# Combined Surgical and Endovascular Embolization of an Orbital Arteriovenous Malformation

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Abstract: This case report presents the successful management of an orbital arteriovenous malformation (AVM) using a combined surgical and endovascular embolization approach. If left untreated, this rare and complex vascular lesion poses a significant risk for vision loss and hemorrhage. Our multidisciplinary approach, including preoperative evaluation, intraoperative embolization, and postoperative follow - up, allowed for complete obliteration of the AVM with preservation of vision and minimal complications.

Keywords: orbital arteriovenous malformation; vascular malformation; embolization; vascular disorders; endovascular embolization

#### 1. Introduction

Arteriovenous malformations (AVMs) within the orbital region are uncommon vascular anomalies believed to have a congenital origin. <sup>1</sup> Orbital AVMs are complex entities, typically exhibiting an intricate arrangement of multiple arterial feeders, a nidus at the center, and an array of enlarged draining veins. <sup>2</sup> These high - flow vascular structures have abnormal connections between arterial and venous vessels, circumventing the usual capillary networks. The identification and assessment of an orbital AVM involve a combination of angiographic and histopathological evaluations, with the former revealing a prominent, quickly filling arterial system connected to the malformation and the latter showing irregular, thick - walled arterial and venous channels, which may present with stromal hemorrhage.

Although the onset of orbital AVMs is generally congenital, they can display various clinical manifestations, and some patients may remain asymptomatic. <sup>3</sup>When symptomatic, orbital AVMs are often characterized by periorbital discomfort, tortuous vessels visible on the ocular surface extending toward the limbus, forward displacement of the eyeball, pulsatile movements, increased intraocular pressure, chronic pain, vision loss, diplopia, and cosmetic deformities. Certain factors, such as menarche, pregnancy, and trauma, can contribute to their growth. <sup>4</sup>

In this case report, we explore the successful treatment of an orbital AVM utilizing a combined surgical and endovascular embolization approach, highlighting the significance of a comprehensive, multidisciplinary strategy to optimize cosmetic outcomes, minimize clinical risks, and preserve the patient's vision.

#### 2. Case Report

A 36 - year - old female patient presented with progressive right upper eyelid swelling. The patient reported that the growth became noticeable during her pregnancy and continued to progress afterwards. Upon examination by a clinical ophthalmologist, the ocular movements were not restricted, and no distensibility was noted when using the Valsalva maneuver. The remainder of the ocular examination, including the fundus, was unremarkable. To exclude any non - vascular etiologies in the right orbit, the patient underwent cranial magnetic resonance imaging (MRI).

The MRI revealed the presence of an extensive intraorbital vascular lesion with an underlying nidal structure, confirming the vascular nature of the pathology. Following the MRI results, the patient was referred to our clinic for further diagnostic evaluations and management of the intraorbital vascular lesion.

At our clinic, we performed digital subtraction angiography (DSA) to understand the lesion's angioarchitecture better. DSA allowed for identifying the arterial feeders, nidus, and venous drainage patterns, providing essential information for planning the optimal treatment strategy. The angiographic examination revealed the presence of an AVM in the patient's right orbit. The feeding vessels of the AVM were identified as originating from the ophthalmic artery (OA) and multiple branches stemming from the external carotid artery's superficial temporal and maxillary branches. After discussing the potential risks and benefits with the patient, the decision was made not to include the feeder vessels from the OA in the preoperative embolization due to the risk of blindness associated with this approach (Figure 1).

DOI: 10.21275/SR23418150512

#### International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2022): 7.942



**Figure 1:** Selective diagnostic catheter angiography of the patient's growing vascular lesion. A prominent nidal structure is visible after injecting contrast agent into the right external carotid artery. The malformation is primarily supplied by the right superficial temporal and maxillary branches (A). Venous outflow is directed to the right superior ophthalmic vein and adjacent frontal diploic veins (B). Upon selective internal carotid artery contrast injection, arterial supply from the ophthalmic artery is also evident (C).

Consequently, preoperative embolization was performed using a non - adhesive liquid embolic agent to occlude the external carotid artery feeder vessels. However, residual flow from the branches of the ophthalmic artery was still evident (Figure 2).



**Figure 2.** Preoperative endovascular embolization of the orbital arteriovenous malformation. The target vasculature for this endovascular session originated from the external carotid artery (ECA) and its branches. Selective microcatheter navigation of the distal vasculature was achieved (A), followed by carefully applying a non - adhesive liquid embolic agent to safely occlude only the nidal compartment (B). A step - by - step catheterization and occlusion of all visible ECA supply was performed (C, D). After the careful withdrawal of the detachable microcatheter (E), selective ECA control confirmed the complete disconnection of the nidal compartment arising from the aforementioned artery. However, residual supply from the ophthalmic artery (OA) and its distal branches was observed.

The patient received corticosteroid and non - steroidal anti inflammatory therapy to manage postproceduraloedema and ischemic pain for 14 days. Surgical intervention was scheduled for the following month.

Prior to surgery, anMRI scan confirmed the presence of a residual AVM primarily supplied by branches of the

ophthalmic artery. Through a lateral orbitotomy, the lesion was debulked after exposing and clipping the largest feeder vessel from the lacrimal artery. The complete removal of the AVM was achieved with minimal cosmetic damage. Histopathological examination corroborated the diagnosis of an AVM. The patient fully recovered within five days and was discharged without any clinical complaints (Figure 3).



**Figure 3:** Macroscopic appearance of the right orbital AVM before (A) and after (B) the combined treatment. The images demonstrate the lesion before the combined endovascular and surgical intervention (A) and the complete surgical removal of the AVM upon hospital discharge (B).

Clinical follow - up at six months after the treatment did not observe any complications or residual symptoms. A follow up MRI at six months confirmed the radiological success of the treatment.

### 3. Discussion

Orbital AVMs are relatively rare entities but represent one of the most common vascular pathologies of the orbit. <sup>5</sup>These lesions can manifest with various symptoms, such as proptosis, periocular lesions, pain, visual deficits, and swelling of the orbit or periorbital structures.<sup>6</sup> Progression of orbital AVMs might be associated with pregnancies or other conditions, and their growth can lead to cosmetic issues that negatively impact patients' quality of life and self - esteem. The morbidity associated with these malformations can be significant, resulting in potential visual impairment and disfigurement. <sup>7</sup> Furthermore, there are isolated case reports documenting the occurrence of hemorrhage, exacerbating the existing ocular symptoms and cosmetic defects.<sup>2</sup> Orbital AVMs may be associated with syndromes such as Wyburn - Mason and Osler - Weber - Rendu syndrome. 6, 8

Early identification and proper characterization of these lesions are crucial for effective management. Non - invasive radiological modalities like the MRI play a key role in the initial diagnostic process, as it helps delineate the extent of the lesion and rule out non - vascular etiologies. However, selectiveDSA remains the gold standard for planning and understanding the angioarchitecture of the AVM, providing essential information on arterial feeders, the nidus, and venous drainage patterns.<sup>7</sup>

AVMs can be classified based on their flow characteristics, which can be categorized as low - flow or high - flow lesions. <sup>4</sup> This classification assists in determining the most appropriate treatment strategy and predicting the potential risks and complications associated with each approach.

thorough understanding of the pathology Α and angioarchitecture of orbital AVMs is crucial for determining the most effective treatment strategy. <sup>9</sup>Due to the vascular nature of these lesions, observation is not recommended for symptomatic patients, as untreated AVMs can lead to progressive worsening of symptoms and complications. Recent advancements in endovascular embolization. including introducing non - adhesive liquid embolic agents (LEAs), have enabled curative results in some instances. Additionally, developing advanced microcatheters allows for more precise distal navigation, further improving the safety and efficacy of endovascular procedures. 10-12 Alternative approaches such as transvenous embolization and direct punctures of the lesion can also be suitable in specific cases, depending on the angioarchitecture and location of the AVM.<sup>13, 14</sup>

Surgical intervention may be necessary for some patients; however, it is essential to consider the potential anxiety, discomfort, and operative complications that may arise. The close proximity of fragile structures within the orbit, such as the optic nerve and extraocular muscles, presents unique challenges during surgical resection, increasing the risk of inadvertent damage and subsequent morbidity. Moreover, the vascular nature of AVMs heightens the possibility of intraoperative bleeding, further complicating the surgical procedure.<sup>15</sup>

In light of these considerations, a combined treatment approach, incorporating both endovascular embolization and surgical resection, is vital to managing complex orbital AVMs. By carefully planning the endovascular and surgical procedures, clinicians can enhance patient outcomes and minimize the risks associated with each treatment modality. This strategy allows for better control over the intervention, reducing complications while maximizing the likelihood of complete AVM removal.<sup>16-18</sup>

In conclusion, the management of complex orbital AVMs demands a comprehensive, multidisciplinary approach that considers the potential risks and benefits of each treatment option. This case report underscores the value of combining endovascular embolization and surgical resection in achieving favorable outcomes while minimizing complications. By adopting a patient - centered, collaborative strategy, clinicians can optimize the treatment of orbital AVMs and enhance patient outcomes.

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## Volume 12 Issue 4, April 2023

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Volume 12 Issue 4, April 2023

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