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SPECIAL TOPIC

Craniofacial/Pediatric

Single-session Preoperative Embolization and Surgical Resection of Vascular Anomalies: A Case Series

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Summary: Vascular anomalies encompass 2 broad classifications including vascular tumors and vascular malformations. The management of vascular anomalies is best approached by a multidisciplinary team. Surgical treatment can offer definitive treatment, but carries several risks such as intraoperative hemorrhage, recurrence, and collateral vascular formations from incomplete resections. Here, we present a case report of 3 patients with different vascular anomalies who were all treated by a multidisciplinary team including interventional radiology and plastic surgery. All underwent preoperative embolization before surgical excision, accomplished under a single anesthetic. Here, we discuss the surgical planning and overall approach to patients presenting with localized vascular anomalies and support the use of preoperative embolization with surgical excision under a single anesthetic as a treatment approach.
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INTRODUCTION

Vascular anomalies result from improper formation of blood vessels.[1] The International Society for the Study of Vascular Anomalies divides anomalies into 2 broad classification: vascular tumors and vascular malformations.[2] Vascular tumors are defined by a neoplastic proliferation of the vascular endothelium, and can be graded as benign, borderline, or malignant. Benign vascular tumors encompass infantile hemangiomas (IHs), which form after birth and typically regress soon afterwards, and congenital hemangiomas, which form during pregnancy and present at birth.[3] Congenital hemangiomas are further subdivided into rapidly involuting, partially involuting, and noninvoluting congenital hemangiomas.

Vascular malformations are abnormal networks of blood vessels that arise as nonneoplastic proliferations of vascular endothelium. These can be classified as either simple or combined depending on involvement of 1 or more malformations in the same lesion, respectively.[2] Venous malformations (VMs) are an example of a simple lesion and are the most common type of congenital vascular malformation, occurring in 1–2 per 10,000 births.[4,5] They typically present as a cutaneous or intramuscular lesion appearing violaceous or blue and can range in size and shape. Traditional therapies for VMs include surgery, sclerotherapy, or laser therapy.[5] Embolization of smaller VMs before excision has been shown to minimize intraoperative blood loss.[6,7] However, excision of larger, complicated VMs remains challenging due to potential intraoperative blood loss as well as aesthetic considerations.

Capillary-arteriovenous malformations (CAVMs) are an example of a combined lesion that can present early in life due to a genetic predisposition and are associated with future complications such as heart failure and skin ulcerations.[8] The treatment approach is not standardized and CAVMs may be managed with laser therapy, embolization, or surgery depending on the size and involvement of the lesion.[9–11] The goal of this study was to demonstrate surgical excision of different lesions with preoperative embolization under the same anesthetic.

METHODS

In this report, 3 separate patients with an IH, VM, and CAVM underwent preoperative embolization before surgical excision of the lesion under the same anesthetic. The skin closure was planned to minimize scarring and achieve a desirable appearance. Pre- and postembolization imaging, clinical characteristics of the lesion, intraoperative blood loss, and patient outcomes were evaluated for

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each patient. This case report supports the use of preoperative embolization with surgical excision under a single anesthetic as a treatment approach to localized vascular anomalies.

RESULTS

Clinical Report 1: IH

This patient was a 5-year-old boy who presented with a vascular mass on his left forearm. He was diagnosed with an IH and was being followed up by his dermatologist and treated with propanol. However, the lesion failed to involute and was intermittently firm, leading the patient to become self-conscious about its appearance. The tumor was located on the dorsoradial aspect of the patient's left antecubital fossa (Fig. 1A). The patient was originally considering serial excision of the hemangioma at an outside hospital but sought a second opinion with interventional radiology at our institution. Upon evaluation, it was determined that the patient was a candidate for single-stage embolization and excision.

The patient was placed under general anesthesia in the interventional radiology (IR) suite for the first phase of this procedure. Vascular access was obtained via the patient's right femoral artery, and the catheter was advanced to the brachial artery proximal to the hemangioma. An angiogram via the brachial artery demonstrated a hypervascular mass with multiple arterial feeders (Fig. 1B). The 300- to 500-μm particles were used to embolize the largest feeding arteries (Fig. 1C). After completing embolization, the brachial artery angiogram demonstrated minimal blood flow to the IH (Fig. 1D). The catheter was then removed, and the patient was transported under the same anesthesia to the operating room (OR) for surgical resection.

In the OR, the edges of the hemangioma measured 10 cm × 7.5 cm × 2.5 cm (Fig. 2A). Excision was planned with 2 mm margins around the tumor. Circumferences of his right arm at the level of the tumor and his left arm distal to the elbow were measured at 14 cm to estimate the postresection circumference. The tumor was localized to the skin and adipose layers and above the fascia. Excision was performed with minimal intraoperative blood loss at 5 mL (Fig. 2B); 1.5 cm of skin from each side of the excision was left to advance for the closure (Fig. 2B). The remaining skin defect measured 4.5 cm in width, which was closed with a full-thickness skin graft measuring 4.5 cm × 10 cm obtained from the left groin area (Fig. 2B). Local anesthesia was administered by the surgeon around the area of excision, and the patient was transferred to the recovery room once stabilized.

The multidisciplinary department conference reviewed the case and confirmed that the lesion was positive for GLUT-1, and confirmed the diagnosis of an IH.

Clinical Report 2: VM

This case involved a 6-year-old boy who presented for consultation of a vascular lesion on his right shoulder (Fig. 3A). The lesion initially presented as a blue patch at birth that rapidly enlarged between 2 and 3 years of age and was associated with occasional pain with pressure. Although initially diagnosed as a hemangioma, the diagnosis was revised to a venous malformation based on magnetic resonance imaging. The patient had previously undergone sclerotherapy, which had short-term improvement; however, the lesion recurred within a year. Retreatment with sclerotherapy was considered but deferred due to the risk of skin ulceration; thus, the patient was scheduled for single-stage embolization and excision.

Upon induction of anesthesia, the patient began the procedure, with IR percutaneously accessing the venous malformation with a 21G needle. The patient was injected with 500- to 700-μm particles. A venogram was performed which confirmed a venous malformation (Fig. 3B), and N-butyl cyanoacrylate glue was injected percutaneously (Fig. 3C).

Under the same anesthetic, the patient was transferred to the OR for resection. An elliptical skin excision spanning 7 cm × 2.5 cm was planned along the local Langer lines (Fig. 4A). The VM was estimated to be 9 cm × 6 cm. Skin flap dissection was performed on both sides, and multiple vessels surrounding the VM were ligated. Excision began from the base of the malformation overlying the deltoid fascia (Fig. 4B). The wound was then irrigated and hemostasis was ensured before wound closure (Fig. 4C). There were no postoperative complications.

Pathology was determined by the multidisciplinary consensus conference to be consistent with a VM. Intraoperative blood loss was limited to 10 mL.

Clinical Report 3: CAVM

This patient was an 11-year-old girl with an arteriovenous malformation (AVM) involving the distal aspect of the right fifth digit with overlying skin changes and history of spontaneous bleeding requiring emergency room visits (Fig. 5). Due to concern for reflux of ethanol into the digital arteries with direct stick embolization alone, preoperative embolization with glue and resection was pursued. Ultrasound guidance was utilized to access the right ulnar artery with a 22-gauge angiocatheter. The AVM nidus was then directly accessed percutaneously and embolized with 0.2 mL of a 1:1 N-butyl cyanoacrylate-to-lipiodol ratio. Follow-up angiogram demonstrated near complete cessation of blood flow to the malformation. The catheter was

Takeaways

Question: Can preoperative embolization of different types of vascular anomalies be used before surgical excision under a single anesthetic as a viable treatment approach?

Findings: Embolization by interventional radiology diminished blood flow in each case, improving circumscription of the malformation or tumor before excision and closure by plastic surgery.

Meaning: Multidisciplinary teams with interventional radiology and plastic and reconstructive surgery are critical to determine diagnosis, embolization approach, and a plan for excision and closure and achieve optimal outcomes.

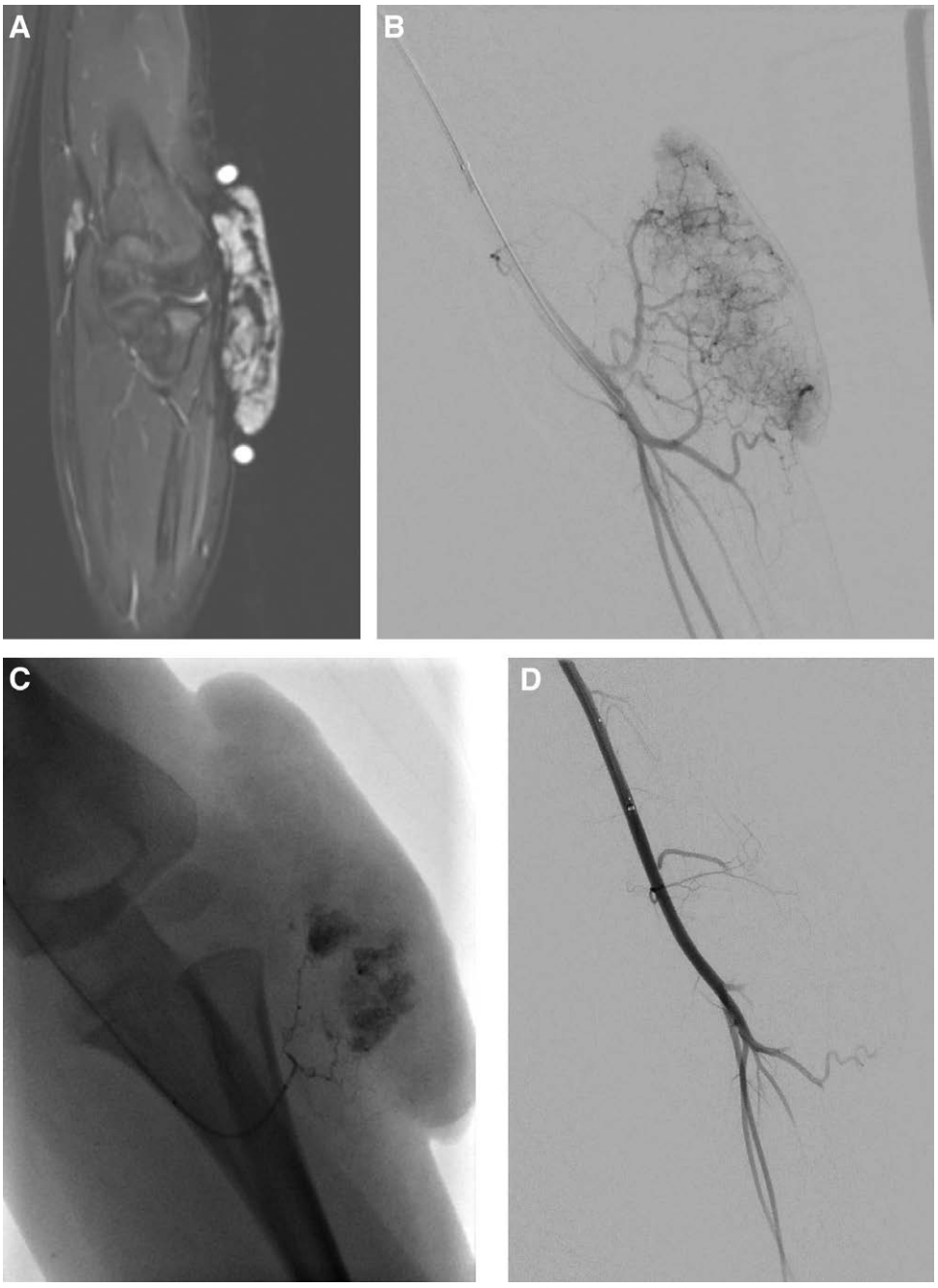

Fig. 1. Imaging of IH. A, Coronal T2 magnetic resonance imaging with fat saturation showing a lesion centered within the subcutaneous tissue adjacent to the antecubital fossa. B, An angiogram via the brachial artery shows a hypervascular mass with multiple arterial pedicles. C, A selective angiogram of an arterial pedicle is selected with a microcatheter and embolized with 300–500 μm particles. D, Angiogram via the brachial artery postembolization of multiple arterial pedicles shows decreased blood flow to the mass.

removed and hemostasis was achieved, and the patient was transferred to the OR.

In the OR, a 1.5 cm × 1 cm excision was planned. Upon incision, the embolized AVM was noted to extend from the skin surface down to bone. The feeding vessel was identified proximally, and the incision was extended to expose the vessel and excise it entirely (Fig. 6A). Given the extensive soft-tissue defect due to the size of the AVM, a cross-finger skin flap of 2 cm × 1.5 cm between the DIP and PIP of the fourth digit was raised above the extensor tendon paratenon and sutured to the fifth digit with multiple 4-0 chromic single knots (Fig. 6B). The new defect to the donor side along the dorsum of the finger was measured to be 3 cm × 2 cm (Fig. 6C), and a full-thickness skin graft

Fig. 2. Intraoperative images of IH. A, Gross appearance of IH on patient's left dorsolateral elbow. B, Postoperative images of IH excision area showing progression of skin graft healing.

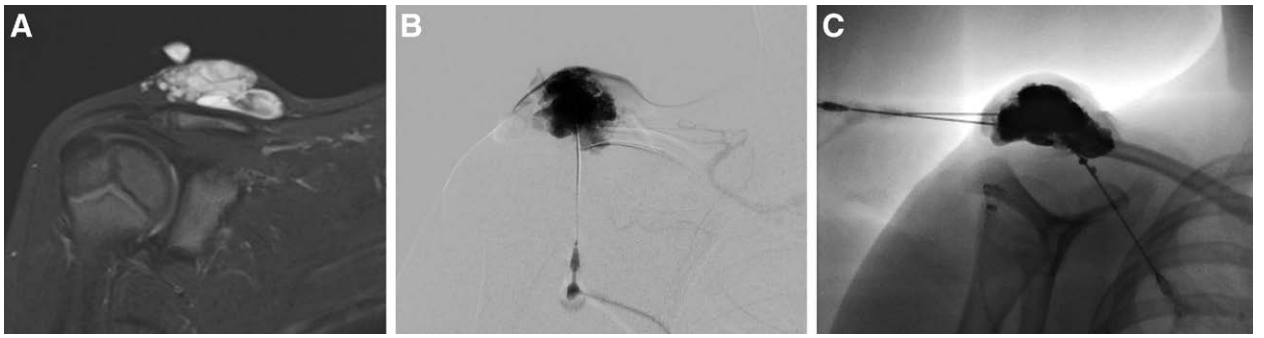

Fig. 3. Imaging of VM. A, Coronal T2 fat sat shows a lesion centered with the subcutaneous tissue overlying the right acromoclavicular joint. B, A venogram shows filling of the VM and venous drainage medially. C, Single fluoroscopic image showing the lesion after injection of glue (N-butyl cyanoacrylate) percutaneously.

was obtained from the antecubital area of the right arm to be placed over the defect. Although the antecubital area was chosen, it is worth noting that other hidden sites may be utilized as well. The antecubital donor site was then closed, and the patient was extubated and transferred to recovery.

Three weeks later, the patient returned for scheduled division of the cross-finger flap. The flap was divided and noted to have good vascular supply. Residual soft tissue on both fingers was rearranged and sutured into final position (Fig. 6D). Across both procedures, the patient had a total of 10 mL of blood loss. Pathology results were consistent with a CAVM, and follow-up angiogram performed at 3 months showed no residual shunting.

DISCUSSION

The management of vascular anomalies is best approached by a multidisciplinary team. Surgical treatment offers a definitive treatment for certain patients, but it carries several risks, such as intraoperative hemorrhage, recurrence, and collateral vascular formations from incomplete resections, which can complicate future treatments.[12–14] One method to decrease these risks and improve patient outcomes is preoperative embolization by interventional radiology. This can help devascularize a vascular tumor or malformation and provide better defined margins, which aids with resection.[6] Plastic surgeons can then leverage their expertise with soft-tissue contouring to conceal scarring postoperatively. Interdisciplinary management of hemangiomas and vascular malformations in the head and neck region with embolization before surgical excision has been described with favorable outcomes.[15–18] There is some literature describing the benefits within the trunk, such as a recent report that described a favorable clinical and cosmetic outcome in a patient who had a large noninvoluting congenital hemangioma in the gluteal region[19]; however, this has yet to become a widespread treatment paradigm for vascular anomalies.

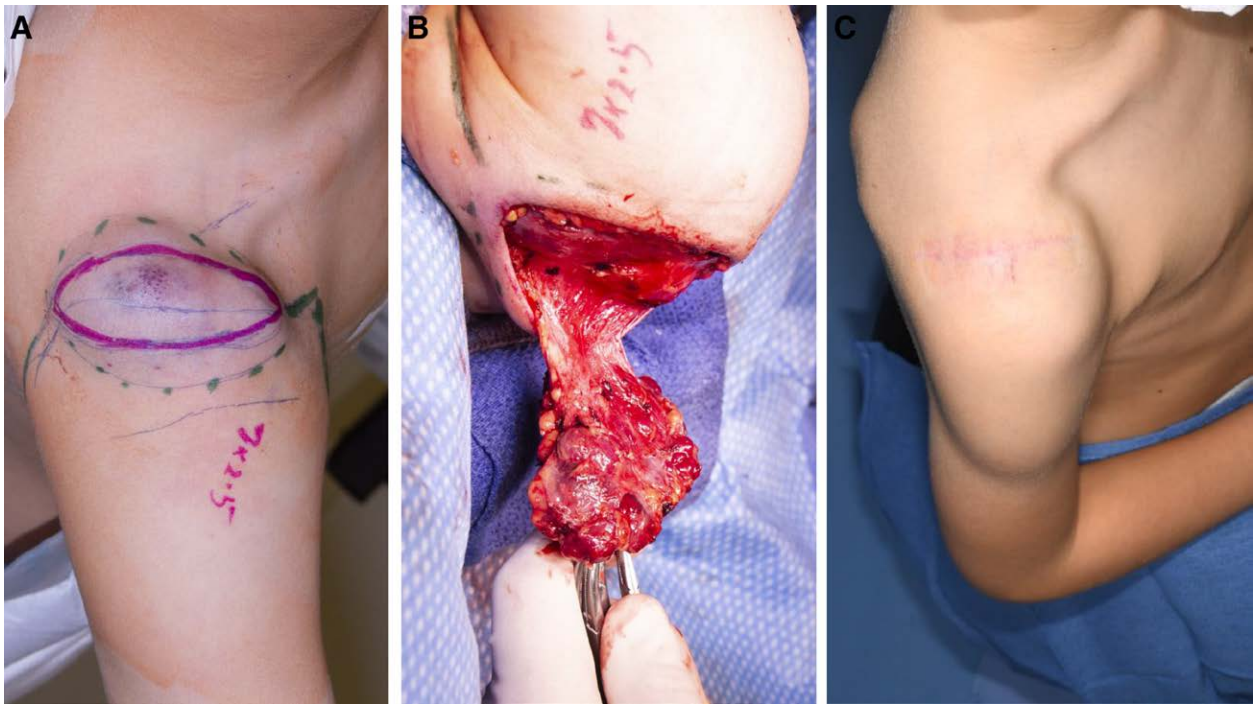

Fig. 4. Intraoperative images of VM. A, Planned elliptical excision with 2 mm margin. B, VM excision from base above the deltoid fascia. C, Postoperative area of excision.

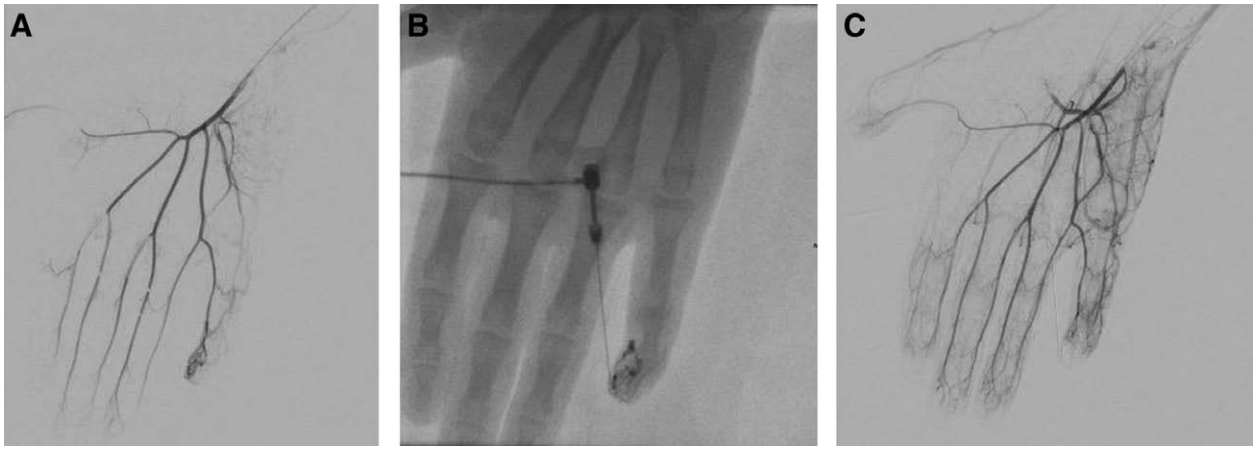

Fig. 5. Imaging of finger AVM. A, Angiogram showing the presence of AVM on right fifth digit. B, 22-gauge catheter insertion into AVM. C, Postembolization angiogram.

The use of preoperative embolization before surgical excision under a single anesthetic is a viable treatment approach to several types of vascular anomalies. Embolization adequately diminished blood flow to these lesions in this case report, which allowed for improved circumscription of the malformation or tumor before excision. In the immediate postembolization period as the patient is being transferred from the angiographic suite to the OR, the overall engorgement of the lesion decreased due to decreased blood flow, which facilitated resection. However, a limitation of this study is that the lack of pre- and postinjection changes in size. Each patient's skin closure was completed by accounting for the tissue-expanding effects of the skin overlying these anomalies.[20] These were leveraged to mimic natural body contours as closely as possible.

To ensure success with future implementations of this approach, multidisciplinary teams are critical. Preoperative evaluation of the imaging by interventional radiology is critical to ensure an accurate diagnosis, as this determines the appropriate embolization approach. In addition, preoperative evaluation by plastic surgery is necessary to ensure that the mass can be excised and that primary closure is feasible. In addition, the logistics of transporting patients between IR suites and ORs is a process that requires close collaboration between the departments, which allows for these cases to be completed under a single anesthetic.

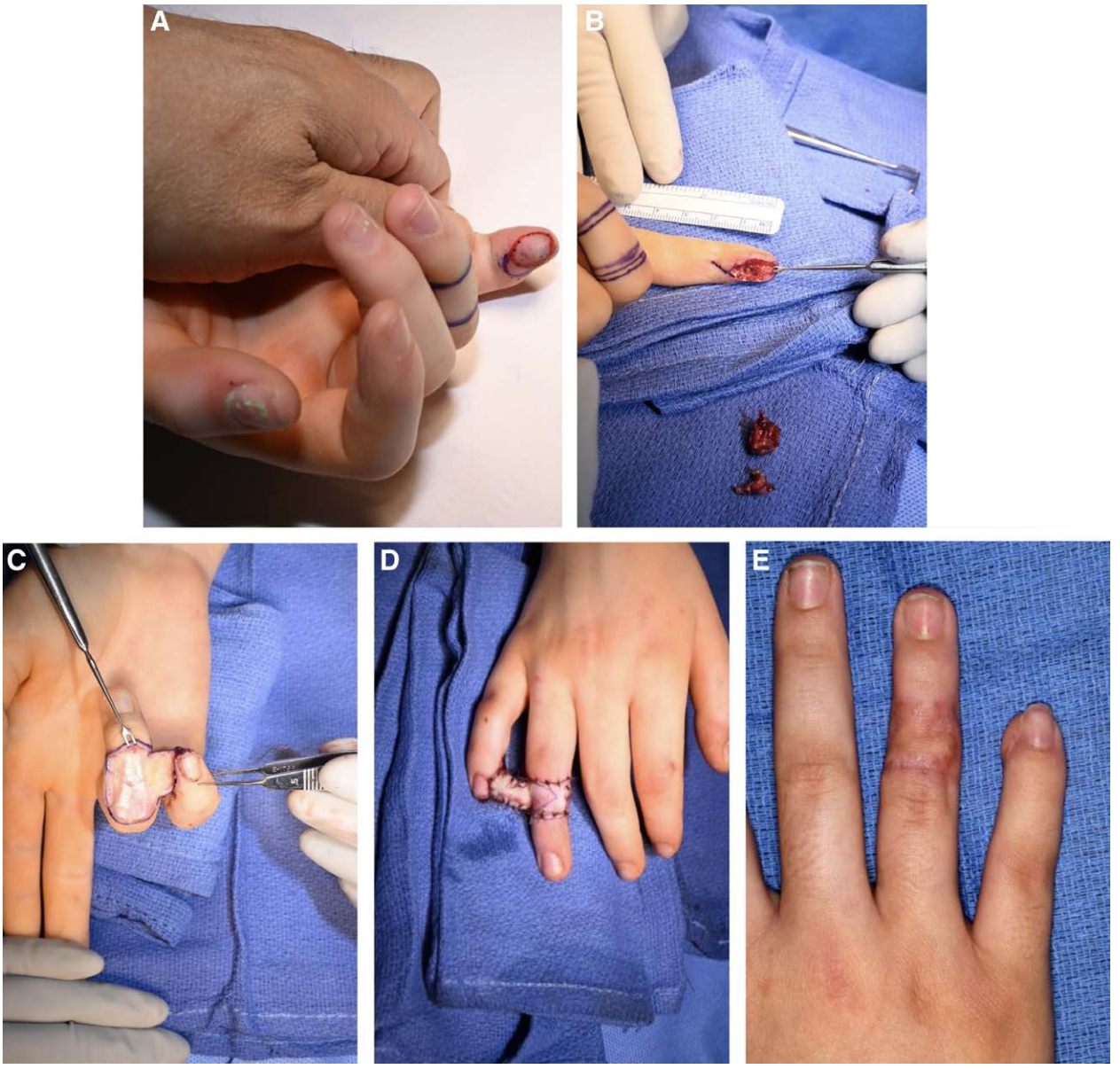

Fig. 6. Intraoperative images of finger AVM. A, Preoperative AVM. B, Excision of AVM. C and D, Cross-finger skin flap construction from the fourth digit. E, Division of closed finger flap.

CONCLUSIONS

A preoperative evaluation that combines a team composed of interventional radiology and plastic surgery is critical to proper diagnosis and surgical removal of vascular anomalies. With an interdisciplinary approach, patients with vascular anomalies can have these lesions excised with minimal blood loss, lower recurrence rates, and a favorable cosmetic outcome.

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DISCLOSURE

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

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