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Manual superficial temporal artery compression using a circular plastic material for embolization of meningioma: illustrative case

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BACKGROUND In meningiomas that occur in the high-convexity region, the superficial temporal artery (STA) frequently feeds the tumor, and when embolizing from the middle meningeal artery (MMA), the embolic material may not reach the tumor vessels because of the pressure gradient resulting from the STA blood flow, resulting in inadequate embolization. In this case, a circular plastic material was used to apply circumferential pressure around the parietal foramen to control blood flow to the tumor.

OBSERVATIONS A 45-year-old male underwent head magnetic resonance imaging that revealed a 2.2-cm meningioma in the right high-convexity region. Preoperative embolization was performed. When N-butyl-2-cyanoacrylate was injected from the right MMA while using a circular plastic material to compress the skin around the parietal foramen through which the bilateral STAs (the tumor feeders) flow, it was able to fully penetrate the tumor vessel and occlude the other feeders in a retrograde manner. The patient underwent tumor removal after embolization uneventfully.

LESSONS Manual compression of the STA using a circular plastic material is useful when the tumor is fed by the STA through the parietal foramen and is also applicable to transarterial embolization of dural arteriovenous fistulas fed by the STA or occipital artery.

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KEYWORDS meningioma; tumor embolization; superficial temporal artery; N-butyl-2-cyanoacrylate; manual compression

Preoperative embolization for meningioma is performed to reduce intraoperative blood loss, decrease blood transfusions, and shorten the operative time.[1–3] In the case of meningiomas that occur in the high-convexity region or near the superior sagittal sinus, the superficial temporal artery (STA) frequently feeds the tumor,[4] and when embolizing from the middle meningeal artery (MMA), the embolic material may not reach the tumor vessels because of the pressure gradient caused by blood flow from the STA, resulting in inadequate embolization. When embolizing from the STA, the embolic material may not penetrate into the dural feeders through the foramen but flow into the surrounding cutaneous arteries; thus, the transosseous feeder cannot be completely occluded, resulting in impaired skin circulation.[5] Therefore, to achieve adequate embolization from the MMA, the embolic material must be injected while controlling the blood flow from the STA.

Several studies have reported on how to control blood flow from the STA.[4,6,7] Occlusion of the STA with an embolic material is undesirable, because it may adversely affect wound healing, considering the subsequent tumor removal procedure.[5] Furthermore, as compared with the MMA, the STA is very tortuous, and guiding microcatheters to the feeding vessels near the tumor is not easy.[8] Therefore, it is useful to temporarily control the blood flow from the STA only during the injection of embolic material through the MMA.

Because the STA has abundant collateral circulation with occipital artery and contralateral STAs,[9] blood flow cannot be adequately controlled unless compression is applied directly above the parietal foramen. However, it is difficult to identify the exact location on the body surface. To control blood flow to the STA and the collateral blood flow to it, we used a circular plastic material to apply circumferential pressure around

ABBREVIATIONS CTA = computed tomography angiography; DSA = digital subtraction angiography; ICA = internal carotid artery; MMA = middle meningeal artery; MRI = magnetic resonance imaging; NBCA = N-butyl-2-cyanoacrylate; STA = superficial temporal artery; TAE = transarterial embolization.

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the parietal foramen. A circular plastic material is an accessory used to protect the tip of the catheter. In this article, we report the technique of manual STA compression using a circular plastic material for embolization of meningioma. To our knowledge, this is a new method for controlling blood flow to the tumor from the STA.

Illustrative Case

History and Examination

A 45-year-old male underwent magnetic resonance imaging (MRI) of the head, which incidentally revealed a neoplastic lesion in the right frontal region that was being followed up by his previous hospital. Because the neoplastic lesion had increased in size over the past 6 years, the patient was referred to our hospital. The patient was asymptomatic with no neurological deficit. Head MRI showed a 2.2-cm neoplastic lesion with a dural tail sign in the right frontal high-convexity region (Fig. 1A). Digital subtraction angiography (DSA) showed that the middle internal frontal artery, posterior internal frontal artery, bilateral MMAs, and bilateral STAs were feeding the tumor (Fig. 1B and C).

Preoperative computed tomography angiography (CTA) showed that the bilateral STAs were anastomosed subcutaneously and connected to the dural artery via the left parietal foramen, feeding the tumor (Fig. 1D). We decided to perform preoperative embolization followed by tumor resection to soften the tumor, facilitate internal decompression, and interrupt pial feeder from deep within the tumor.

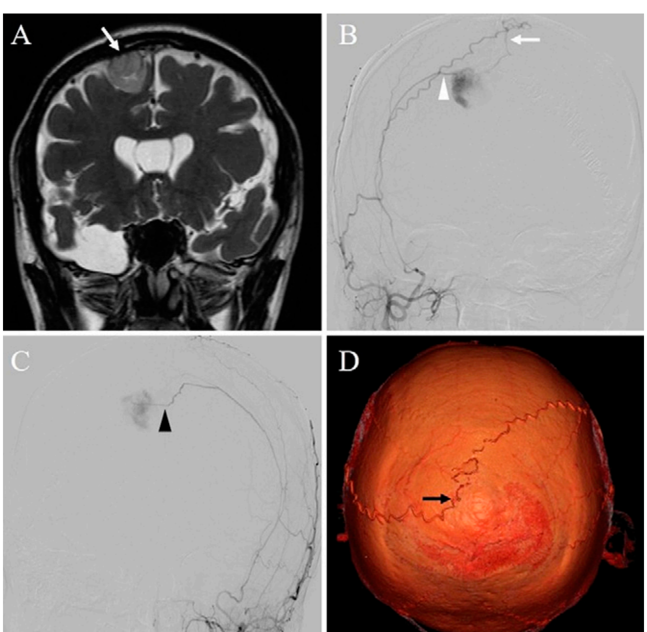

FIG. 1. A: Coronal T2-weighted MRI showed an extra-axial tumor (*white arrow*) in the high-convexity region. **B:** Right external carotid artery angiography (ECAG) showed the tumor feeding from the right MMA (*white arrowhead*) and right STA (*white arrow*). **C:** Left ECAG showed the tumor feeding from the left MMA (*black arrowhead*). **D:** Bilateral STAs were anastomosed and flowed into the tumor through the parietal foramen (*black arrow*) on three-dimensional CTA.

Endovascular Procedure

Preoperative embolization was performed under general anesthesia. A 7-Fr sheath was inserted into the right femoral artery, and a 7-Fr Roadmaster 90 guiding catheter (Goodman) was introduced into the right internal carotid artery (ICA). Subsequently, we guided a 3.2-Fr/3.4-Fr GuidePost 120 distal access catheter (Tokai Medical Products) into the intracranial ICA. A Marathon microcatheter (Medtronic) was introduced into the middle internal frontal artery, which fed the tumor and occluded the feeding artery, using 12.5% N-butyl-2-cyanoacrylate (NBCA). Afterward, we placed a 7-Fr Roadmaster 90 guiding catheter into the right external carotid artery and guided another 3.2-/3.4-Fr GuidePost distal access catheter into the origin of the right MMA. The Marathon microcatheter was guided into the right MMA anterior convexity branch feeding the tumor. The assistant wore a lead glove and applied manual pressure with a circular plastic material around the parietal foramen where the STA flowed in (Fig. 2A), confirming that feeding from the STA had disappeared (Fig. 2B and C). The parietal foramen with STA inflow was identified with reference to preoperative CTA, and the compression site was adjusted until the STA blood flow was blocked. We injected 12.5% NBCA through the Marathon microcatheter guided into the right MMA anterior convexity branch and directed it into the tumor vessel. As a result, the tumor vessel was embolized, and other feeders were retrogradely occluded. After we released the pressure from the circular plastic material, we performed DSA, confirming that feeding from the right MMA and right STA had disappeared (Fig. 2D and E).

Postoperative Course

The patient underwent tumor removal on the second day after embolization. Intraoperative bleeding was minimal, and no blood transfusion was performed. The pathological diagnosis was angiomatous meningioma. The patient had a good postoperative course and was discharged home without neurological deficit.

Discussion

Sufficient preoperative embolization softens the tumor[10] and facilitates internal decompression, which makes it easier to block pial feeders from deep within. Chen et al. reported in their meta-analysis that preoperative embolization helps reduce blood loss and surgical time during meningioma resection.[11] To achieve this effect, we believe that the embolization rate must be as high as possible.

Here, the tumor softened, which decreased the difficulty of the resection intraoperatively. Well-controlled further investigations will be needed to define the benefit from the procedure.

Observations

In tumors with more than one feeder, when the embolization material is injected from one feeder, the blood flow from the other feeders may push the embolization material back and prevent it from fully penetrating the tumor vessel. Therefore, it is necessary to control the blood flow from other feeders. In addition, manual compression of the STA on the parietal foramen using a circular plastic material can control collateral blood circulation from the contralateral STA as well (Fig. 3).

Although previous studies have reported methods to control blood flow in the STA, these methods have been used mostly in transarterial

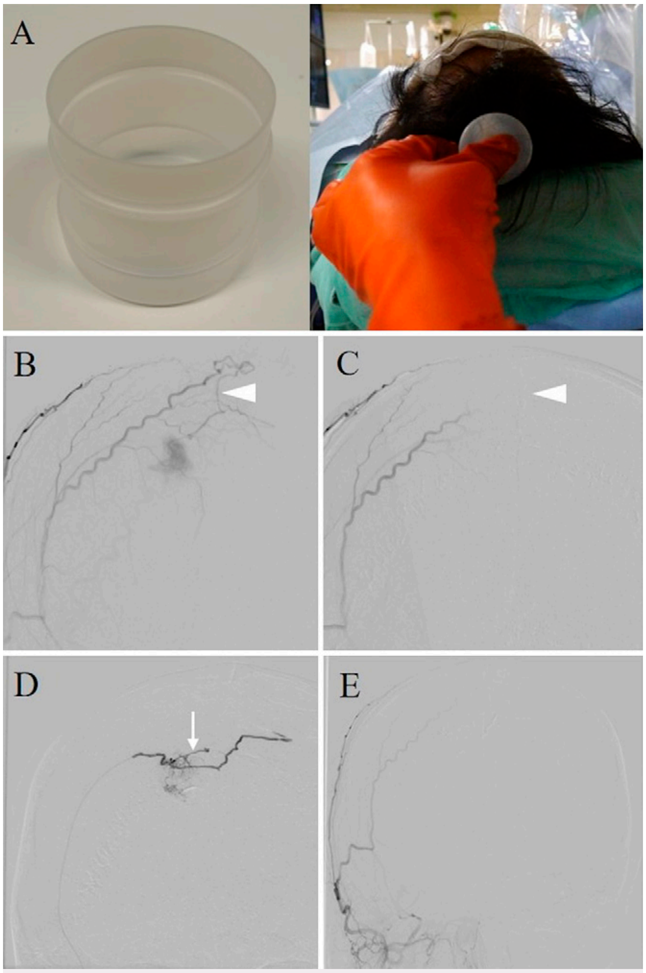

FIG. 2. Circular plastic material (**A**) was used to compress the bilateral STAs on the parietal foramen. Anterior views of the right ECAG (**A–D**) showing that the right STA (*white arrowheads*) was feeding the tumor (**B**). The STA was occluded by the pressure of the circular plastic material (**C**). The cast of the NBCA was injected from the right MMA, and the NBCA penetrated into the dural branch (*white arrow*, **D**) continuous with the STA. Right ECAG (**E**) after tumor embolization showed that feeding from the STA has disappeared.

embolization (TAE) of dural arteriovenous fistulas[6,7] and rarely in tumor embolization. Onishi et al.[4] reported a method for controlling control blood flow in the STA by occluding the proximal portion of the STA with coils. Yamauchi et al.[7] reported the use of subcutaneous infiltration of epinephrine-containing lidocaine to control the blood flow from the STA during TAE of dural arteriovenous fistulas. Omura et al.[12] reported a damp-and-push technique for embolization of dural arteriovenous fistulas while preserving cutaneous vessels. In this method, liquid embolic material is injected from a major feeder while occluding a high-flow feeder with a balloon microcatheter. This method can also be applied to the embolization of meningiomas. A similar approach to present case is the cookie-cutter technique for high-flow vascular malformation of the scalp.[13] This is the technique in which circular plastic is used to apply pressure around the shunt so that the embolic material effectively stays in the shunt. This is similar to the presenting case but has a different purpose.

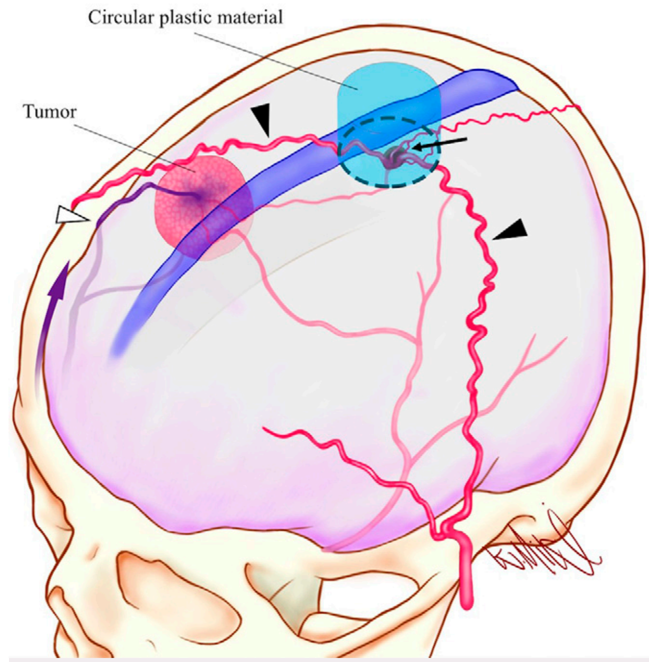

FIG. 3. Schema with circular plastic material compressing around the parietal foramen (*black arrow*). By compressing the bilateral STAs (*black arrowheads*) at the edge of a circular plastic material (*dotted circle*), the blood flow to the tumor was reduced. The cast of NBCA was injected from the right MMA (*white arrowhead*).

The advantages of our method are as follows: (1) the range of compression can be changed by adjusting the size and shape of the plastic material; (2) the compression site can be freely changed according to the location of the foramen where blood vessels flow into, making it possible to treat lesions in various locations; (3) strong compression can completely block blood flow in the STA; and (4) the STA is not occluded by embolic material and is reversible.

The disadvantage of this technique is the radiation exposure to the assistant performing the compressions. Radiation exposure occurs only during the injection of NBCA and is thus, considered to be low. Lead gloves were used to reduce radiation exposure. The procedure can possibly be performed without exposure to radiation by using a rubber band to fix the plastic material, although that was not used in the treatment of this case and is thus a subject for future study.

Lessons

Manual STA compression using a circular plastic material is useful in cases in which the tumor is fed by the STA through the foramen, and it is also applicable to TAE of dural arteriovenous fistulas fed by the STA. We hope that this technique will be used to treat various diseases in the future.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Horio, Kobayashi, Abe. Acquisition of data: Horio, Kawano. Analysis and interpretation of data: Horio, Kawano, Kobayashi. Drafting the article: Horio, Morishita. Critically revising the article: Morishita. Reviewed submitted version of manuscript: Miki, Fukumoto, Abe. Approved the final version of the manuscript on behalf of all authors: Horio. Administrative/technical/material support: Amamoto, Kobayashi. Study supervision: Kobayashi, Takemoto, Abe.

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