

# Super Selective Embolization and Immediate Resection of a High-flow Arteriovenous Malformation in the Hand

Rafael Reynoso, MD\*  
 Alfonso Echeverría, MD\*  
 Carlos Alberto Saldivar Rodea,  
 MD†

**Summary:** A significant proportion of high-flow arteriovenous malformations (AVMs) in the hand are complex to treat due to their multicentricity, size, and risk of jeopardizing distal circulation. Therefore, AVMs are frequently considered “inoperable.” We present the case of a multifocal recurrent AVM treated in conjunction with the interventional radiology department, with intra-arterial embolization and excision followed by immediate distal revascularization to replace the resulting arterial deficit. This is a case of a 24-year-old woman with a high-flow multifocal AVM in her right hand, partially excised 2 years ago, showing a pulsatile mass in the palm and dorsum of the right hand, and a reporting pain of 8 of 10 on the visual analogue scale. The procedure was performed in our hybrid operating room. This procedure lasted 4 hours, with intraoperative bleeding of 75 mL. Three weeks after the procedure, patency and good circulation of the three revascularized fingers was demonstrated using arteriography and no evidence of vascular anomalies were found. No skin loss occurred, and no reintervention was required. For radical excision of this complex high-flow recurrent AVM, detailed intraoperative documentation of its afferent and immediate embolization with gelatin-based hemostatic agents allowed its obliteration with a low reactive material. We consider that this approach might be an option to treat AVMs that are currently considered inoperable. (*Plast Reconstr Surg Glob Open* 2023; 11:e5159; doi: 10.1097/GOX.0000000000005159; Published online 3 August 2023.)

Vascular anomalies are a therapeutic challenge encompassing a wide range of management with an uncertain evolution.<sup>1</sup> The current literature does not offer detailed statistics.<sup>2</sup> The International Society for the Study of Vascular Anomalies has constantly improved the classification over the years; however, treatment of anomalies remains a challenge.<sup>3</sup>

A significant proportion of high-flow arteriovenous malformations (AVMs) in the hand are complex to treat due to their multicentricity, size, and risk of jeopardizing distal circulation. Therefore, AVMs are frequently considered “inoperable.”<sup>4</sup> Modern arteriography provides a remarkable vascular landmarking, but trans-surgical findings do

not always correlate.<sup>5</sup> The evolution without treatment is heading toward worsening conditions: recurrent bleeding, severe complications, and distal amputations may occur. We present here the treatment of a multifocal recurrent AVM involving the procedure of its intra-arterial embolization followed by surgical excision and immediate revascularization.

## METHODS

We base our approach in five important steps:

1. Characterize the afferent and efferent flow of the AVM.
2. Embolize the arterial afferents manually with gelatin-based hemostatic agents.
3. Perform a wide block excision of the AVM.
4. Use of arteriography control (identifying and embolizing any afferent evidence when the local flow is rearranged and repeat the resection/embolization sequence until achieving a complete resection).
5. Protect the distal vascular flow with immediate revascularization.

From the \*Department of Plastic and Reconstructive Surgery, General Hospital of Mexico, Mexico City, Mexico; and †Department of Interventional Radiology, General Hospital of Mexico, Mexico City, Mexico.

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### Case Presentation

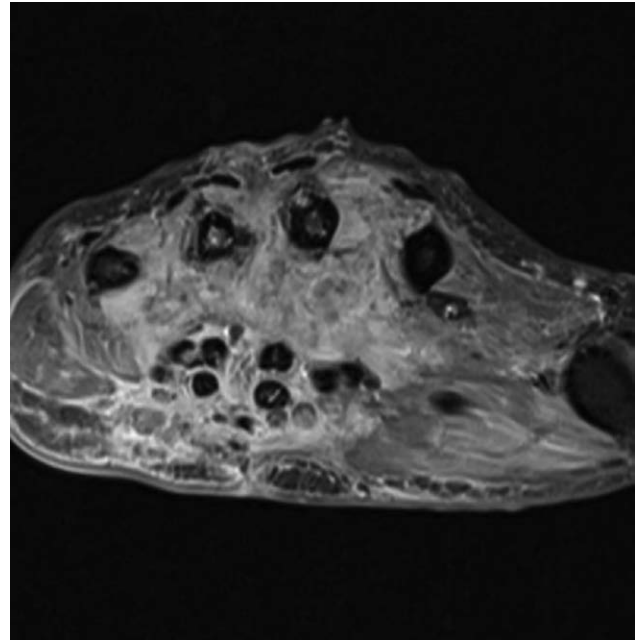
We present the case of a 24-year-old woman with an AVM in her right hand diagnosed 3 years before. There were no other pathological conditions nor a family history of vascular anomalies. There was no reference of smoking or drug abuse. During the first year, no bleeding, no pain, and no nerve entrapment symptoms were seen. The patient was treated with oral medication (beta-blockers) and compressive dressing. In the second year of evolution, the patient presented a pain score of 6 of 10 on the visual analog scale, which was managed with surgical intervention involving a partial excision of the malformation. During the third year of evolution, when attending to our unit, the patient presented a pulsatile mass in the palm and dorsum of the right hand, with a pain score of 8 of 10 on the visual analogue scale (Fig. 1). MRI and arteriography showed a high-flow multifocal AVM in the right hand (Fig. 2). Preoperative blood tests and cardiological evaluation were found to be normal.

### Surgical Approach

In the operating room, we began the surgical approach, setting microvascular clamps applied to all the



**Fig. 1.** Clinical picture of the vascular anomaly. Mass at the palm and dorsum of the right hand, with considerable scar contracture at the palm, from the previous surgery.



**Fig. 2.** Imaging of vascular anomaly. Axial plane of a magnetic resonance with gadolinium, demonstrating a mass with vascular reinforcement affecting adjacent structures (flexor tendons and intrinsic muscles of the hand).

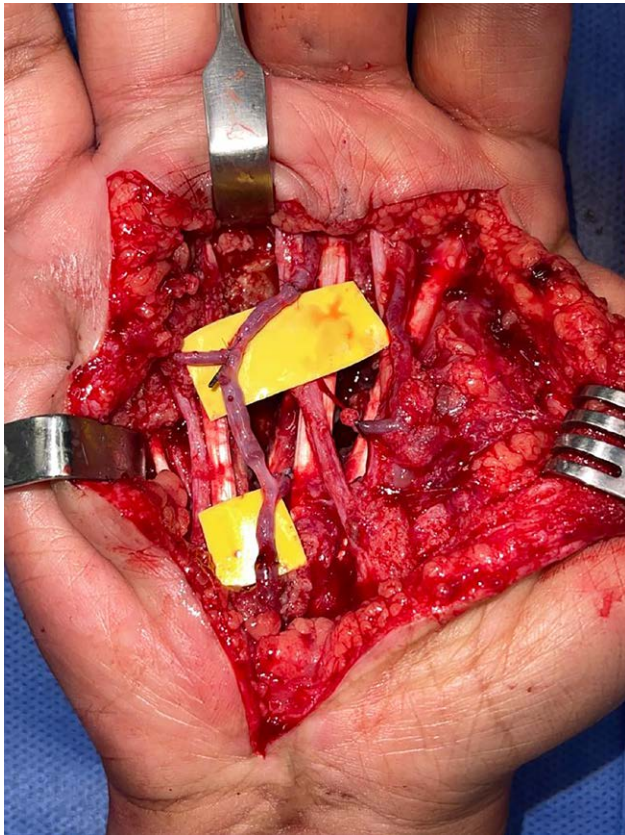
digital arterial trunks to avoid distal embolization. We continued with a detailed intraoperative arteriography and super selective embolization with gelatin-based hemostatic agents (Gelfoam) until total vascular obliteration was verified.

After embolization, we proceeded to excision using an arm tourniquet and monopolar energy for surgical dissection. We performed palmar and dorsal approaches for excision of the main afference through the deep palmar arch, and of the other two malformations that extensively involved the intrinsic musculature of the second, third, and fourth fingers.

After the excision and the tourniquet removal, three ulnar fingers were clinically found with arterial insufficiency. We decided to immediately proceed to revascularization using a multi-strand noninverted grafting of veins from the dorsum of the foot, connecting their trunks with the healthy end of the ulnar artery (Fig. 3). The procedure lasted 4 hours, and intraoperative registration (anesthesiologist surgical balance and surgical nurse quantification) was unanimously reported in 75 mL of blood loss. After the surgery, the patient remained under continuous post-surgical monitoring, and hospital discharge was decided 24 hours later. We prescribed a prophylactic antibiotic, a simple painkillers scheme, and oral anticoagulants at prophylactic doses.

## RESULTS

Three weeks after the procedure, the angiography showed patency and good circulation of the three revascularized fingers, with no images of anomalous vascular paths. (See Video [online], which displays hand digital



**Fig. 3.** Immediate revascularization. Multi-afferent vein graft anastomosed from the ulnar artery to the third and fourth digital trunks.

substraction angiography with brachial artery catheterization preoperative, intraoperative, and postoperative imaging.) At week 12, the patient had no pain; there was no suspicion of vascular malformation during handheld Doppler tracing, and no other clinical evidence of recurrence. No skin loss occurred, and no reintervention was required. Concerning donor site, the wound healed favorably with no infection and no skin contracture, and no signs of venous congestion at the foot were reported. The patient continued with a rehabilitation program, improving her hand range of motion (Fig. 4).

### DISCUSSION

We performed data base research (PubMed, ScienceDirect, ClinicalKey) looking for a treatment of this complex high-flow recurrent AVM. Our search revealed that management is not yet standardized and varies according to the experience of each author and health-care center.

Particularly in extremities, there are important morbidities associated with embolization, (including ischemia and necrotizing distal tissue), which may sometimes require amputations. We created a team in conjunction with the interventional radiology service, to perform an intraoperative embolization with distal vascular protection, avoiding distal damage after the intra-arterial occlusion.

Embolization results in temporary flow occlusion of the nidus, and it is recommended 24–48 hours before the



**Fig. 4.** Follow-up. Affected hand 6 months after surgery, with no clinical evidence of recurrence, no skin loss, and no wound contracture. Note the adequate range of motion.

surgical procedure.<sup>6,7</sup> In our case, trans-surgical embolization avoided intraoperative bleeding, and the use of gelatin-based agents lessened the inflammatory response and destruction of the vascular intima caused by other means of intra-arterial occlusion.

Some authors recommend avoiding simultaneous dorsal and volar approaches.<sup>2,4</sup> While using intraoperative arteriography, redirection of the blood flow and new vascular malformations were detected, encouraging us to perform simultaneous approaches and resect the entire AVM.

There are few proposals for vascular hand reconstruction after AVM excision, including skin grafts, local flaps, and free tissue transfer.<sup>8</sup> In our case, using a multistrand vein graft from the dorsum of the foot was an effective way of bridging in a similar caliber with a healthy donor vessel, and correcting the arterial deficit after the resection.

As far as we know, the current literature does not report any approach based on distal vascular protection before intraoperative embolization, followed by surgical excision and immediate revascularization.

### CONCLUSIONS

Management of vascular anomalies is complex and currently unclear. There is still great room for research and improvement regarding this field. Our work stands out as an innovative multidisciplinary approach, but certainly, more cases are needed to validate it as a good treatment option for treating complex AVMs. We consider that our approach may become a promising treatment option for AVMs currently considered inoperable.

Alfonso Echeverría, MD

Department of Plastic and Reconstructive Surgery  
General Hospital of Mexico  
Mexico City, Mexico

E-mail: [aecheverriad@gmail.com](mailto:aecheverriad@gmail.com)

### DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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