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## Original Article

## Traumatic pseudoaneurysms of external carotid artery branch: Case series and treatment considerations

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## ABSTRACT

**Purpose:** To explore the diagnosis and treatment of traumatic external carotid branch pseudoaneurysms. **Methods:** Eleven cases of traumatic external carotid artery branch pseudoaneurysms were admitted in our hospital. Digital subtraction angiography was performed in all patients. It revealed that the pseudoaneurysms originated from the internal maxillary artery in 5 cases, superficial temporal artery in 5 cases and occipital artery in 1 case. Five cases of internal maxillary artery pseudoaneurysms and 2 cases of superficial temporal artery pseudoaneurysms were treated by embolization; the other 3 cases were surgically resected.

**Results:** Complete cessation of nasal bleeding was achieved in all the 5 pseudoaneurysms of internal maxillary artery after the endovascular therapies. Scalp bleeding stopped and scalp defect healed up in 2 patients with superficial temporal artery pseudoaneurysms treated by interventional therapy. All patients were followed up for 0.5–2.0 years without recurrence of nosebleed and scalp lump.

**Conclusion:** For patients with repeated severe epistaxis after craniocerebral injury, digital subtraction angiography should be performed as soon as possible to confirm traumatic pseudoaneurysm. Endovascular therapy is an effective method for traumatic internal maxillary artery pseudoaneurysms. For patients with scalp injuries and pulsatile lumps, further examinations including digital subtraction angiography should be performed to confirm the diagnosis. Surgical treatment or endovascular therapy for scalp traumatic pseudoaneurysm is effective.

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## Introduction

Epistaxis and scalp injury are common clinical manifestations of head injury. Post-traumatic epistaxis usually manifests as a small amount of nasal bleeding, and most patients can be cured by conservative treatment. Neurosurgeons rarely encounter life-threatening, intractable epistaxis after traumatic brain injury. Scalp injuries are usually cured after simple treatment. However, traumatic external carotid artery branch pseudoaneurysms should be considered when recurrent massive nosebleed or progressive enlargement of the scalp lesion occurs after craniocerebral injury. Digital subtraction angiography (DSA) can reveal traumatic pseudoaneurysms. We retrospectively reviewed 11 cases of traumatic external carotid artery branch pseudoaneurysms presenting as

massive epistaxes and progressive enlarged scalp lumps, which successfully treated with endovascular therapy and operation.

## Methods

From January 2011 to January 2018, 11 cases of traumatic external carotid artery branch pseudoaneurysms were admitted in our hospital, including 7 males and 4 females, aged 39–90 years. The causes of injuries were traffic injuries (7 patients), fall down injuries (2 patients), and high falling injuries (2 patients). Five patients were manifested as refractory epistaxes and accompanied by skull base fracture. All the 5 patients had decreased hemoglobin. Hemoglobin was less than 70 g/L in 3 patients and less than 90 g/L in 2 patients. Two patients had to be treated with blood transfusion. Five cases had been treated with conventional management procedures, including nasal packing, which unfortunately failed to stop bleeding completely. Among 6 other patients with scalp injuries, 2 cases presented as scalp ulcerations, scalp defects with recurrent bleeding and no pulsatile mass, the other 3 cases showed the

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progressive enlargement of pulsatile scalp lumps. The other clinical manifestations of 11 patients were the othemorrhagia, cerebrospinal fluid leakage, peripheral facial paralysis, coma, etc. One patient underwent emergent craniotomy for evacuation of intracranial hematoma. The data of all patients were showed in Tables 1 and 2.

DSA was performed in all the 11 patients. The time interval from injury to DSA examination was 2–11 days in patients with refractory epistaxes and 7–46 days in patients with scalp injury. It revealed that the pseudoaneurysms originated from the internal maxillary artery in 5 cases presenting as epistaxes, from superficial temporal artery in 5 cases and from occipital artery in 1 case, which presented as scalp injuries and scalp lumps.

Computed tomography angiography (CTA) was performed in 2 cases of internal maxillary artery pseudoaneurysms, 3 cases of superficial temporal artery pseudoaneurysms and 1 case of occipital artery pseudoaneurysm. Preoperative CTA showed superficial temporal artery pseudoaneurysms in 3 cases (Fig. 1), but did not show aneurysms in the remaining cases. The right occipital scalp lesion was found on enhanced CT (Fig. 2); however, CTA did not show aneurysm. It was considered that there were a large number of thrombi in the scalp pseudoaneurysms and the blood flow was very slow, which maybe affected the display of the aneurysm in CTA.

Five cases of internal maxillary artery pseudoaneurysms were treated by interventional therapy. Polyvinyl alcohol particles (PVA) were used in 2 cases ( Figs. 3 and 4 ) and Onyx glue for 3 cases (Fig. 5). One patient had multiple internal maxillary artery pseudoaneurysms (Fig. 3). In another case of internal maxillary artery pseudoaneurysm, leakage of contrast agent was found during cerebral angiography, suggesting bleeding of the pseudoaneurysm (Fig. 4).

Two cases of superficial temporal artery pseudoaneurysms who presented as scalp ulcerations and scalp defects with recurrent bleeding were embolized with gelatin sponge (Fig. 6). Other 3 cases of superficial temporal artery pseudoaneurysms (Fig. 7) and 1 case of occipital artery pseudoaneurysm (Fig. 8) were surgically resected.

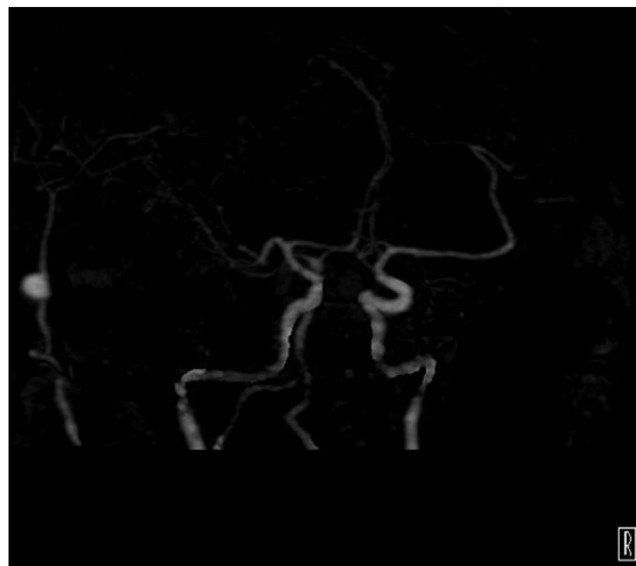


Fig. 1. Computed tomography angiography shows a superficial temporal artery pseudoaneurysm.

**Table 1**  
Case summary of pseudoaneurysms of the internal maxillary artery.

Patient No.	Sex/Age (years)	Mechnism of injury	Clinical manifestation	Time from trauma to diagnosis (days)	Hemoglobin (g/L)	Multiple pseudoaneurysms	Embolism materials	Intraoperative bleeding	Postoperative bleeding	Recurrence episode
1	F/41	Traffic accident	Epistaxis, othemorrhagia, cerebrospinal fluid leakage	11	56	No	Onyx	No	No	No
2	M/90	Fall down	Epistaxis, peripheral facial palsy	2	89	No	Onyx	No	No	No
3	M/71	Traffic accident	Epistaxis, cerebrospinal fluid leakage	6	61	Yes	PVA	No	Yes	No
4	M/57	Traffic accident	Epistaxis, othemorrhagia, peripheral facial palsy	2	59	No	PVA	Yes	No	No
5	F/38	Traffic accident	Epistaxis, othemorrhagia, coma	7	86	No	Onyx	No	No	No

PVA: polyvinyl alcohol particles.

**Table 2**  
Case summary of traumatic scalp pseudoaneurysms.

Patient No.	Sex/Age (years)	Mechnism of injury	Clinical manifestation	Time from trauma to diagnosis (days)	Affected artery	Multiple pseudoaneurysms	Treatment	Recurrence episode
1	F/51	Fall down	Scalp ulceration, scalp defect, recurrent bleeding	30	Superficial temporal artery	No	Embolization	No
2	M/40	Traffic accident	Pulsatile scalp lump	14	Occipital artery	No	Surgery	No
3	M/64	Traffic accident	Pulsatile scalp lump	42	Superficial temporal artery	No	Surgery	No
4	M/56	High falling	Pulsatile scalp lump	22	Superficial temporal artery	No	Surgery	No
5	F/52	High falling	Scalp defect, recurrent bleeding	7	Superficial temporal artery	No	Embolization	No
6	M/44	Traffic accident	Pulsatile scalp lump	46	Superficial temporal artery	No	Surgery	No



Fig. 2. Enhanced CT shows the lump on the right occipital scalp.

## Results

Patients with multiple internal maxillary artery pseudoaneurysms still had a small amount of nasal bleeding after endovascular therapy. Complete cessation of bleeding was achieved 3 days after embolization. The other 4 cases of internal maxillary artery pseudoaneurysms were cured without postoperative bleeding after endovascular therapy. Two cases of superficial temporal artery pseudoaneurysms were treated by interventional therapy and the scalp bleeding stopped and the scalp defects healed up (Fig. 6). All patients were followed up for 0.5–2 year without recurrence of nosebleed and scalp lump.

## Discussion

Epistaxis caused by head injury is very common, and often accompanied by skull base fracture. Nasal bleeding usually stops within a few days. If massive hemorrhage or the delayed repeated hemorrhage in nasal cavity occurs, it is necessary to consider possibility of injury of the external carotid artery or internal carotid artery. All of 5 patients with epistaxis were confirmed as pseudoaneurysm of internal maxillary artery by DSA. Traumatic internal maxillary artery pseudoaneurysm is a rare and life-threatening vascular injury caused by disruption of the layers of the artery, leading to uncontrolled massive bleeding.<sup>1</sup> Nasal packing is usually effective in hemostasis of mild epistaxis clinically. Because pseudoaneurysm ruptures and hemorrhages profusely, the effectiveness

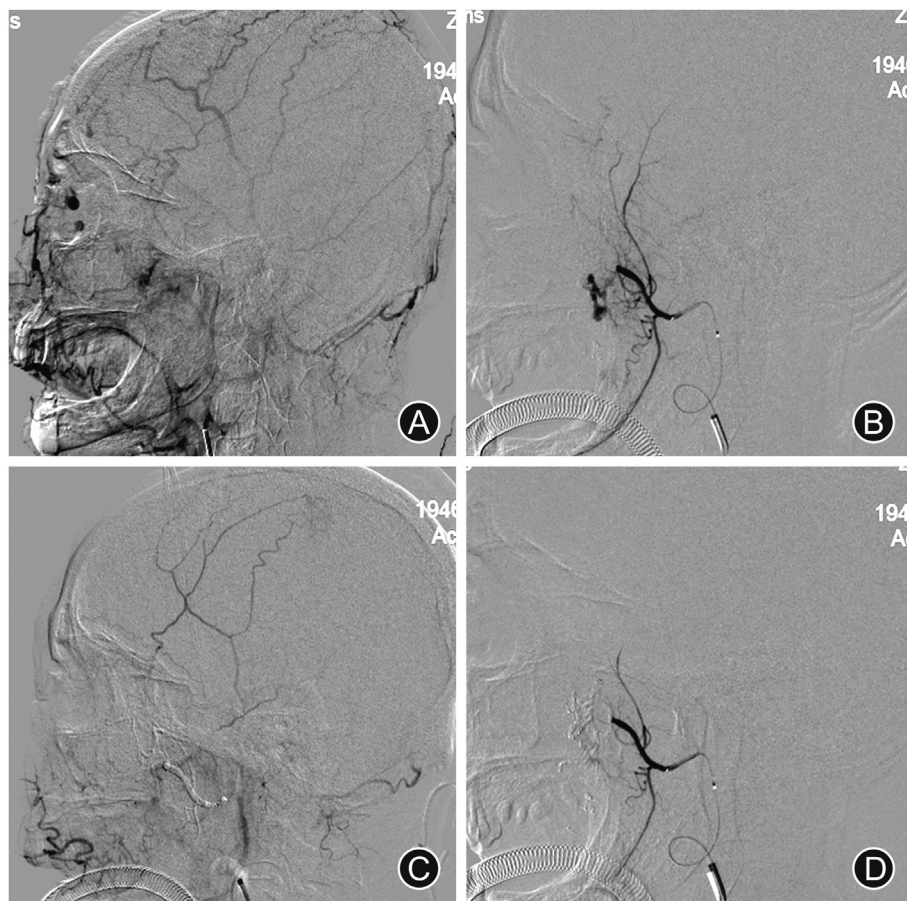
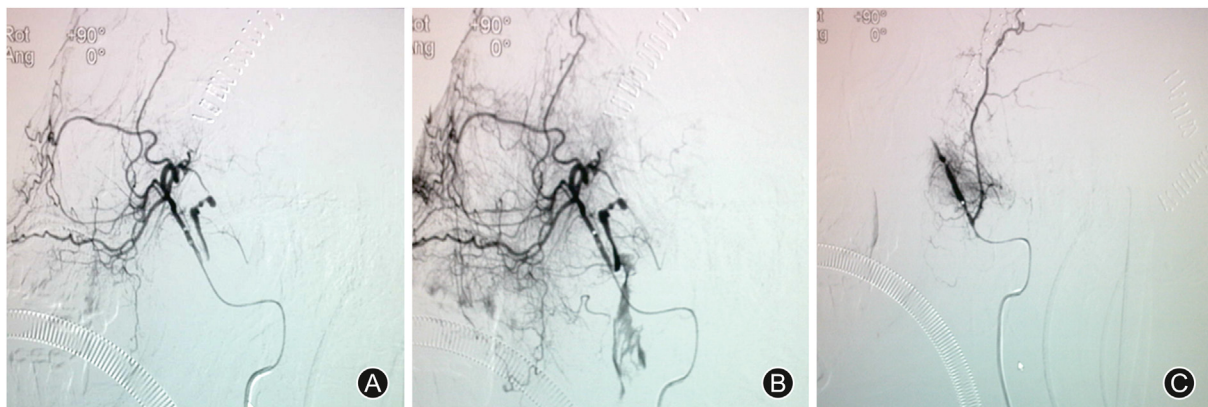
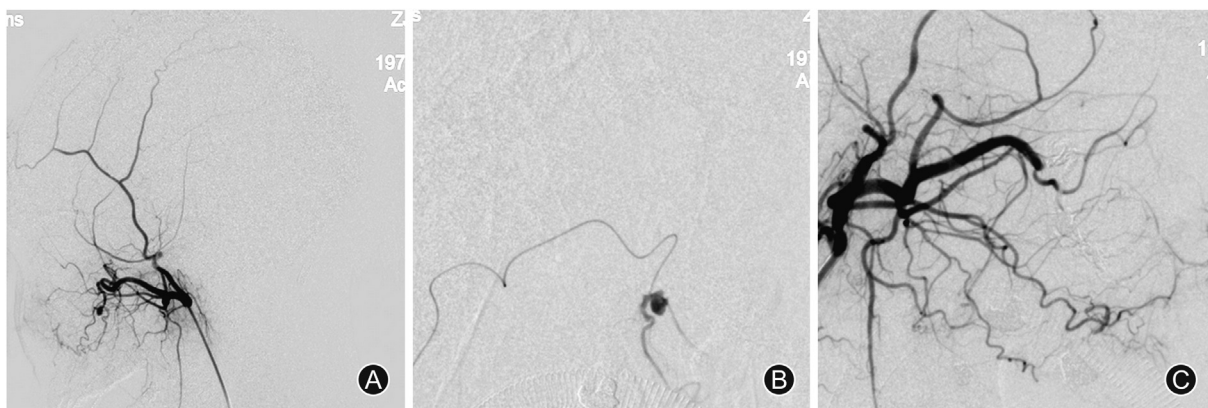


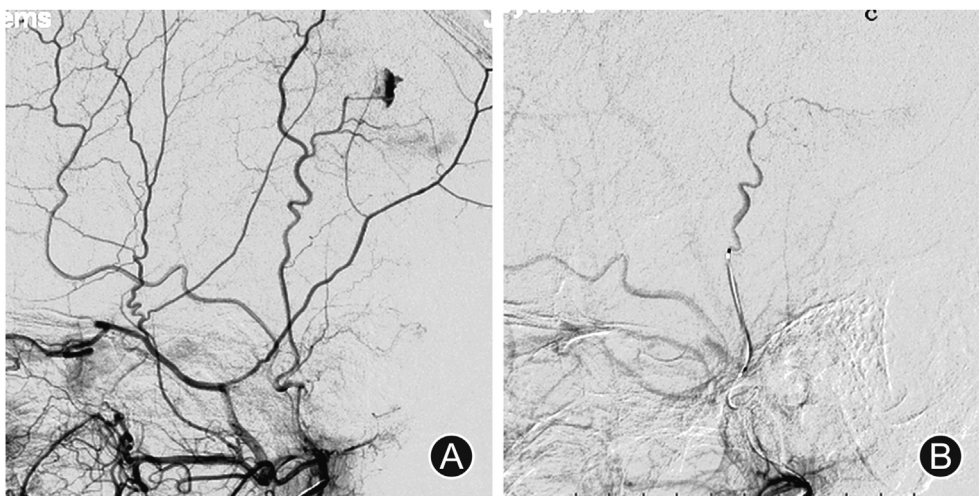
Fig. 3. (A) Digital subtraction angiography shows multiple internal maxillary artery pseudoaneurysms. (B) Selective angiogram shows the internal maxillary artery pseudoaneurysm. (C and D) Digital subtraction angiography shows pseudoaneurysms being not visualized after embolization.



**Fig. 4.** (A and B) Digital subtraction angiography shows the internal maxillary artery pseudoaneurysm and leakage of contrast agent. (C) Digital subtraction angiography shows that bleeding is stopped and the pseudoaneurysm is not visualized after embolization.



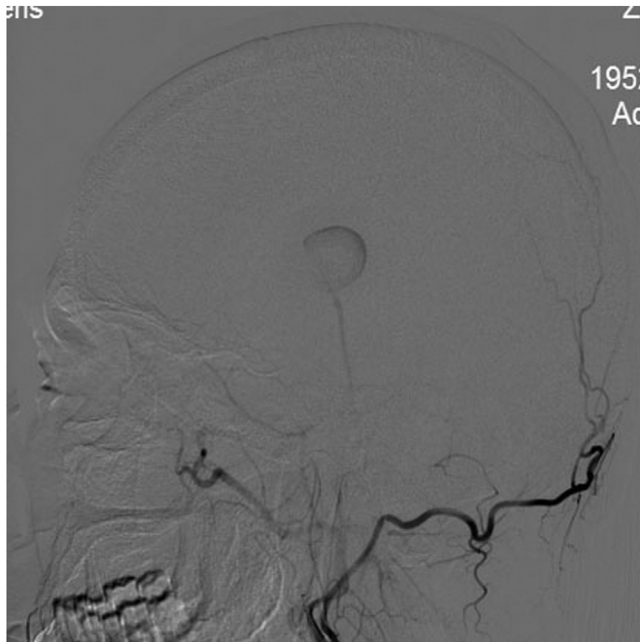
**Fig. 5.** (A) Digital subtraction angiography shows an internal maxillary artery pseudoaneurysm. (B) Selective angiogram shows a pseudoaneurysm. (C) Digital subtraction angiography shows the pseudoaneurysm being not visualized after embolization.



**Fig. 6.** Digital subtraction angiography shows a superficial temporal artery pseudoaneurysm. Digital subtraction angiography shows the pseudoaneurysm being not visualized after embolization.

of nasal tamponade and compression is temporary and often poor.<sup>2</sup> In this series, all the 5 cases of epistaxis had a history of nasal

tamponade. But the curative effect was not good and epistaxis occurred again. Therefore, for patients with pseudoaneurysms of



**Fig. 7.** Digital subtraction angiography shows a superficial temporal artery pseudoaneurysm.

internal maxillary artery, repeated blind nasal packing has poor hemostatic effect, causing patients to suffer more pain and delaying the opportunity of rescue.

All cases of internal maxillary artery pseudoaneurysms were treated by intravascular embolization. Endovascular embolization has the following advantages: (1) The diagnosis and treatment can be conducted simultaneously; (2) The treatment of multiple pseudoaneurysms is feasible; (3) The operation time is short and there is no surgical scar.

For embolization of pseudoaneurysms, embolic materials should be placed into the pseudoaneurysms and the local involved areas of the internal maxillary artery. The adjacent branches of the parent artery should be preserved as far as possible to reduce the risk of facial ischemia.<sup>3,4</sup>

Although the technique of embolization is mature, complications may still occur, including facial and nasal ischemia. The most dangerous complication is that embolization materials enter the

internal carotid artery or the ophthalmic artery through dangerous anastomosis or reflux.

Embolization materials include gelatin sponge, PVA, spring coil, Onyx glue, etc. We used Onyx glue and PVA to embolize the pseudoaneurysms of the internal maxillary artery, and the results were satisfactory.

In addition to nasal packing and endovascular embolization, emergency open surgery for ligation of the internal maxillary artery had also been reported.<sup>5</sup> However, due to the complexity of the operation, as well as high risk of nerve injury and facial scar, this method had not been widely used in clinical practice.

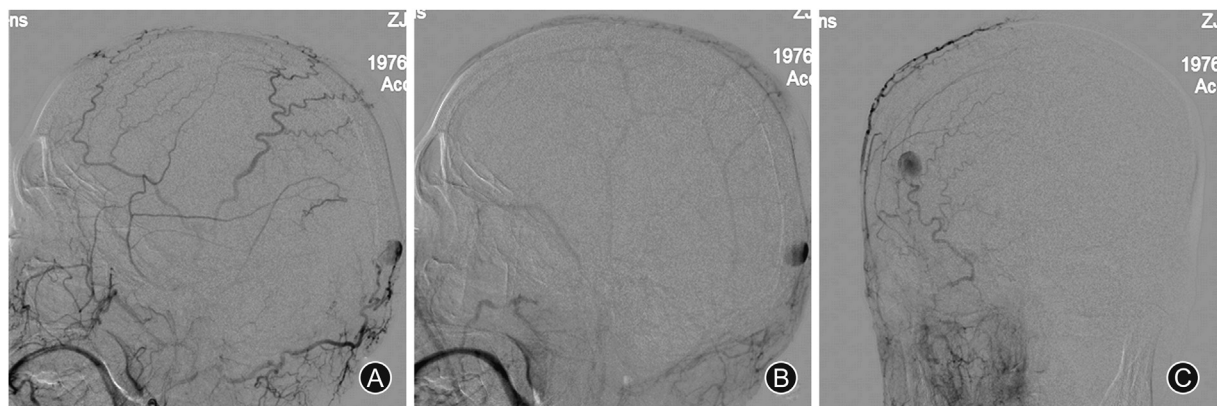
Traumatic scalp pseudoaneurysm is rare clinically, mainly involving superficial temporal artery pseudoaneurysm and occipital artery pseudoaneurysm. The superficial temporal artery is located superficially, and lacks soft tissue cushion between the skin and bone, which makes it more prone to traumatic aneurysms.<sup>6</sup> However, the occipital artery bifurcates from the external carotid artery and is protected by muscles until it passes through the trapezius fascia.<sup>7</sup> So occipital artery pseudoaneurysm is more rare than superficial temporal artery pseudoaneurysm. Up to 2008 since the first report of occipital artery pseudoaneurysm in 1644, only 4 cases of traumatic occipital artery pseudoaneurysms had been reported in the literature.<sup>7</sup> Chaudhry<sup>8</sup> reviewed the literature and found that from 1977 to 2017, a total of 9 cases of traumatic occipital artery pseudoaneurysms were reported.

In addition to trauma, other causes of scalp pseudoaneurysms are mainly iatrogenic injuries, including temporomandibular arthroplasty, puncture hair grafting, CT guided biopsy, and various neurosurgical operations in the area.<sup>9,10</sup>

Scalp pseudoaneurysms usually occur 2–4 weeks after trauma, and some occur within 2–4 days after trauma.<sup>6,11,12</sup> This series of pseudoaneurysms occurred 7–46 days after trauma. Most of the scalp pseudoaneurysms had no other symptoms except for scalp lumps. However, a few scalp pseudoaneurysms were accompanied by headache, facial pain or facial paralysis, ear discomfort, visual impairment, dizziness and hemorrhage.<sup>5,13,14</sup>

Scalp pseudoaneurysm is a rare vascular lesion, so further imaging examinations, such as ultrasound, CTA, DSA, are required to make a definite diagnosis and to exclude abscesses, arteriovenous fistula, subcutaneous cysts or vascular tumors.

DSA is the “golden standard” for the diagnosis of pseudoaneurysms. It can reveal the characteristics of pseudoaneurysms and correctly identify their feeding arteries. Some scalp pseudoaneurysms can be ignored only by non-invasive examinations such as



**Fig. 8.** (A and B) Lateral view of right external carotid artery digital subtraction angiography shows an occipital artery pseudoaneurysm. (C) Anteroposterior view of right external carotid artery digital subtraction angiography shows an occipital artery pseudoaneurysm.

ultrasonography and hence DSA is the key to prevent the omission of small pseudoaneurysms or other vascular lesions.<sup>11</sup>

Some scholars believed that surgery was the first choice of treatment considering the superficial position of scalp pseudoaneurysm.<sup>8,15</sup> But surgical treatment will leave scars and may damage adjacent nerves. Endovascular therapy is another available option.<sup>14,16,17</sup> Other possible treatments included direct injection of thrombin and ultrasound-guided compression, which may not work out and were not commonly used at present.<sup>18,19</sup> In our opinion, if pseudoaneurysms are small and patients have high cosmetic requirements, interventional therapy should be chosen. If pseudoaneurysms are large and there are many thrombi in the pseudoaneurysms, surgery should be chosen because the scalp lump will persist and recur easily after interventional treatment.

In clinical practice, we can also encounter pseudoaneurysms of the middle meningeal artery which cause epidural hematomas. More than 40 traumatic middle meningeal artery pseudoaneurysms have been reported.<sup>20–22</sup> We also treated a pseudoaneurysm of the middle meningeal artery. The patient's consciousness suddenly deteriorated 7 days after trauma, and CT revealed a marked increase of epidural hematoma. An emergency operation was performed, and a pseudoaneurysm of the middle meningeal artery was found intraoperatively. However, there were no intraoperative imaging data and preoperative CTA or DSA, so it was not included in this series.

DSA should be performed as soon as possible in patients with repeated massive nasal bleeding after craniocerebral injury to confirm the traumatic pseudoaneurysms. Endovascular therapy is a relatively safe, effective treatment for traumatic internal maxillary artery pseudoaneurysms. For patients with scalp injuries and pulsatile lumps after head and facial trauma, further examinations, including DSA, should be performed to clarify the diagnosis. Surgical treatment or interventional treatment for scalp traumatic pseudoaneurysm is effective.

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## Ethical statement

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Jiaying University.

## Declaration of competing interest

The authors report no conflicts of interest in this work and are responsible for the content and writing of this article.

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