In one large series, Ogawa et al. identified factors indicating low risk for spinal recurrence to be unifocal tumour less than 4 cm in size, and treatment with whole brain or ventricular radiotherapy [5]. No patient in this low risk group developed spinal recurrence. Our patient fulfils all criteria for this group, highlighting the need for long-term follow-up even in low risk patients.

Although radiotherapy is an effective treatment modality, the role of prophylactic craniospinal irradiation (CSI) remains a matter of debate [2]. Supporters of CSI argue that the most powerful risk factor for recurrence is inadequate radiation coverage, as almost all recurrences occur outside the initial radiation field, as occurred in our patient [3]. Studies report distant control in the spine post-CSI to be 100%, compared to 62–87.5% depending on whether patients had focal or whole brain radiotherapy [6,7].

In this context one might argue that our patient would have benefited from CSI at initial presentation. However, the benefits must be weighed against the potentially toxic effects and long-term risks, especially in a paediatric patient population [2]. A reliable method is needed of identifying those individuals at high risk of developing spinal recurrence, and therefore most likely to benefit from CSI. Ogawa et al. suggested that CSI would be appropriate in patients with large primary intracranial germinomas, however, our patient proved to be an exception [5]. There is promising data on the use of low-dose CSI in preventing spinal recurrence whilst limiting the toxic effects of irradiation [7].

In the absence of prospective trials, managing primary localised intracranial germinoma will remain controversial [2]. Further work is required to create a reliable method of identifying those at risk of recurrence. This case highlights the need for a prolonged period of clinical and radiological surveillance to ensure the early identification of spinal recurrence, thereby limiting disability in this young patient population.

Conflicts of Interest/Disclosures

The authors declare that they have no financial or other conflicts of interest in relation to this research and its publication.

References

[1] Louis DN, Ohgaki H, Wiestler OD, et al. WHO classification of tumours of the central nervous system. 4th ed. WHO, IARC; 2007.
[2] Rogers SJ, Mosleh-Shirazi MA, Saran FH. Radiotherapy of localised intracranial germinoma: time to sever historical ties? Lancet Oncol 2005;6:509–19.
[3] Kahn L, Fridley J, Patel AJ, et al. Disseminated germinoma in the brain and cervical spinal cord 10 years after radiographic resolution of pineal germinoma. J Clin Neurosci 2012;19:1055–7.
[4] Hanakita S, Takenobu A, Kambe A, et al. Intramedullary recurrence of germinoma in the spinal cord 15 years after complete remission of a pineal lesion. J Neurosurg Spine 2012;16:513–5.
[5] Ogawa K, Yoshii Y, Shikama N, et al. Spinal recurrence from intracranial germinoma: risk factors and treatment outcome for spinal recurrence. Int J Radiat Oncol Biol Phys 2008;72:1347–54.
[6] Nguyen QN, Chang EL, Allen PK, et al. Focal and craniospinal irradiation for patients with intracranial germinoma and patterns of failure. Cancer 2006;107:2228–36.
[7] Schoenfeld GO, Amdur RJ, Schmalfuss IM, et al. Low dose prophylactic craniospinal radiotherapy for intracranial germinoma. Int J Radiat Oncol Biol Phys 2006;65:481–5.

http://dx.doi.org/10.1016/j.jocn.2015.06.023

A novel technique for identifying the fistulous point in a direct carotid-cavernous fistula

Kiyoshi Tsuji *, Nobuhiro Nakagawa, Norihito Fukawa, Kazuhiro Nagatsuka, Naoki Nakano, Amami Kato

Department of Neurosurgery, Kinki University School of Medicine, 377-2 Ohno-Higashi, Osaka-Sayama, Osaka 589-8511, Japan

ARTICLE INFO

Article history:
Received 1 April 2015
Accepted 20 June 2015

Keywords:
Balloon guiding catheter
Direct carotid-cavernous fistula
Fistulous point
Manual aspiration
Three-dimensional digital subtraction angiography

ABSTRACT

The fistulous point in a direct carotid-cavernous fistula (CCF) can often be difficult to identify because of high-flow shunting. A novel technique that is useful for identifying the fistulous point is reported. A 71-year-old woman underwent endovascular therapy for a left direct CCF that presented with sudden diplopia and tinnitus. To identify the fistulous point, vertebral angiography with manual compression of the left carotid artery was attempted, as was slow injection of a contrast agent from a balloon guiding catheter, closing off the left internal carotid artery; however, the shunt flow was very rapid, and identification was not possible. Therefore, three-dimensional digital subtraction angiography of the vertebral artery was performed while also performing manual aspiration from the balloon guiding catheter, closing off the left internal carotid artery. This reduced early visualization of the cavernous sinus and enabled an aneurysm in the cavernous sinus to be clearly visualized. Embolization was performed transarterially and transvenously, and the shunt flow disappeared completely. Vertebral angiography combined with manual aspiration from a balloon guiding catheter closing off the internal carotid artery is useful for identifying the fistulous point in a direct CCF.

1. Introduction

A direct carotid-cavernous fistula (CCF) is an abnormal arteriovenous shunt between the internal carotid artery trunk and the cavernous sinus, and it is Type A shunt in the Barrow classification [1]. A direct CCF is generally a high-flow shunt, and because of the possibility for not only ocular symptoms, but also severe intracranial hemorrhage, it is necessary to make a diagnosis as soon as possible and treat immediately. The gold standard of treatment is endovascular therapy [2]. In endovascular therapy, it is important to first accurately identify the fistulous point, but this is often dif-

* Corresponding author. Tel.: +81 72 366 0221; fax: +81 72 365 6975.
E-mail address: kiyoshi-tsuji@med.kindai.ac.jp (K. Tsuji).

ficult because of the high-flow shunt. A novel technique that is useful for identifying the fistulous point is reported here.

2. Case report

A 71-year-old woman presented with sudden onset diplopia and left-sided tinnitus approximately 4 months earlier; her condition progressively worsened. A CCF was observed on MRI, and she was referred to our department. The observed ocular manifestations were left ptosis, left pupil dilation, and left total external ophthalmoplegia.

She first underwent diagnostic cerebral angiography under local anesthesia. The left internal carotid artery was not visualized in anterograde flow intracranially, and blood flow was entirely diverted to the cavernous sinus (Fig. 1A). The left cerebral hemisphere was perfused with blood flow from the contralateral internal carotid artery and the posterior circulation (Fig. 1B, C). To identify the fistulous point, vertebral angiography and three-dimensional digital subtraction angiography (3D-DSA) with manual compression of the left carotid artery were performed; however, the shunt flow was very rapid, and the cavernous sinus was visualized early, so it was difficult to identify the fistulous point (Fig. 2A, B).

Subsequently, she underwent endovascular therapy under general anesthesia. A 9 French (9F) sheath was placed in the right femoral artery, and a 4 French (4F) sheath was placed in the left femoral artery and the left femoral vein. After sheath placement, heparin was administered intravenously, and the activated clotting time during the procedure was maintained at approximately 300 seconds. A 9F balloon guiding catheter (Optimo; Tokai Medical Products, Aichi, Japan) was placed in the left internal carotid artery, and a 4F diagnostic catheter was placed in the left vertebral artery origin. The proximal end of the 9F balloon guiding catheter was connected with the 4F sheath that was placed in the left femoral vein.

First, a contrast agent was slowly injected from the 9F balloon guiding catheter, closing off the left internal carotid artery in an attempt to identify the fistulous point, but assessment was impossible because the shunt flow from the collateral circulation via the Circle of Willis was very rapid. As such, left vertebral angiography and 3D-DSA were performed while also performing manual aspiration from the 9F balloon guiding catheter, closing off the left internal carotid artery. Manual aspiration was performed using a 30 mL syringe with a lock, and the aspirated blood was returned to the left femoral vein each time. This method reduced the early visualization of the cavernous sinus and enabled an aneurysm in the cavernous sinus to be clearly visualized (Fig. 2C, D).

After the working angle was determined, coil embolization of the aneurysm was performed using a balloon-assisted technique with a 4 × 15 mm HyperGlide balloon (ev3, Irvine, CA, USA). However, the microcatheter herniated out of the aneurysm during the coil embolization, and tight packing was not possible, resulting in incomplete embolization. Therefore, a transvenous approach was attempted, and sinus packing of the cavernous sinus was performed with coils until the shunt disappeared completely. After embolization, the left internal carotid artery was visualized in anterograde flow intracranially (Fig. 3).

3. Discussion

It is often difficult to identify the fistulous point in a direct CCF. Reported techniques for identifying the fistulous point include vertebral angiography with manual compression of the carotid artery [3]; slowly injecting a contrast agent from a balloon catheter, closing off the internal carotid artery [4]; and microcatheter angiography with interruption of internal carotid artery flow using a HyperGlide balloon [5]. In many instances, these techniques make it possible to identify the fistulous point. However, if there is a very rapid shunt from the collateral circulation via the Circle of Willis, as in the present patient, identification is difficult even when these techniques are used.

We devised a method using vertebral angiography while also performing manual aspiration from a balloon guiding catheter, closing off the internal carotid artery. This method is very useful for identifying the fistulous point because aspiration makes it possible to reduce early visualization of the cavernous sinus. Moreover, when 3D-DSA is added to this method, the working angle can be determined in the same way as in an unruptured cavernous sinus aneurysm, and coil embolization can be performed safely. Unfortunately, it was not possible to completely obliterate the shunt solely with aneurysm embolization by the transarterial

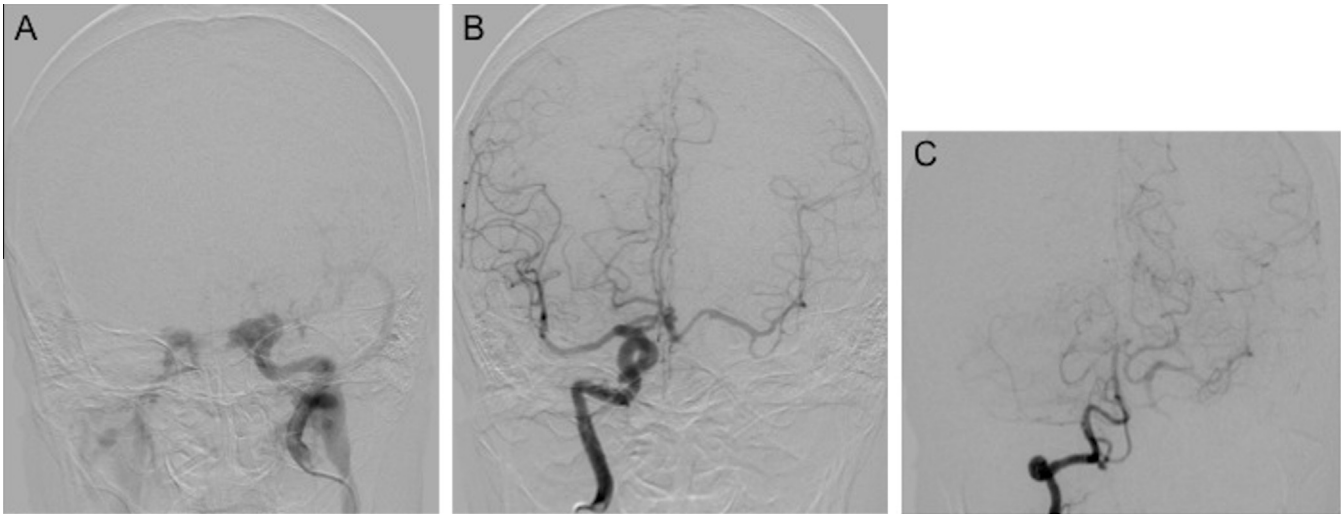

Fig. 1. Preoperative anteroposterior view of left internal carotid angiography (A). The left internal carotid artery is not visualized in anterograde flow intracranially, and the blood flow is all diverted to the cavernous sinus. Preoperative anteroposterior view of right internal carotid angiography (B) and preoperative anteroposterior view of right vertebral angiography (C). The left cerebral hemisphere is perfused with blood flow from collateral circulation via the anterior communicating artery and posterior communicating artery.