Digital Ischemia during Sclerotherapy of an Arteriovenous Malformation

Paul J. Rochon, MD¹ James H. Hill, MD¹ Mitchell T. Smith, MD, MS¹

¹Department of Radiology, Division of Vascular and Interventional Radiology, University of Colorado, Anschutz Medical Campus, Aurora, Colorado

Address for correspondence Paul J. Rochon, MD, University of Colorado, Anschutz Medical Campus, Stop L954, 12401 E. 17th Avenue, Room 510, Aurora, CO 80045 (e-mail: paul.rochon@ucdenver.edu).

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Vascular malformations (VMs) are usually treated conservatively until patients become symptomatic (i.e., pain, complications secondary to venous hypertension, neuropathy, and high-output cardiac failure). They are classified by either low-flow or high-flow characteristics (►Table 1). Minimally invasive treatment methods are utilized to manage these lesions. The authors share a case utilizing a referenced method and noting an incidental risk/complication of a high-flow VM.

Case

An 11-year-old boy presented with a right forearm mass to which his mother attributed to a bump while playing football. However, physical examination demonstrated a ventral right forearm mass with a bruit. Radial and ulnar arterial pulses were intact. An ultrasound and magnetic resonance imaging (MRI) of the arm were obtained that diagnosed an arteriovenous malformation (AVM) and facilitated preprocedural planning (►Fig. 1). The patient was scheduled for an upper extremity angiogram with sclerotherapy utilizing ethanol under general anesthesia. A compression tourniquet was placed on the upper arm to control venous outflow; angiography of the right upper extremity was performed that demonstrated the large AVM (►Fig. 2A). A microcatheter was used to select a nidus of the AVM (►Fig. 2B). Multiple angiograms were performed with the cuff inflated and deflated. Absolute ethanol was injected through the microcatheter. The patient tolerated the procedure and was discharged home without complication.

Given that a small portion of the mass was treated, the patient was brought back to the interventional radiology (IR) laboratory for a second sclerotherapy under general anesthesia. An angiogram of the right arm was performed. A microcatheter was used to select the nidus and repeat angiograms were performed with the tourniquet inflated to note venous drainage as well as calculate the amount of sclerosant needed. A similar amount of absolute ethanol was slowly injected; this was repeated again. The patient's hand was evaluated follow-

ing the sclerosant injection and was noted to be dusky, at which time the ethanol injection was stopped. An angiogram of the hand was performed (►Fig. 3A) and demonstrated nonfilling of the small arteries of the first through third digits. This complication was attributed to ethanol reflux into a normal artery. The procedure was aborted, and nitroglycerin paste was applied to the patient's hand with no immediate relief.

The patient was subsequently seen in the IR clinic and his hand was examined (►Fig. 4A). He was also seen by plastic surgery and vascular surgery, with noted progression of ischemia (►Fig. 4B). He was readmitted to the hospital to help manage his significant postcomplication pain. However, no intervention was performed as capillary refill was noted indicating adequate perfusion for tissue healing.

The patient also had physical therapy sessions to restore function. Four months after the second sclerotherapy session, a follow-up angiogram to plan for possible future interventions was performed; this angiogram demonstrated improved flow to the digits. It also revealed sumping of flow into the radial artery via the malformation that was likely the cause of the reflux when the tourniquet was inflated. Follow-up clinic appointments demonstrated return to baseline function with formation of an eschar that eventually sloughed (►Fig. 4C).

Table 1 Vascular malformation classification

Low flow	High flow
Venous malformation	Arteriovenous malformations
Lymphatic malformation	Arteriovenous fistula
Mixed venolymphatic malformation	
Capillary malformation	

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Figure 1 (A) Color Doppler image demonstrating turbulent flow, as evidenced by to-and-fro flow, within the AVM. (B) Gadolinium-enhanced fat-saturated T1 axial image demonstrates intramuscular enhancement of the AVM (black arrow) with numerous flow voids (white arrow). (C) Delayed magnetic resonance angiography demonstrating feeding arteries (open black arrow), niduses (solid black arrow), and draining veins (solid white arrow). AVM, arteriovenous malformation.

Discussion

VMs are entities of dysplastic vessels with differing histologic and flow characteristics. AVMs are high-flow malformations that are composed of abnormal arteries connected by a nidus to draining veins.¹ AVMs are present at birth and can grow aggressively especially in the setting of trauma, infection, or pregnancy.

In the past, surgery was the only treatment available for VMs; however, cure rates were low and recurrence rates were high.³ Currently, embolo/sclerotherapy is available for treatment of VMs and is considered the primary treatment modality.²⁻⁴ Absolute ethanol is one of these methods that have shown to be very efficacious in treating AVMs^{4,5};

however, there is a trade-off for its potential serious complications. These consist of minor complications including skin ulceration and peripheral nerve damage to major complications of cardiovascular collapse. Studies using ethanol for VMs have shown minor and major complications of 12.4 and 27.9%, respectively.⁶

Evaluation of these lesions requires cross-sectional imaging for diagnosis, characterization, and planning. MRI is the

Figure 2 (A) Catheter-directed angiogram of right upper extremity demonstrating the AVM with multiple niduses (open arrow). (B) Subselective angiogram through a microcatheter demonstrating a nidus. AVM, arteriovenous malformation.

Figure 3 (A) Angiogram of right hand demonstrating abrupt cut of digital arteries of the first through third digits. (B) Angiogram of the right forearm demonstrating the ulnar (black arrow) and interosseous (arrowhead) arteries with faint opacification of the radial artery (white arrow). The AVM sumps flow from this artery when compression is not used. AVM, arteriovenous malformation.

Figure 4 (A–C) Demonstration of progressive ischemic changes of the thenar eminence, thumb, and first digit.

modality of choice, as it provides optimal characterization of low- and high-flow malformations, extent of involvement, and uses no ionizing radiation.^{1,7} Ultrasound can also be used in conjunction with MRI if direct percutaneous methods are

employed. Catheter-directed angiography is also imperative prior to treatment to assess the malformation with different states of selectivity and compression.

In this specific case, the complication of digital ischemia arose because of the lack of thorough evaluation of the radial artery that was shown not to be conspicuous due to sumping by the AVM. Even though the first session of sclerotherapy was without complication, the nature of malformations proved to be ever changing. This warranted creating a new baseline for treatment. Meticulous assessment of these malformations is imperative to determine the therapeutic method and agent as well as to minimize complications.

Teaching Points

1. Meticulous angiography should be performed before injecting any sclerosant. Distal runoffs should be performed to document a baseline.
2. Monitoring of distal limbs should be performed throughout the procedure.
3. Compression cuffs to control flow should be utilized when possible.
4. Subsequent procedures should be considered as a new baseline for treatment due to rapid changes of AVMs after previous rounds of sclerotherapy.

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