International Surgery Journal
Mérida DMS et al. Int Surg J. 2026 Apr;13(4):618-623
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20260849

Case Report

Multimodal surgical approach to complex arteriovenous malformation of the scalp

Daniela M. Santillán Mérida*, Luis R. Cajamarca Bermeo, Sebastián Trigueiros Guzmán, Armando G. Apellaniz Campo

Department of Plastic, Aesthetic and Reconstructive Surgery, Hospital General "Dr. Manuel Gea González", Mexico City, Mexico

Received: 17 December 2025
Revised: 23 January 2026
Accepted: 17 February 2026

***Correspondence:**
Dr. Daniela M. Santillán Mérida,
E-mail: Samd0128@comunidad.unam.mx

ABSTRACT

Arteriovenous malformations are vascular anomalies characterized by abnormal connections between arteries and veins, originating from genetic mutations that alter vessel formation. Their management presents a challenge due to their unique behavior in each patient and the high rate ofmorbidityand recurrence. The case of a 21-year-old female with an arteriovenous malformation in the region is described parietotemporooccipital. The left side of the body had been previously treated with a series of embolizations. Upon evaluation, a pulsatile, progressively growing tumor was found in the aforementioned region. A coordinated approach between endovascular therapy and plastic surgery was implemented, achieving selective embolization prior to definitive surgical resection. A wide resection was performed with partial-thickness skin grafting. Postoperative recovery was favorable, with adequate graft integration and a satisfactory functional outcome. The management of arteriovenous malformations requires an individualized strategy based on a comprehensive evaluation. The combination of embolization and resection remains the most effective option for lesion control and complication reduction, especially in complex or recurrent cases.

Keywords: Arteriovenous malformation, Surgical resection, Embolization, Coverage defect

INTRODUCTION

Arteriovenous malformations are considered aberrant connections between arteries and veins, and are generally classified as intracranial and extracranial etiology. It stems from genetic mutations that cause alterations in vasculogenesis.[1-9] These genetic mutations have been identified in different signaling pathways such as KRAS, BRAF, MTOR among others.[1-10] These same factors are related to the degree of aggressiveness and its clinical implications.[1-10] The patient's quality of life, symptom severity, and survival depend on the complexity and drainage of the condition.[8] These conditions are generally asymptomatic but can present with symptoms ranging from headaches to seizures, as their clinical spectrum is highly variable.[5]

Despite the clinical challenge involved, this is the primary diagnostic method, used in conjunction with complementary laboratory studies. Its management depends on the location, size, and symptoms present, it can be conservative or surgical, taking into account therapeutic innovations such as targeted drug therapies and medical embolization in conjunction with reconstructive techniques.[1,4,8,11] A multidisciplinary and comprehensive approach will always be the cornerstone of treatment, especially in recurrent and/or complex cases.[1-9]

CASE REPORT

A 21-year-old female with no relevant family or personal medical history; however, during the period of 2023 to 2025, she underwent a series of 3 embolizations each year at the National Institute of Neurology and Neurosurgery “Manuel Velasco Suárez”, due to a prior diagnosis of arteriovenous fistula extracreaneal. She was referred in August 2023 to our Plastic, Aesthetic and Reconstructive Surgery service at the "Dr. Manuel Gea González" General Hospital for evaluation. An oval, pulsatile, soft, and mobile mass of approximately 3x2cm was observed in the region parietotemporooccipital left, with surrounding area of alopecia (Figure 1). The possibility of surgical resection with a reconstructive procedure was raised, discussing the risks and benefits; however, despite this discussion, the intervention was accepted. Prior to the surgical procedure, embolization was required, so the patient was referred back to the referral hospital for this procedure.

Figure 1 (a-c): Preoperative photographs.

The patient was lost to follow-up due to personal issues, and therefore returned to our service seven months later. At that time, an increase in the size of the tumor (4x4 cm) was observed, with the same characteristics as previously described.

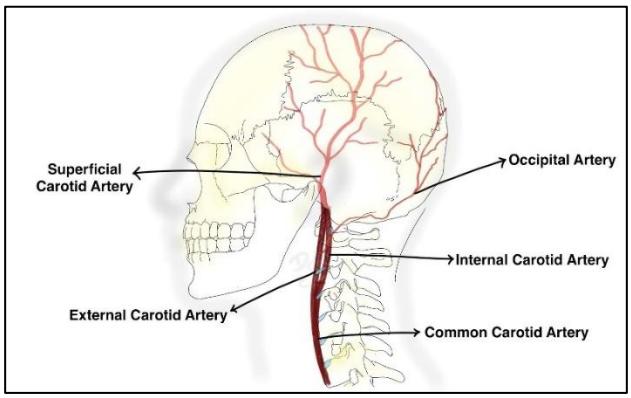

Figure 2: Schematic representation of the nutrient arteries involved in the patient’s scalp arteriovenous malformation. (source: author’s own illustration, created for explanatory purposes).

A magnetic resonance imaging (MRI) scan with gadolinium was ordered to better visualize the tumor and thus plan the surgical approach. One week later, she returned to our service with the report of the requested imaging study, which indicated a persistent arteriovenous fistula dependent on feeding arteries (left superficial temporal and left occipital arteries) with venous drainage into the left jugular vein (Figure 2). The Endovascular service of the referral hospital rules out the option of performing a new embolization due to the risk of scalp necrosis in the left hemicranial region. Despite the comments from both services, the patient decides to undergo the surgical procedure, Angiography with subtraction technique is requested prior to the therapeutic procedure (Figure 3) and it is agreed with both hospitals to perform embolization prior to the proposed surgical treatment, having a window of time between both procedures of 24 hours, taking Angiography with subtraction technique post embolization control.

Surgical technique

Under balanced general anesthesia, the left parietotemporo-occipital region was prepared with aseptic and antiseptic techniques, and sterile drapes were then applied. A scalp scab was removed, and a mechanical tourniquet was applied to resect the lesion. Hemorrhage was controlled by electrocoagulation and ligation. A partial-thickness skin graft was harvested from the frontoparietal region using a dermatome, and sutures were placed. Galeales to approximate the edges and fix the graft with 4-0 Vicryl suture. At the end, a 7mm Jackson Pratt drain is placed in the subgaleal region with a tie over plus epifast in the donor area and a textile dressing, the approximate surgical time is 8 hours with 300 mL of intraoperative bleeding (Figure 4). The surgical specimen was sent to the pathology Service, who diagnosed it as an Arteriovenous Malformation with the presence of foreign material in medium and large caliber vessels with solar elastosis (Figure 5). Following the surgical procedure, the patient was scheduled for weekly follow-up appointments to monitor graft viability and condition, with regular wound care for scab removal and

scar management. Her recovery has been satisfactory, with adequate functional status and no postoperative complications as (Figure 6).The patient is scheduled for a second appointment to place a tissue expander with subsequent skin advancement for the coverage defect.

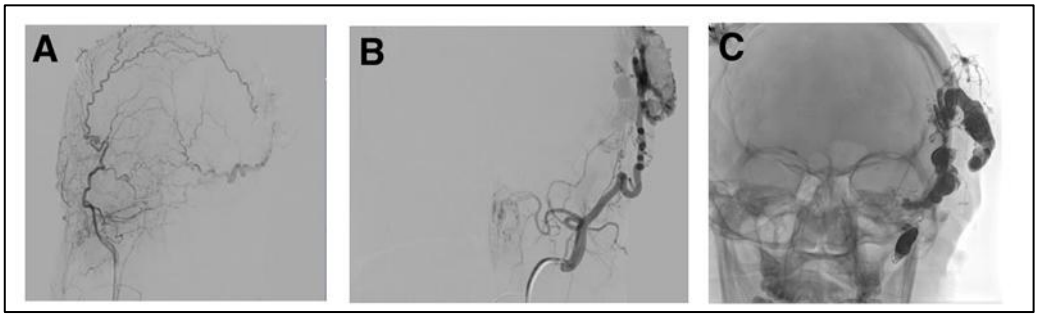

Figure 3: Subtraction angiography: A) right anteroposterior view showing selective catheterization of the right external carotid artery with adequate opacification of the vessel and its collateral branches without flow alteration, B) left anteroposterior view showing selective catheterization of the left external carotid artery, with adequate opacification of its collateral branches and moderate dilation of the occipital artery in its proximal third, and tortuosity in its middle third where material from previous embolizations is identified and C) embolization with a glue-type liquid material administered into a distal branch of the left occipital artery, previously catheterized in a superselective manner. Adequate penetration of the embolic material into the target vascular bed is observed, with complete occlusion of distal flow.

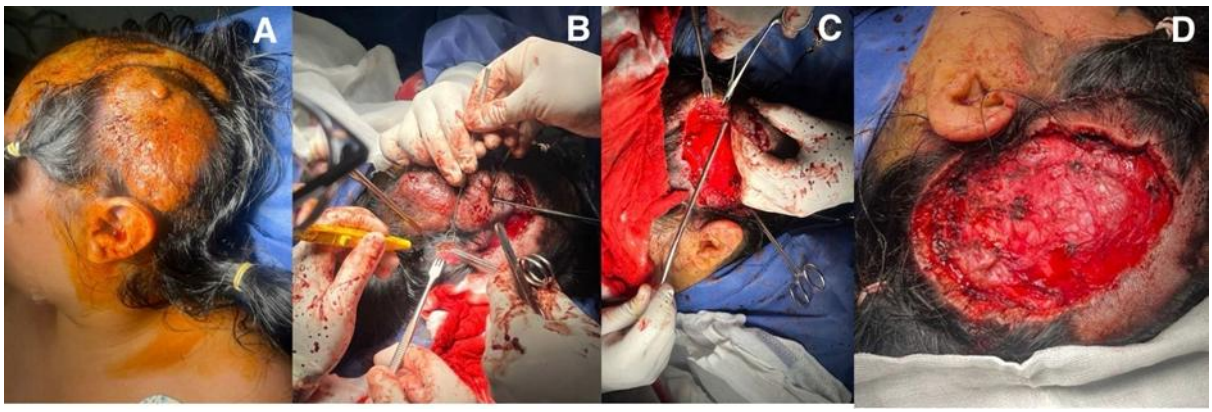

Figure 4: A) asepsis and antisepsis of the surgical site, B) ligation of nutrient arteries (left occipital and left superficial temporal) and C) partial-thickness graft to cover the defect.

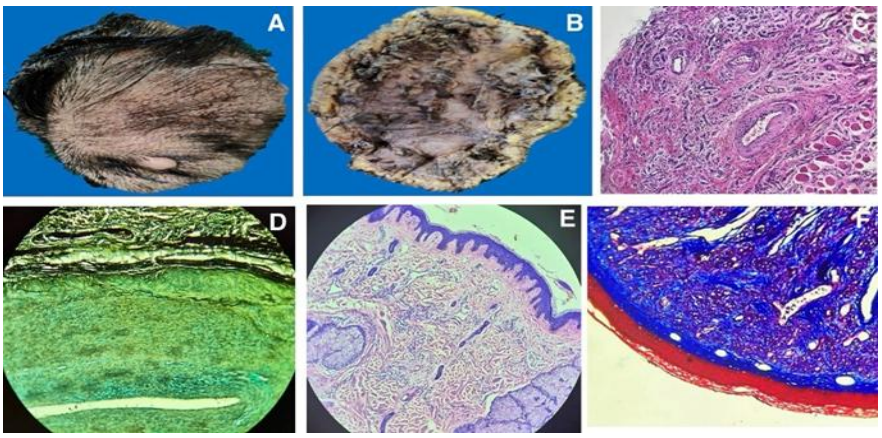

Figure 5: A) surgical specimen, external appearance, 13x9x2 cm, B) surgical specimen, 13x9x2 cm, internal appearance, C) surgical specimen, microscopic appearance, hematoxylin-eosin stained at 10x magnification, showingcapillary proliferation, D) elastin stained at 40x magnification, E) youhematoxylin-eosin stain at 40x magnification showing variation in the size and shape of blood vessels, F) masson stainwhere variation in blood vessels is observed.

Figure 6: A) immediate postoperative photograph, B) postoperative follow-up photograph at 3 months and C) postoperative follow-up photograph at 6 months.

DISCUSSION

Arteriovenous malformations are fast-flowing vascular anomalies characterized by abnormal arteriovenous communications of malformed arteries, veins, and capillaries. They are usually sporadic or associated with syndromes, although most are congenital. Their worldwide prevalence remains <1%. The most frequent location is extracranial, in the head and neck, followed by the extremities, trunk, and viscera. They develop in utero and are usually evident at birth; in most cases, they grow proportionally with the patient and show little or no proliferative activity.

Human malformations during embryological development fatal these conditions can occur due to prenatal mutations, which can be germline or somatic. Genetic alterations that occur during embryonic development induce dysregulation of vasculogenesis, resulting in dysmorphic vessels. Causative genes have been identified in many arteriovenous malformations. High-flow malformations show abnormalities in the cell signalling pathway. Ras and MAPK Conversely, the most common low-flow anomalies, such as venous and lymphatic malformations, are caused by somatic mutations affecting genes of the pathway. PI3K, AKT y mTOR. De novo arteriovenous malformations also occur, and their pathogenesis remains unknown and highly speculative. The most widely accepted hypothesis is that they may require cumulative mutations, that is, postnatal somatic mutations occurring in cells with a prenatal mutation in a double-hit mechanism.[1]

Histologically, they are rarely demonstrated as they generally require multiple serial samples. They vary in appearance, although they contain large, tortuous, thick-walled arteries and veins along with a small vessel component; this component often has a capillary-like appearance. The arteries may show focal loss of the internal elastic lamina, and the veins may show thickened walls due to vascular hypertension that develops into a fibrotic wall. A distinctive feature is blood shunting through a collection of tortuous, dysmorphic vessels, known asnest, that is to say, abnormal channels connecting the feeding artery to the draining veins are distinct from a fistula, which is a direct connection from an artery to a vein. Thrombi may be present in malformed vessels, and foci of microvascular proliferation are very common; these are thought to be expanding reactive proliferative foci.[2] They are generally observed as capillary-like clusters, but can also present with a morphology similar to that of a pyogenic granuloma or even other changes pseudokaposiformes. It can be classified in various ways as shown in the following table (Table 1).

Table 1: Classification of arteriovenous malformations according to their vessel of origin.

Developed anomalies of own vessels	
High flow	**Low flow**
Isolated	Capillary
Syndromic	Arterial
Multifocal	Venous
	Combined

The diagnosis of a vascular malformation should only be made after correlation with clinical findings and complementary imaging studies, the most common are MRI, angiography, or computed tomography (Table 2). Embolization with arteriography is the best option even though this procedure in an arteriovenous malformation with intracranial drainage can be potentially dangerous, cases of material migration have been reported. Embolic agent towards the venous system, causing life-threatening complications.[4]

Because arteriovenous malformations are usually diffuse and affect multiple tissue planes and important structures, a cure is rare and the treatment plan is chosen depending on the specific circumstance's complexity. The management of arteriovenous malformations depends largely on their size and surgical risk. Small arteriovenous malformations are generally managed with embolization or isolated surgical resection. Medium-sized malformations usually require a combined approach consisting of embolization followed by surgical resection and subsequent reconstruction. Large arteriovenous

malformations also require multimodal treatment, including embolization, surgical resection, and reconstructive procedures. In cases classified as the high-risk surgical arteriovenous malformations, palliative measures are considered the most appropriate therapeutic option.[4,6,7] There is a high recurrence rate due to collateral circulation in these malformations. The goal of treatment is usually to control the malformation and prevent its progression. Intervention focuses on relieving symptoms, preserving vital functions, and improving the deformity. Treatment options include embolization, resection, or a combination of both.[5] Resection offers the best chance of long-term control, but the re-expansion rate is high and excision can worsen the deformity. Almost all arere-expandafter embolization. Therefore, embolization is used to reduce blood loss during resection.

Table 2: Imaging studies for arteriovenous malformations and their diagnostic features.

Ultrasound	Magnetic resonance imaging with gadolinium	Digital subtraction arteriography	Arteriography with embolization
Heterogeneous, poorly defined masses with vascular dilatations that, on spectral doppler, may present low or high arterial flows, turbulent or pulsatile venous flows.	In t1/t2, image grouping is observed Hypointense serpiginous lines due to absence of signal void.	Method of choice, it allows knowledge of the angioarchitecture, including afferent arteries and drainage vessels.	It has different access routes such as transradial and transfemoral, through which agents are injected via a catheterchemosteroidsand/or coils. These generate progressive stiffness with a radiopaque marker that allows them to be identified.

Resecting an arteriovenous malformation leaves sequelae that require reconstructive procedures. Reconstructive options are selected according to the principles of the reconstructive ladder in which techniques are arranged in ascending order of complexity and morbidity, these options include from simplest to most complex first intention closure, skin injection, tissue expansion, local flaps, distal flaps, free flaps, and secondary closure. The choice of reconstructive technique is based on defect characteristics, vascular status, and overall patient condition, aiming to achieve adequate coverage while minimizing morbidity.[6,7] while the reconstructive elevator concept allows direct selection of the most appropriate reconstructive option without the need to follow a strict stepwise sequence. This approach includes a wide range of techniques such as direct closure, skin grafting, local flaps, distal flaps, tissue expansion, and microsurgical free flaps. The choice of the reconstructive method is individualized and based on defect characteristics, tissue availability, vascular status, and patient-specific factors, aiming to optimize functional and aesthetic outcomes while minimizing morbidity.[6,7]

CONCLUSION

Extracranial arteriovenous malformations present a diagnostic and therapeutic challenge due to their complexity, clinical variability, and tendency to recur. This case demonstrates the importance of a multidisciplinary approach and the combination of embolization and surgical resection to achieve better lesion control and reduce complications. Proper planning, diagnostic imaging, and reconstructive techniques allowed for a satisfactory functional outcome, highlighting the importance of individualizing treatment according to each patient's characteristics and the complexity of their condition.

ACKNOWLEDGEMENTS

The authors thank the surgical team who contributed to data collection and patient care.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Ethical approval was obtained from the Ethics Committee of Hospital General "Dr. Manuel Gea González" Written informed consent for publication of clinical details and images was obtained from the patient

REFERENCES

1. Coulie J, Seront E, Vikkula M, Boon LM. Extracranial arteriovenous malformations: Towards etiology-based therapeutic management. J Clin Invest. 2025;135(6):e172837.
2. Phung TL. Histopathology of vascular malformations. Dermatol Clin. 2022;40(4):345-55.
3. Nowak D, Fraser A, Monaro D, Darmary F, Baki A, Snape J, et al. Clinical practice guideline for the management of venous malformations. Pediatrics. 2018;143(4):e20163375.
4. Gregorio MA. Interventional radiology: Half a century innovating for medicine. Res Gate. 2020:15-22.
5. Alcorta MC, Mandolesi JE. Incidental cerebral arteriovenous malformations (grade 1, 2 and 3) in my office. Argent J Neurosurg. 2022;36(4).

6. Gottlieb LJ, Krieger LM. From the reconstructive ladder to the reconstructive elevator. Plast Reconstr Surg. 1994;93(7):1503-4.
7. Losee JE, Neligan PC. Plastic surgery: Volume 3: Craniomaxillofacial, head and neck surgery and pediatric plastic surgery. Philadelphia (PA): Elsevier. 2017.
8. Redondo P. Classification of vascular anomalies (tumors and malformations): Clinical characteristics and natural history. An Sist Sanit Navar. 2004;7(1):9-25.
9. ISSVA. Updated Classification of Vascular Anomalies. J Vasc Anom. 2025;6(2):e113.
10. Fernández-Flores A, Cassarino D, Colmenero I. Vascular malformations: A histopathologic and conceptual appraisal. Actas Dermosifiliogr. 2023; 114(3):213-28.
11. Lloret Pons C. Techniques and indications for embolization (microparticles and microcoils) of small veins and visceral sectors. Angiology and Vascular Surgery. Barcelona: Parc de Salut Mar; 2026.

Cite this article as: Mérida DMS, Bermeo LRC, Guzmán ST, Campo AGA. Multimodal surgical approach to complex arteriovenous malformation of the scalp. Int Surg J 2026;13:618-23.