

Role of CT and Endovascular Embolization in Managing Pseudoaneurysms of the Internal Maxillary Artery

Chao-Bao Luo*, Michael Mu-Huo Teng, Feng-Chi Chang, Cheng-Yen Chang
Department of Radiology, Taipei Veterans General Hospital, and National Yang-Ming University School of Medicine, Taipei, Taiwan, R.O.C.

Background: The purpose of this study was to evaluate the role of computed tomography (CT) and endovascular embolization in managing 10 patients with 11 internal maxillary arterial pseudoaneurysms (IMPAs) with acute oronasal hemorrhage.

Methods: A series of 10 patients with 11 IMPAs presenting with profuse oronasal hemorrhage, all treated with endovascular embolization, were reviewed. There were 9 males and 1 female ranging in age from 10 to 56 years (mean, 38 years). The predisposing factors of IMPA were trauma ($n = 6$) or head and neck carcinomas (HNCs) after surgical treatment and/or postradiation therapy ($n = 5$). Before embolization, all patients had CT of maxillofacial regions to evaluate the extension of trauma or to evaluate the treatment outcome for HNCs. Endovascular embolization was employed to occlude the IMPAs by delivering the embolic agents of liquid adhesives ($n = 9$) or microcoils ($n = 2$) to the IMPAs.

Results: On the lesion side, CT revealed maxillofacial fractures in all 5 trauma patients and recurrent or residual tumors in 3 patients with HNCs. In the other 2 patients with HNCs, CT showed no significant finding and contributed little to the catheter angiography in detecting the IMPAs. Endovascular treatment was technically successful in all 11 IMPAs, ceasing hemorrhage immediately after embolization. No recurrence of bleeding was observed. No patient developed neurologic deficit, skin, or mucosal necrosis at the maxillofacial region. Clinical follow-up was 2–36 months (mean, 14 months). Two patients with advanced carcinoma died during follow-up because of disease progression.

Conclusion: CT is a useful tool for guiding catheter angiography to localize the majority of IMPAs. Endovascular embolization can succeed in managing IMPAs, and should be performed as soon as the IMPA is depicted. [*J Chin Med Assoc* 2006;69(7):310–316]

Key Words: computed tomography, endovascular embolization, internal maxillary artery, pseudoaneurysm

Introduction

Pseudoaneurysm (PA), also known as a false aneurysm, is an outpouching of a blood vessel, with actual disruption of 1 or more layers of its wall, rather than with an expansion of all wall layers in true aneurysm. PAs are characterized by residual contrast media retention in the lesion long after the arterial phase of diagnostic angiogram is over. PAs of the external carotid artery (ECA) are rare. In a series of over 8,000 aneurysms, McCollum et al¹ reported only 21 PAs of the ECA, and 19 of them occurred after carotid surgery. The rarity of PA of the ECA is thought to be secondary to the small

size of the ECA branches, which makes complete transection much more likely than partial laceration; besides, the deeper and larger vessels are protected by softer tissue. The vast majority of reported PAs of the ECA arose from the superficial temporal, distal facial and distal internal maxillary arteries (IMAs). These vessels are most vulnerable due to their relatively superficial course and their crossing bony structures.

Internal maxillary arterial pseudoaneurysm (IMPA) is rare. The management of IMPA has sporadically been reported in the form of case reports,^{2–4} and endovascular management of IMPAs has not been well evaluated. The purpose of this study was to define the

*Correspondence to: Dr Chao-Bao Luo, Department of Radiology, Taipei Veterans General Hospital, 201, Section 2, Shih-Pai Road, Taipei 112, Taiwan. R.O.C.
 E-mail: cbluo@vghtpe.gov.tw • Received: September 20, 2005 • Accepted: May 16, 2006

role of computed tomography (CT) and endovascular embolization in managing 11 IMPAs and to evaluate the efficacy and safety of endovascular embolization.

Methods

Between July 1996 and June 2005, 10 patients with 11 IMPAs were urgently referred to our institute for diagnostic angiography and endovascular embolization to manage profuse oronasal hemorrhage. Before angiography, all 10 patients had CT scan to evaluate the maxillofacial trauma ($n=5$) or follow treatment outcomes in head and neck carcinomas (HNCs) within 2 months. Information collected from the charts and angiograms included patient's age and sex, predisposing factors, blood transfusion, relevant CT and angiographic findings, and embolic agents as well as outcomes (Table 1).

There were 9 males and 1 female aged from 10 to 56 years with a mean age of 38 years. The predisposing factors of the 11 IMPAs were blunt trauma ($n=6$, Figure 1) or HNCs after surgical treatment and/or postradiation therapy ($n=5$, Figures 2 and 3). All 11 IMPAs were associated with rupture and profuse oronasal bleeding and treated initially by oronasal packing with gauze or intranasal balloons; in addition, all patients underwent blood transfusion to maintain their vital signs, in volumes varying from 1,000 to 8,600 mL (mean, 2,900 mL).

In all patients, the previous CT scan was reviewed to detect the predisposing factors of IMPA and attempt

to find the lesion site. All CTs (HiSpeed, Advantage, GE Medical Systems, Milwaukee, WI, USA) were obtained within 2 months and were performed from skull base to thoracic inlet in 5 mm axial section before and after intravenous contrast administration.

Endovascular procedures were performed under local ($n=8$) or general anesthesia ($n=2$) using a femoral artery approach. Angiograms of bilateral carotid and vertebral arteries including neck and skull base were performed to search for the formation of potential PAs and/or vascular rupture. The first injection was usually targeted to the affected artery based on the CT findings, such as fracture of the maxillofacial region in trauma patients or recurrent/residual tumor, pharygocutaneous fistula or flap necrosis in HNC patients. If the PA was depicted, embolization was carried out immediately, followed by carotid and vertebral angiograms to look for the second potential vascular lesion. The endovascular procedure was initiated with a 6F femoral sheath and 6F guiding catheter positioned in the main trunk of the ECA in 9 adult patients, while a 5F femoral sheath and guiding catheter was used in a 10-year-old girl. A microcatheter was introduced and navigated to coaxially pass to the affected artery near PAs. Super selective angiograms were obtained through the microcatheter to delineate the anatomy of the affected arteries and PAs. The liquid adhesives, about 50% *N*-butyl-2-cyanoacrylate (NBCA)/Lipiodol, were used as an embolic agent in 9 IMPAs (Figures 1 and 2), while microcoils were employed in 2 to occlude the affected artery and PAs (Figure 3).

Postembolization control angiograms were routinely obtained to assess the effect of embolization.

Table 1. Demography and outcome of 10 patients with 11 IMPAs managed by endovascular embolization

Case no.	Sex/age	Etiology of IMPAs	Affected segment of the IMA	Blood transfusion (mL)	Relevant CT findings	Angiographic findings	Embolic agents	Follow-up (mo)
1	M/22	Trauma	PP	2,300	MF fracture	PA, CE	NBCA	25
2	M/43	Trauma	PP	2,500	MF fracture	PA	NBCA	23
3	F/10	Trauma	PP	1,600	MF fracture	PA	NBCA	36
4	M/33	Trauma	PP	1,000	MF fracture	PA	NBCA	18
5	M/18	Trauma	BIL, PP	5,600	MF fracture	PA, CE	NBCA	3
6	M/52	NPC, R/T	PP	1,500	Nil	PA	NBCA	14
7	M/40	NPC S/P, R/T	PP	3,200	Recurrent/ residual tumor	PA, CE	Coil	8*
8	M/51	NPC, R/T	PP	1,500	Nil	PA	NBCA	12
9	M/53	Tongue carcinoma, S/P, R/T	Pterygoid	1,200	Recurrent/ residual tumor	PA	NBCA	2
10	M/56	NPC, S/P, R/T	PP	8,600	Recurrent/ residual tumor	PA, CE	Coil	2*

*Death during follow-up. BIL = bilateral; CE = contrast extravasation; IMA = internal maxillary artery; IMPA = internal maxillary pseudoaneurysm; MF = maxillofacial; NBCA = *N*-butyl-2-cyanoacrylate; NPC = nasopharyngeal carcinoma; PA = pseudoaneurysm; PP = pterygopalatine segment; R/T = radiotherapy; S/P = postsurgery.



Figure 1. Images of a 22-year-old male patient who presented with massive nasal bleeding after head and facial injury. (A) CT demonstrated fracture of the left maxillary sinus with air retention in the nearby soft tissue. (B) Left carotid angiogram disclosed a PA with contrast extravasation in the distal segment of the IMA (arrow). (C) Total obliteration of the PA was achieved by infusion of *N*-butyl-2-cyanoacrylate (NBCA) into the affected artery and PA.

The nasal pack was maintained throughout the duration of the procedure, and was removed immediately after that, allowing for evaluation of bleeding and re-embolization if necessary.

Results

The results and follow-up findings are tabulated. Ten IMPAs occurred in the distal segment (pterygopalatine segment) of the IMA (Figures 1 and 3), 1 was located in the middle segment (pterygoid segment) of the IMA (Figure 2) and no IMPA was in the proximal segment (mandibular segment). CT was successful to guide the lesion site in 9 IMPAs but failed to demonstrate the exact segment in all 11 IMPAs; however, fractures

of maxillofacial regions associated with hematoma/air retention occurring in the lesion site were identified in all 5 trauma patients (Figure 1A), while residual/recurrent tumors were identified in 3 of 5 patients (Figure 2A) with tumor necrosis or cavity, and in 2 patients without significant CT findings. The predisposing factor was presumed to be radiation arteritis. All 11 IMPAs were totally obliterated on postembolization angiograms with complete cessation of bleeding immediately after the procedure. No evidence of adhesion of the NBCA mixture to the microcatheter was observed in all 8 patients who underwent liquid adhesive embolization. There was no procedural-related complication, such as neurologic deficit or skin necrosis on the facial region, in any patient. The clinical follow-up period for these patients was 2–36 months,

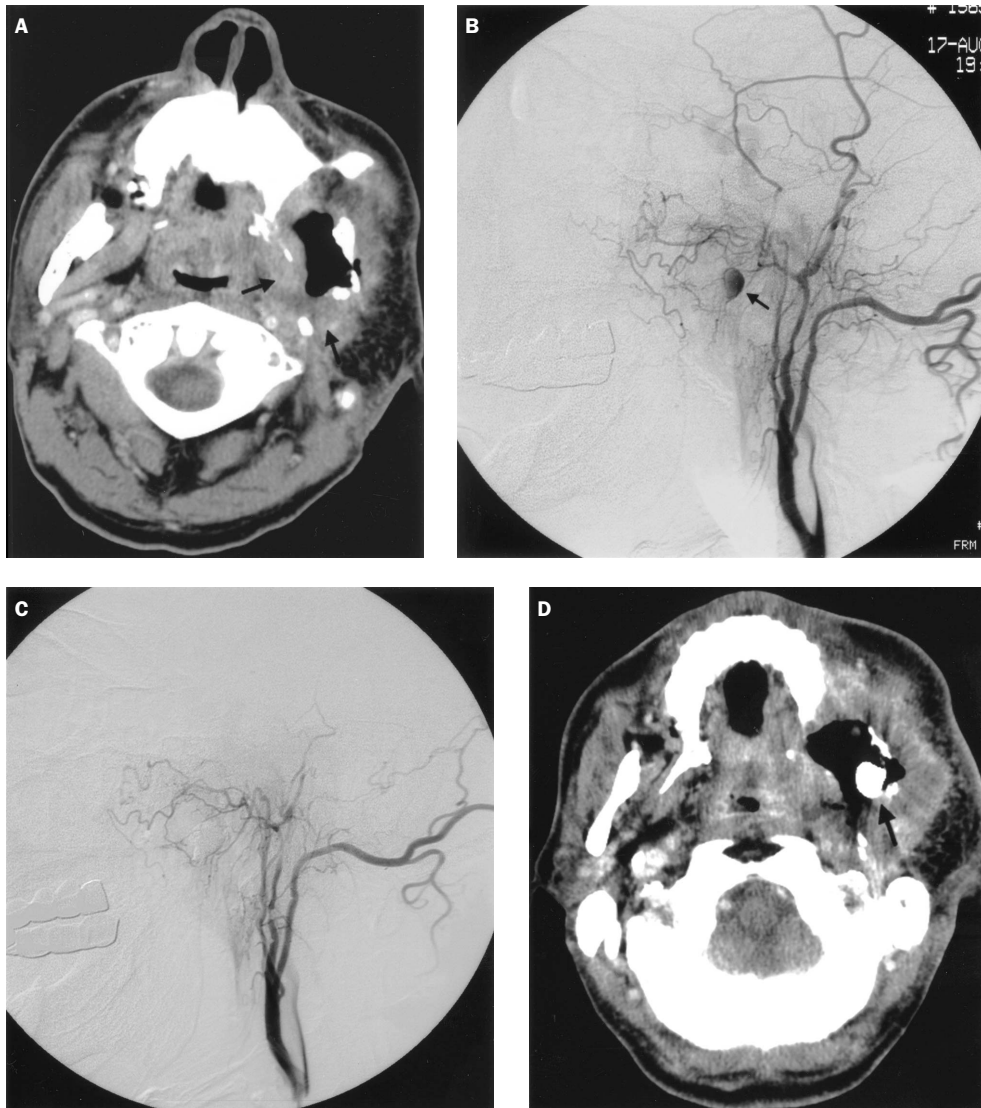


Figure 2. Images of a 53-year-old male patient with tongue carcinoma after surgery and radiation therapy. (A) Contrast-enhanced CT revealed a recurrent tumor with a cavity in the left infratemporal fossa and parapharyngeal space (arrows). (B) Left lateral carotid angiogram depicted a PA in the middle segment of the IMA (arrow). (C) After NBCA embolization, postembolization angiogram showed total obliteration of the PA with preservation of the nearby ECA branches. (D). Follow-up CT revealed radio-opaque NBCA cast at the PA (arrow).

with a mean of 14.3 months. Two patients with advanced HNCs died during follow-up because of disease progression.

Discussion

The IMA is the largest and terminal branches of the ECA. It originates behind the neck of the mandible at the distal ECA bifurcation and is divided into 3 main segments: the proximal mandibular, the middle pterygoid, and the terminal pterygopalatine segment.⁵ The IMA terminates within the pterygopalatine fossa by dividing into branches that supply the deep face and

nose. The distal IMA has numerous anastomoses with other ECA branches such as the facial artery and is a major source of potential collateral blood flow from the external to the internal carotid artery via the inferolateral trunk and vidian artery; and anastomoses with the ophthalmic artery via the ethmoid artery.

IMPAs are rare events, documented as a possible complication of trauma,^{2,3} infection or occurring as a result of maxillomandibular surgery.⁴ More rarely, IMPAs may result from postradiation vasculopathy or tumor invasion in patients with HNCs who received composite treatment.^{6,7} Most IMPAs occur in the terminal pterygopalatine segment of the IMA, as demonstrated in 10 IMPAs in our series. IMPAs can



Figure 3. Images of a 56-year-old male patient with nasopharyngeal carcinoma after radiation therapy. (A) Left lateral carotid angiogram revealed a PA in the distal segment of the IMA (arrow). (B) Postembolization angiogram showed obliteration of the PA by deposition of the coils (arrow).

lead to different complications and clinical manifestations, such as life-threatening oronasal hemorrhage following rupture of the PA, compression of the adjacent nerves or artery, and release of embolic thrombi to downstream blood flow, to produce thromboembolic events.⁸ In addition, unruptured IMPAs may also present as an expanding, pulsatile mass, often with an audible bruit heard almost exclusively during systole. These must be distinguished from arteriovenous fistula, which can result from partial injury to both an artery and a nearby vein. In our series, patients were divided into 2 groups depending on the predisposing factors. The first was the trauma group associated with maxillofacial fracture, composed of 5 patients; while the second was the tumor group composed of 5 patients who received composite treatment for HNCs. All these IMPAs presented with profuse life-threatening oronasal bleeding because of the rupture of IMPAs.

CT has been widely used to evaluate the extension of the maxillofacial trauma and to evaluate the treatment outcome in patients with HNCs. Although the diagnosis of IMPA depended solely on catheter angiography, on occasion, CT can directly visualize IMPA larger than 1 cm; nevertheless, in most instances, precise detection of IMPA is difficult, especially when it is small or obscured by hematoma or oronasal packing. However, CT remains helpful in managing IMPA. In trauma patients, association of the fracture, hematoma, or subcutaneous emphysema at the maxillofacial region is very common. Pharyngocutaneous fistula, flap

necrosis, or necrotic tumor may occur in HNC patients after composite treatment. In this series, 9 out of 11 IMPAs had these associated findings, enabling us to target the affected side and, possibly, the involved artery correctly, and to find the IMPA earlier to reduce the procedural time. However, if CT scan is not available before angiography, it should not be encouraged, particularly when patients have active bleeding, since CT is an adjuvant tool to manage IMPA, and the delay in time may increase the risk of morbidity and mortality.

The management of IMPAs with profuse life-threatening oronasal bleeding should start with tight nasal and oral packing to cease oronasal bleeding, followed by blood transfusion to maintain vital signs. However, such packing or compression was temporary and ineffective, since the bleeding resulting from ruptured artery is massive. In addition to conventional packing, emergent open surgical ligation of the IMA has been used; nevertheless, it is sometimes ineffective and difficult, especially when the patient is critically ill with active life-threatening bleeding. With the development of coaxial microcatheter systems, endovascular embolization has become important in the management and treatment of neurovascular lesions over the past few years; thus, embolization is recommended as the treatment of choice for epistaxis.⁹⁻¹¹ The advantages of endovascular embolization include the same session in the diagnostic angiography and embolization, demonstration of bleeding points, the more distal access to the bleeding points, control of

multiple bleeding points, no necessity for general anesthesia in most cases and short procedural time. In addition, super-selective localization of the bleeding to the IMA allows preservation of all the other branches of the ECA. The goal of embolization is not directed toward cure of the underlying cancer disease, but is palliative for controlling catastrophic hemorrhage and prolonging life, whether caused by tumor, trauma, or postsurgical complications.

An important concept in endovascular management of IMPAs is to deliver the embolic materials precisely to the PAs and a small segment of the affected IMA with the preservation of the branches adjacent to the affected artery and to reduce the risk of ischemia of the face and neck. However, the complex vascular structure and rich anastomoses mean the possibility of complications; the most significant of which are intracranial, with backflow of the embolic material or through dangerous anastomoses into the internal carotid artery or ophthalmic artery. The super-selective technique with microcatheter reduces the risk of misplaced embolic materials significantly. As to the selection of embolic agents for IMPA, a permanent embolic agent that can mechanically obstruct the IMPA is effective. The common permanent embolic agents employed for endovascular embolization of vascular lesions in the head and neck are polyvinyl particle (PVA) foam, microcoils, and liquid adhesive. PVA has been widely used for the treatment of idiopathic epistaxis or for preoperative tumor embolization. The disadvantage of PVA is the potential recurrent PAs with bleeding after embolization. Sometimes, it may be difficult to deliver the particles to the affected artery because of the occlusion of the lumen of the microcatheter by PVA. Microcoils such as platinum microcoils or Guglielmi detachable coils (GDC, Boston Scientific, Fremont, CA, USA) have been used successfully to treat intracranial aneurysms or arteriovenous fistulas.¹²⁻¹⁴ GDCs have the advantage of being very soft and retrievable, and can be precisely placed in the affected artery. However, direct filling of the IMPAs with microcoils is usually not adequate because of the lack of true walls of the PA and its ability to expand when filled. The flow into the hole is usually too great to cease bleeding. Therefore, tight and dense coil packing of the affected artery and PAs may be required and recurrent bleeding may occur via collateral circulation if coils are placed into the parent artery. In addition, if the caliber of the affected artery is less than 2 mm in diameter, it is impossible to occlude the affected artery with GDC.

NBCA is a monomeric liquid adhesive and has been widely used for embolization of intracranial

arteriovenous malformations. It has the advantages of good penetration and free dispersion compared with other embolizing materials, and rapid permanent induction of thrombosis and occlusion of the affected artery and PA. Also, it is quite easy to deliver through a microcatheter with a single injection and short procedural time. Theoretically, there are 2 potential disadvantages when NBCA is used as an embolizing agent for treating IMPAs. The first is that highly concentrated NBCA polymerizes very rapidly and tends to stick to the microcatheter. The rate of this complication is very low, with 3% incidence by the use of 25% NBCA mixture.¹⁵ To reduce the frequency of being glued, the microcatheter should be pulled out as quickly as possible. The second drawback is the potential risk of leakage or migration of the NBCA mixture into the branches of the ECA, causing mucosal or skin necrosis, or to the internal carotid artery via dangerous anastomosis resulting in cerebral infarction and/or ophthalmic artery occlusion. To avoid uncontrolled escape of the NBCA mixture, deeper microcatheterization to the IMA near PAs is crucial. In addition, the high concentration, more than 50% glue, must be used to allow early polymerization. The glue should be injected very slowly with simultaneous good quality road-mapping digital subtraction angiography, which can show any reflux of glue. In our institute, the selection of embolic materials is largely dependent on catheterization of the affected artery and its PA. If the PA could be approached as close as possible by the microcatheter, NBCA or microcoils are selected. Generally, we prefer to use the NBCA mixture to occlude the PA, as in 9 of 11 IMPAs, largely because of its short procedural time; microcoils were used when the operator was concerned about the risk of reflux of the NBCA mixture to the nearby branches of the ECA or keeping patency of the affected artery beyond the IMPA. PVA foam was selected only when we failed to super-select the IMPA by microcatheter because the affected artery and IMPAs were too tortuous to approach.

The immediate success rates in the obliteration of the IMPAs and controlling the profuse oronasal bleeding in our series were 100%; no recurrent active bleeding was found in all 11 IMPAs. Two patients died 8 and 2 months after coil embolization, respectively, from disease progression not related to the location and extent of the IMPA or the selection of embolic agent. In this study, the endovascular procedure prolonged the life of patients with massive oronasal bleeding by more than 2 months. We advocate that for any patient with profuse oronasal bleeding,

emergent angiography should be initiated to exclude the possibility of IMPAs, especially in patients with traumatic maxillofacial injuries or with HNCs after composite treatment. Before initiation of the endovascular procedure, detailed evaluation of the CT images may help to guide catheter angiography to localize the IMPA. Endovascular embolization is a successful way to manage IMPAs with profuse oronasal bleeding, and should be performed as soon as the IMPA is depicted.

Acknowledgments

This article was supported by a grant from Taipei Veterans General Hospital (VGH94-398).

References

1. McCollum CH, Wheeler WG, Noon GP, DeBakey ME. Aneurysm of the extracranial carotid artery. Twenty-one years' experience. *Am J Surg* 1979;137:196-200.
2. D'orta JA, Shatney CH. Post-traumatic pseudoaneurysm of the internal maxillary artery. *J Trauma* 1982;22:161-4.
3. Rogers SN, Berirne MPJ, Nixon TE. Traumatic aneurysm of the maxillary artery: the role of interventional radiology. *Int J Oral Maxillofac Surg* 1995;24:336-9.
4. Lanigan DT, Hey JH, West RA. Major vascular complication of orthognathic surgery. False aneurysms and arteriovenous fistulas following orthognathic surgery. *J Oral Maxillofac Surg* 1991; 49:571-5.
5. Osborn AG. The external carotid artery. In: Osborn AG, 2nd edition. *Diagnostic Cerebral Angiography*. Philadelphia: Lippincott Williams & Wilkins, 1999:49-55.
6. Citardi MJ, Chaloupka JC, Son YH, Ariyan S, Sasaki CT. Management of carotid artery rupture by monitored endovascular therapeutic occlusion (1988-1994). *Laryngoscope* 1995; 105:1086-92.
7. Chaloupka JC, Putman CM, Citardi MJ, Ross DA, Sasaki CT. Endovascular therapy for the carotid blowout syndrome in head and neck surgical patients: diagnostic and managerial considerations. *AJNR Am J Neuroradiol* 1996;17:843-52.
8. Gerbino G, Rocia F, Grosso M, Regge D. Pseudoaneurysm of the internal maxillary artery and Frey's syndrome after blunt facial trauma. *J Oral Maxillofac Surg* 1997;55:1484-90.
9. Luo CB, Teng MMH, Lirng JF, Chang FC, Chen SS, Guo WY, Chang CY. Endovascular embolization of intractable epistaxis. *J Chin Med Assoc* 2000;63:205-12.
10. Luo CB, Chang FC, Teng MMH, Chen CC, Lirng JF, Chang CY. Endovascular treatment of the carotid artery rupture with massive hemorrhage. *J Chin Med Assoc* 2003;66:140-7.
11. Moreau S, De Ruyg GD, Babin E, Courtheous P, Valdazo A. Superselective embolization in intractable epistaxis: review of 45 cases. *Laryngoscope* 1998;108:887-8.
12. Luo CB, Teng MMH, Chang FC, Lirng JF, Chang CY. Endovascular management of the traumatic cerebral aneurysm associated with traumatic carotid cavernous fistulas. *AJNR Am J Neuroradiol* 2004;25:501-5.
13. Teng MM, Chen CC, Lirng JF, Chen SS, Lee LS, Chang T. *N*-butyl-2-cyanoacrylate for embolization of carotid aneurysm. *Neuroradiology* 1994;36:144-7.
14. Cognard C, Weill A, Tovi M, Castings L, Rey A, Moret J. Treatment of distal aneurysms of the cerebellar arteries by intraaneurysmal injection of glue. *AJNR Am J Neuroradiol* 1999;20:780-4.
15. Debrun GM, Aletich VA, Shownkeen H, Ausman J. Glued catheters during embolization of brain AVMs with acrylic glue. *Interv Neuroradiol* 1997;3:13-9.