolism.

An interdisciplinary approach involving radiologists, phlebologists, and engaged patient participation is essential for timely diagnosis and effective treatment. Early detection by means of ultrasound, with deliberate

assessment of the deep, superficial, and intramuscular venous systems — particularly in post-traumatic patients — is critical for improving clinical outcomes and preventing serious thromboembolic complications.

5. DISCLOSURE

5.1. Author Contributions

Conceptualisation: A. Kozińska, N. Fidut. Methodology: A. Kozińska, A. Zuzak. Software check: A. Zuzak. Formal analysis: A. Kozińska, A. Zuzak. Investigation: M. Zbroja-Putowska, M. Kuczyńska. Data curation: N. Fidut, A. Zuzak. Writing — original draft: A. Zuzak, A. Zarajczyk. Writing — review and editing and visualisation: A. Kozińska, M. Kuczyńska, M. Zbroja-Putowska. Supervision: M. Drelich, M. Kuczyńska, M. Zbroja-Putowska. All authors have read and agreed with the published version of the manuscript.

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5.3. Institutional Review Board Statement

Not applicable.

5.4. Informed Consent Statement

Written informed consent for publication was obtained from the patient. Imaging material has been anonymised.

5.5. Conflict of Interest Statement

The authors declare no conflict of interest.

5.6. Data Availability Statement

Data supporting the findings of this case report are contained within the article.

5.7. Acknowledgements

Not applicable.

5.8. Declaration of Generative AI Use

In preparing this work the authors used ChatGPT (OpenAI) for the sole purpose of improving the grammar and writing style of the English version. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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