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Direct Puncture of the Superficial Temporal Artery in Embolization of a Scalp Arteriovenous Fistula: A Case Report

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We describe a minimally invasive endovascular approach to treat an arteriovenous fistula of the scalp. We performed a direct puncture of the lesion through the patient's scalp for liquid embolic agent injection along with external compression of the superficial temporal artery to perform a "manual pressure-cooker technique." The combination of these minimally invasive techniques resulted in an excellent clinical and radiographic outcome.

Key Words: Arteriovenous fistula; Endovascular procedures; Punctures; Embolization, therapeutic

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INTRODUCTION

Arteriovenous fistulae (AVF) in the scalp can be treated by surgical or endovascular approaches. Regardless of the technique, the treatment of scalp AVF is often technically challenging. Endovascular challenges include access *via* tortuous feeding arteries and tortuous or unfeasible venous approaches.

Puncture of the extracranial artery itself has been described[1-5] to circumvent proximal tortuous anatomy of scalp AVF that may be impossible to navigate with a microcatheter and microwire. Herein we describe the successful emboliza-

tion of a large scalp AVF with direct puncture of the lesion itself. This direct puncture technique has several advantages including bypassing the feeding anatomy altogether, avoidance of inopportune tip detachment from microcatheters such as the Apollo, decreased length of procedure, decreased radiation and contrast exposure, and superior penetration of the fistulous point with the liquid embolic agent of choice.

CASE REPORT

The patient is a female in her fifties who presented due to severe headaches and disabling tinnitus. Of note, she was on anticoagulation for a pulmonary embolism. On examination, the patient had a painful, palpable, fluctuant scalp mass with a loud bruit.

Computed tomography and a subsequent diagnostic cerebral angiogram revealed a 3-cm right scalp AVF fed exclusively by the right superficial temporal artery and drained by a superficial temporal vein and right posterior auricular vein, with eventual drainage into the superior sagittal sinus (Fig. 1A–I). There was no involvement of the intracranial arteries. After discussion with the patient, we agreed to pursue endovascular management of this lesion.

With the patient under general anaesthetic, we prepped and draped the patient's scalp and groin in the standard sterile fashion. Transfemoral arterial access permitted a 5-F Vert diagnostic catheter in the right external carotid artery for check angiography and roadmaps. We confirmed that the right internal carotid artery supplied the choroid of the right eye. Under roadmap guidance, we then used an 18-gauge Percutaneous Entry Thinwall Needle (Cook Medical) to directly puncture the fistulous point where the right superficial temporal artery met a large venous pouch. After encountering brisk blood backflow through the needle, we advanced the 18-gauge Angiocath, which was on the needle, retracted the needle, and attached the catheter to a Check-Flo Hemostatic valve (Cook Medical). The microcatheter required an introducer to puncture the valve diaphragm; therefore, we inserted an 0.035-inch Terumo Glidewire (Terumo) housing tip through the valve to pierce the valve diaphragm and act as an introducer for an Apollo 1.5 French microcatheter with a 3-cm detachable tip (Medtronic). We advanced the Apollo over a 0.007-inch Hybrid microwire (Balt Extrusion) to reach the optimal position in the fistula, which we confirmed by angiograms through the Apollo. After priming the system with dimethyl sulfoxide (DMSO), we began embolization with ethylene vinyl alcohol copolymer (SQUID, Balt Extrusion), using 8.5 mL of the liquid embolic agent over 25 minutes, pulling the catheter back slightly as we embolized (Fig. 1). During embolization, we manually compressed the palpable right superficial temporal artery through the scalp to occlude this feeder and improve SQUID penetration into the fistula, much as one would do endovascularly with a balloon as a "pressure-cooker" technique. Care was taken to keep the operator's hand out of the fluoroscopic field with high magnification over the lesion. Check angiography demonstrated complete occlusion of the lesion without any angiographic complications.

The patient awoke neurologically intact with only a mild headache. Clinical follow-up at 1 and 6 months did not reveal any scalp necrosis, headache, tinnitus, or any symptoms or physical findings attributable to the lesion other than the palpable mass corresponding to the SQUID cast within the fistula, which was not subjectively bothersome to the patient. A follow-up cerebral angiogram at 6 months showed complete occlusion and radiographic cure of the lesion. Given the absence of symptoms and the location of the lesion behind the hairline, surgical resection of the SQUID cast was not necessary.

DISCUSSION

With the evolution of endovascular devices, technology, and techniques, the treatment of complex vascular lesions of the head and neck is becoming more feasible using increasingly creative approaches. Vascular lesions of the head and neck, especially scalp AVF, are becoming increasingly feasible to treat endovascularly, but still present a myriad of challenges. Some scalp AVF may be quite superficial but still arduous to access by traditional endovascular routes. These lesions can occur spontaneously, post radiation, or following any sort of trauma – whether it be from surgical trauma to the tissue or blunt force. They can develop from the subcutaneous layer and create a communication intracranially or to any neighboring venous network, even involving the orbital or auricular vasculature.[1,2] Most recently, Clarençon et al. and other groups[1-5] have described direct scalp puncture of the superficial temporal artery feeding an intracranial fistulous shunt point. The direct puncture by Clarençon et al.[3] was

performed after multiple access failures from more traditional sites. The obstacles included prolonged case time, radiation dose, and tortuous anatomy causing microcatheter tip detachment. Upon direct puncture of the superficial temporal artery, they demonstrated an elegant embolization of the fistulous point using a Scepter Balloon (MicroVention)

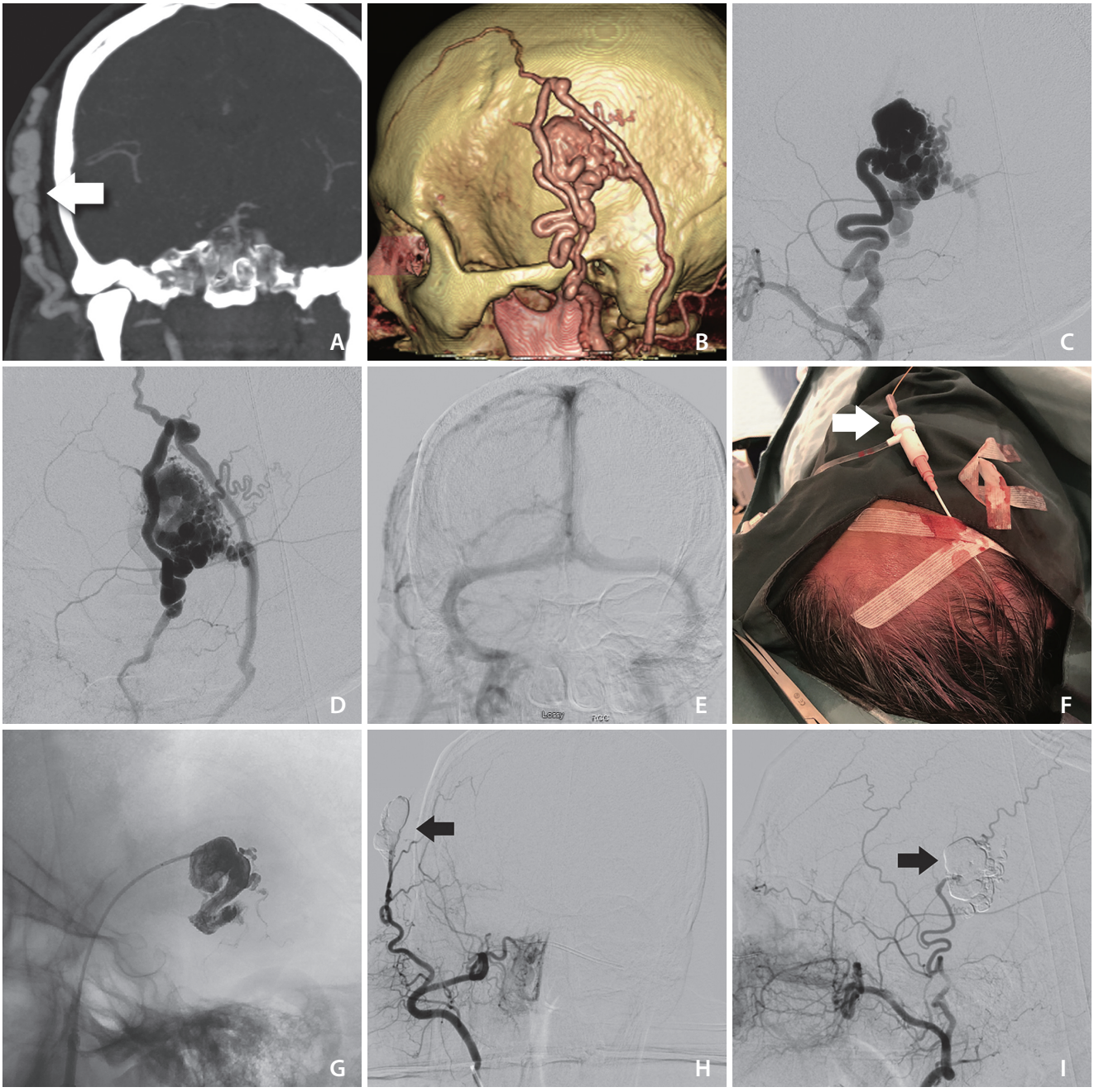

Fig. 1. Brain CTA in coronal view (**A**) shows enlarged vessels in the right scalp area (arrow), fed by the right superficial temporal artery as seen on 3D reconstruction (**B**). The angiogram (**C**, **D**) confirms the presence of an enlarged superficial temporal artery feeding an arteriovenous fistula with a large venous pouch and several enlarged veins, with eventual drainage into the superior sagittal sinus (**E**). (**F**) The Apollo catheter is inserted into the check flow valve using the tip of the Terumo wire housing as an introducer (arrow). The valve is attached to the Angiocath cannula from the thin wall entry needle, and together these act as a sheath directly placed inside the scalp lesion. Using this setup, we were able to inject liquid embolic agent directly into the nidus with no arterial reflux thanks to manual external compression of the feeding superficial temporal artery. (**G**) The patient's symptoms fully resolved immediately after the procedure. (**H**, **I**) The 6-month follow-up angiogram confirmed the complete obliteration of the lesion (arrow).

for proximal flow control. The patient had an excellent radiographic outcome. However, in their case, focal skin necrosis occurred after the procedure which was complicated by infection.

In the treatment of neurovascular disease, endovascular techniques are being increasingly favored over open surgical management, which can result in scarring and additional blood loss, and may require cautery. Endovascular embolization agents for fistulas behind the hairline include Onyx (Medtronic), *n*-butyl cyanoacrylate (NBCA), glue, and, in our case, SQUID. In some cases, coils can be used as scaffolding for the embolic agent or to prevent unwanted reflux into neighboring vasculature. For unconcealed lesions, PHIL (Microvention), a translucent embolic agent, can be considered to avoid skin discoloration.[6] Other occlusive devices, such as a microvascular plug, can also be used, anatomy permitting.[7] For this lesion concealed behind the hairline, SQUID was felt to be a reasonable agent, as it was in a safe location wherein reflux would not have been harmful.

With direct fistula puncture, we thus bypassed many possible obstacles. Upon reaching the fistulous point, we achieved proximal flow control and prevented reflux by manual compression of the palpable superficial temporal artery in the scalp, thereby preventing arterial reflux. The endovascular pressure-cooker technique is well described from the arterial and venous sides, as well as with retrograde approaches.[8-11] In this case, we did not utilize radioprotective gloves during the embolization, but this is a point for future consideration and an area of ongoing research.[12]

Direct puncture of a scalp AVF for liquid embolic agent injection along with external compression of the superficial temporal artery to perform a "manual pressure-cooker technique" is a novel minimally invasive technique that can result in an excellent clinical and radiographic outcome.

Fund
None.

Ethics Statement
Institutional Review Board approval for case reports is not required at our institution. However, patient provided written informed consent for publication.

Conflict of Interest
The authors have no conflicts to disclose.

Author Contributions
Concept and design: GBW, APW, U-EE, RB, and RF. Analysis and interpretation: GBW, APW, U-EE, JH, RB, and RF. Data collection: GBW, U-EE, RB, PS, MPS, CC, SK, KC, GV, JL, HJL, BJD, EPDO, MK, and RF. Writing the article: GBW, APW, JH, U-EE, and RB. Critical revision of the article: GBW, APW, JH, U-EE, RB, MPS, HJL, NH, MH, AQ, BJD, EPDO, MK, and RF. Final approval of the article: GBW, APW, JH, U-EE, RB, PS, MPS, CC, SK, KC, GV, JL, HJL, NH, MH, AQ, BJD, EPDO, MK, and RF. Overall responsibility: RF.

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