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Case Report

Use of frontal flap for reconstruction of malar region following arteriovenous malformation resection: a case report

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ABSTRACT

Arteriovenous malformations (AVMs) are rare congenital vascular anomalies characterized by abnormal artery-vein connections. These malformations often occur intracranially but can be found in extracranial regions, presenting unique clinical challenges. Diagnosis and staging, typically using the Schobinger clinical classification, are essential, and various imaging techniques aid in the process. Treatment of AVMs is a multidisciplinary effort, with minimally invasive endovascular procedures being preferred, and surgical resection considered for extensive cases. In this case report, a 52-year-old male with an AVM in the malar region underwent successful treatment. The procedure involved preoperative marking, anesthesia, flap division, AVM resection, and flap placement, followed by suturing and a second surgical stage. The successful utilization of a contralateral frontal flap for reconstruction following AVM resection is highlighted. This case underscores the importance of a multi-stage surgical approach and careful flap preservation in AVM treatment, emphasizing the skills of surgeons. Collaboration among various medical specialties is crucial for effectively managing AVMs, combining embolization, resection, and reconstruction for tailored treatment that improves both function and aesthetics.

Keywords: Frontal, Flap, Reconstruction, Extracranial, Arteriovenous, Malformation

INTRODUCTION

Arteriovenous malformations (AVMs) are fast-flow vascular anomalies present from birth, characterized by direct connections between underdeveloped, primitive vessels that have not matured into capillaries. These anomalies create direct links between arteries and veins, leading to abnormal shunting of blood within circulatory system.[1]

The exact prevalence of AVMs is not well-established, but data suggest their occurrence ranges from 5 to 613 cases per 100,000 people, rendering them rare vascular malformations, accounting for only 1.5% of all such anomalies.[2] Over 90% of AVMs are found within the

brain, whereas extracranial AVMs, also known as peripheral AVMs, are even less common. These extracranial AVMs differ from central nervous system AVMs in terms of how they present clinically, their natural development, and how they are managed.[3] Head and neck AVMs are most prevalent among extracranial cases, affecting 47.4%. Of these cases, about 50% are located in the oral and maxillofacial region, with cheek being the most common site at 31%, followed by ear at 16%.[4] Furthermore, these AVMs exhibit a preference for females, with male-to-female ratio of 1:1.5.[2]

The exact etiopathology of extracranial AVMs remains unclear and are often sporadic or associated with specific genetic alterations in syndromes. However, extracranial AVMs more commonly present as solitary lesions affecting limbs, pelvis and head/neck, occurring in any organ with superficial, deep/combined distribution.[2,5,6]

Around 50% of extracranial AVMs can be observed from birth and during childhood, initially manifesting as painless pulsating nodules. However, these AVMs tend to grow alongside the individual, becoming more apparent during puberty in up to 80% of cases. Consequently, extracranial AVMs are more commonly diagnosed in adulthood. The progression of these AVMs varies, and factors like trauma, puberty, and pregnancy.[2] As time passes, the abnormal arteriovenous connections lead to localized venous hypertension, reduced tissue perfusion pressure, tissue ischemia, resulting in pain, ulcers, and bleeding, which can lead to significant tissue damage due to their rapid growth, bleeding, functional impairments, severe deformities, and even heart failure.[1] To assess the risks, severity, and progression of AVMs, the Schobinger clinical staging is commonly employed, consisting of four stages: Stage I (Quiescence), stage II (Expansion), stage III (Destruction), and stage IV (Decompensation).[7]

AVMs can be identified through the application of various diagnostic modalities, ultrasound (US) typically serves as the initial diagnostic tool, owing to its capability to provide early, safe, and cost-effective assessments by visualizing the distinctive high-velocity blood flow patterns that typify AVMs. Magnetic resonance imaging (MRI) is a valuable tool for the comprehensive evaluation of both the AVM itself and the adjacent soft tissue, as it reveals vascular enhancement and the specific flow void regions, it can also discern anomalies in the MRI signal, such as alterations in fibroadipose tissue, the presence of edema, and disorganized growth in the surrounding tissues. For the definitive confirmation of AVMs and precise mapping of their vascular architecture, 3D computed tomography angiography (CTA) is an optimal choice. This method offers 3D perspective, facilitating precise identification of vascular structures, which is indispensable for the meticulous planning of surgical procedures and potential endovascular interventions.[3]

The management of AVMs is a demanding undertaking that mandates a high level of expertise and necessitates a multidisciplinary approach. Due to their propensity for recurrence and the requirement for multiple therapeutic interventions, AVMs can engender serious side effects, this arises from the absence of intermediate capillaries, which leads to a state of oxygen deprivation and impedes the healing of wounds.[3] The paramount objective in the treatment of AVMs is to achieve optimal control over complications and mitigate the clinical manifestations. Percutaneous embolization, an elegant and minimally invasive endovascular approach, is regarded as the foremost therapeutic modality for AVMs and is considered the primary therapeutic measure in most cases, however it can also be employed as an adjunct to surgical resection.[3] The successful occlusion of AVMs via the trans-arterial route hinges on the selective occlusion of the arterial blood supply, while concurrently preserving the patency of normal vascular branches, given that AVMs often share their blood supply with the surrounding tissues, however in extensive AVMs, a staged approach with multiple procedures including surgery may be needed.[1]

Patients with localized AVMs may be considered suitable candidates for surgical excision, particularly in cases characterized by the involvement of small-caliber vessels and well-defined margins, which leads to a greater likelihood of achieving a safe and complete resection. Conversely, patients grappling with extensive AVMs have a greater risk of suffering from life-threatening hemorrhage, functional or cosmetic disfigurement, or the persistence of AVM growth despite initial treatment. This is why patients should be judiciously selected for surgical resection coupled with reconstructive procedures. In such circumstances, preoperative embolization serves to optimize surgical conditions by significantly reducing intraoperative hemorrhage during resection and by facilitating precise margin demarcation.[8]

The forehead flap represents a highly versatile and efficacious instrument in the arsenal of plastic and reconstructive surgeons. It finds extensive utility in various reconstructive procedures, consistently yielding favorable results. Within the realm of forehead flaps, the paramedian forehead flap distinguishes itself as a specific subtype. Classified as an axial, pedicled, interpolated flap, it predominantly relies on the superior trochlear artery for its blood supply, rendering it a preferred choice for reconstructive surgeries. An intricate vascular network termed the supraorbital plexus serves the critical role of interconnecting the superior trochlear, dorsal nasal, and supraorbital arteries to ensure optimal perfusion of the paramedian forehead flap.[9]

To optimize the vascular supply to the flap, it is advisable to adhere to a designated "safe zone," situated 7 millimeters above supraorbital rim, particularly in cases involving high-risk patients, such as smokers, poorly controlled diabetics/individuals with previous horizontal forehead scars. During the surgical procedure, surgeons harvest the periosteum, a membranous tissue enveloping

bone of supraorbital rim, approximately 2-3 centimeters from anterior edge of flap. This step holds significance due to superior trochlear artery's anatomical pathway, which directly traverses this periosteum before bifurcating into deep and superficial branches. In the staged reconstruction process utilizing the paramedian forehead flap, the division of pedicle, or the detachment of the flap from its original blood supply, conventionally transpires no earlier than 3 weeks post the initial flap transfer. This duration allows for establishment of sufficient vascular connections within relocated tissue.[9,10]

In summary, paramedian forehead flap constitutes valuable asset in reconstructive surgery, with a multitude of factors-ranging from vascular considerations to timing of surgical stages-playing pivotal roles in the quest for successful outcomes. Passage underscores critical considerations and established practices associated with this surgical technique.

The forehead flap has undoubtedly become a versatile and reliable option for facial reconstructive surgeons. In this case report, we present a male patient with an AVM who underwent embolization as the first surgical step, followed by AVM resection and reconstruction of the malar region using a frontal flap.

CASE REPORT

A 52-year-old male patient with history of congenital hemangioma in malar region and no other significant medical history noticed a nodular lesion of about 0.5 cm in diameter on right malar region since birth. He experienced progressive volume increase and color change, acquiring a purplish tone. He was referred from a primary care unit to a tertiary care center for evaluation by an angiologist. During evaluation, a nodular lesion approximately 7×3 cm was observed on right malar region. It was soft, depressible, not adherent to deep planes, pulsatile, without murmurs or thrills, and non-painful on palpation (Figure 1).

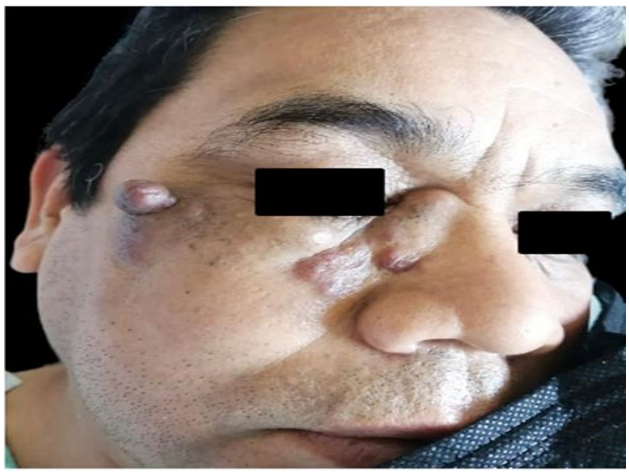

Figure 1: AVM located in right malar and infrorbital region of patient.

Imaging studies were conducted, including supra-aortic trunk CT angiography, which reported well-contrasted internal carotid artery with a maximum axial diameter of 3.86×3.3 mm, showing no evidence of atheromatous disease. An arteriovenous malformation dependent on the facial artery with a vascular niche on malar region was evident, leading to diagnosis of Schobinger II arteriovenous malformation on right malar region (Figures 2 and 3). Patient underwent embolization of facial artery by hemodynamics department, with following intraoperative findings: vascular malformation lesion in right pterygomaxillary fossa, with embolization of internal maxillary artery, facial artery, and distal third of external carotid artery trunk. Blood flow was reduced up to 90% with persistent opacification through the right ophthalmic artery.

Patient referred to plastic and reconstructive surgery department of specialized medical unit at Centro Médico Nacional Siglo XXI for evaluation. Plan included AVM resection, reconstruction using contralateral frontal flap.

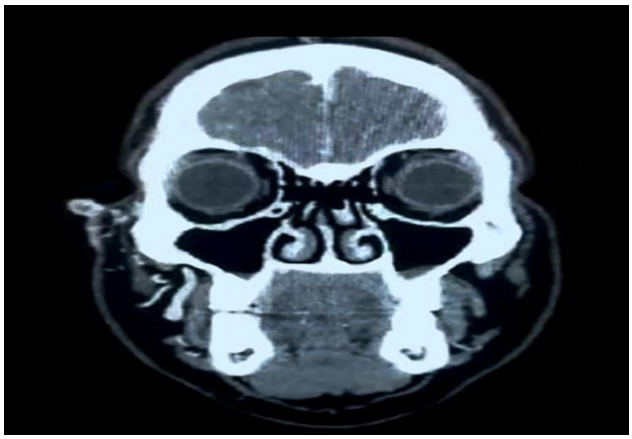

Figure 2: Coronal section reconstruction of arterial phase angiotomography of supra-aortic trunks, of presence of an AVM in malar region dependent on facial artery.

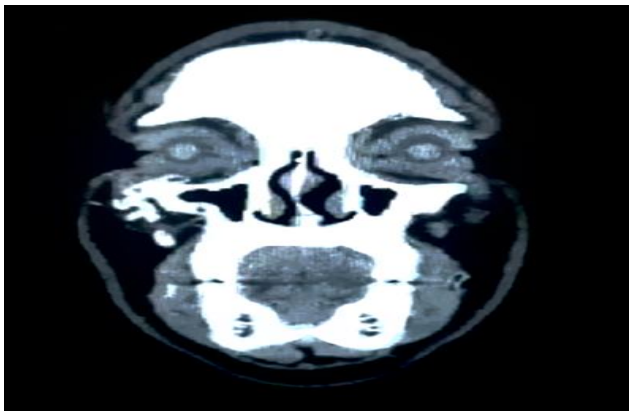

Figure 3: Another coronal section reconstruction of arterial phase angiotomography of supra-aortic trunks, of presence of an AVM in right malar and infraorbital region dependent on facial artery.

Outcomes

After marking flap on contralateral frontal region to AVM using gentian violet, patient was scheduled for surgery. Under balanced general anesthesia and after regional antisepsis, surgical procedure began by infiltrating left frontal and right infraorbital regions with lidocaine and epinephrine. A pivot point maneuver was performed with sterile gauze, and flap was divided into thirds, identifying and preserving vascular supply from supratrochlear artery. In second stage, AVM resection conducted, and flap placed over surgical wound. Flap was sutured in layers using vicryl 3-0 and monocryl 3-0, with flap corners secured using nylon 4-0 sutures. Frontal region surgical wound was sutured in layers using same sutures. Surgical procedure was completed, and patient was scheduled for follow-up appointment in 3 weeks.

During the follow-up appointment, the surgical site was assessed. After confirming flap viability and ruling out infection, a second surgical stage was performed involving pedicle division and suturing the surgical edges using nylon 4-0 sutures (Figure 4).

Figure 4: Second surgical stage was performed 3 weeks later involving pedicle division and suturing surgical edges.

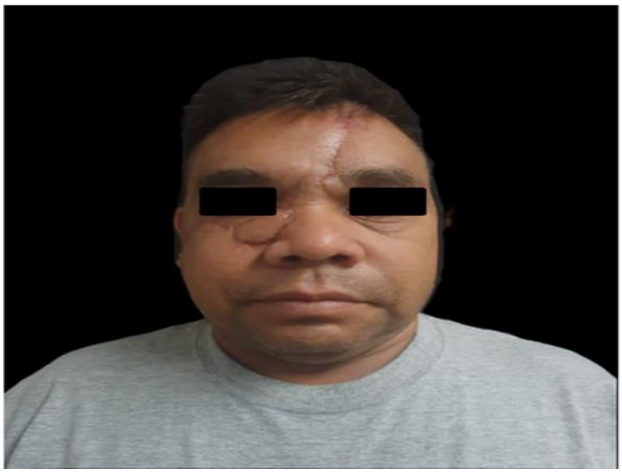

Figure 5: Final cosmetic result two months later.

Subsecuent follow-up appointment was scheduled two months later with significant cosmetic improvement and wound healing (Figure 5).

DISCUSSION

The composition of facial skin is complex, with variations increases, wrinkles, and thickness. These differences pose a significant challenge, even for skilled plastic surgeons, when striving for effective cosmetic and functional restoration of substantial facial defects.[11] The process of facial reconstruction offers a range of techniques, including primary closure, local flap, distant flap, or free flap approaches. The method chosen is influenced by factors such as the size and location of the facial defects and the condition of surrounding tissues.[12]

Forehead flaps are versatile and reliable, allowing for various approaches. They provide a suitable donor flap for facial skin, as their color and texture match that of facial skin. When employing forehead flap reconstruction with primary closure, satisfactory cosmetic outcomes regarding donor site scar formation and deformation have been reported.[13-15] The utilization of this flap type offers the ability to cover large defects on the midface by designing various shapes on the forehead as needed. However, once the forehead flap is in place, it becomes impossible to cover the large defect on the donor site using primary closure, resulting in a scar that is not cosmetically satisfactory. Addressing these issues, if satisfactory reconstruction cannot be achieved with a single forehead flap, the aforementioned limitation can be mitigated by simultaneously employing other reconstruction techniques. As such, a combination of procedures can effectively cover the defect while reducing the width of the forehead flap and facilitating primary closure at the donor site. Plastic surgeons should strive for a delicate balance between applying various flap techniques for reconstruction and minimizing potential complications at the donor site, considering that outcomes at both the donor and recipient sites are deemed important.[16]

CONCLUSION

AVMs are complex congenital vascular anomalies with abnormal artery-vein connections. While intracranial AVMs are more common, extracranial AVMs, especially in the head and neck, pose unique challenges. AVMs can severely affect patients due to their progressive nature and complications. Effective management involves medical, surgical, and interventional approaches. Minimally invasive techniques like endovascular embolization are key, with surgery for extensive cases. The use of the forehead flap in a case highlights surgeons' skill in AVM treatment, enhancing outcomes. Surgical technique advancement and collaboration will improve AVM management, offering better functional and aesthetic results. The case underscores integrated care's

effectiveness, combining embolization, resection, and reconstruction for tailored treatment.

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