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HEAD & NECK

Efficacy and safety of preoperative internal maxillary arterial embolization with gelfoam for nasopharyngeal angiofibroma

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Abstract

Purpose To investigate the efficacy and safety of preoperative internal maxillary arterial embolization with gelfoam particles in patients with nasopharyngeal angiofibroma.

Materials and methods We retrospectively reviewed a total of 27 consecutive patients with pathologically confirmed nasopharyngeal angiofibroma from August 2006 to September 2018. Of the 27 enrolled patients, 10 patients received surgical excision alone; 17 patients received preoperative internal maxillary arterial embolization followed by surgical excision. Embolic agents were gelfoam particles.

Results The mean volume of intro-operative blood loss was 385.3 ml in patients with preoperative arterial embolization, which was significantly lower than 1215.0 ml in the patients without preoperative arterial embolization ($P<0.001$). The mean surgical time was shorter in patients with preoperative arterial embolization than in the patient without preoperative arterial embolization, but the difference had no statistical significance (205.0 vs 264.5 min, $P=0.064$). Neurological complications such as facial palsy or vision loss or hemiplegia were not observed in patients with preoperative arterial embolization.

Conclusion Internal maxillary artery embolization with gelfoam particles suffices to provide an effective and safe adjuvant procedure for surgical excision of nasopharyngeal angiofibroma.

Keywords Preoperative arterial embolization · Nasopharyngeal angiofibroma · Complications

Introduction

Nasopharyngeal angiofibroma (NA), also known as juvenile nasopharyngeal angiofibroma, is a rare highly vascular tumor which accounts for about 0.05% of head and neck tumors and usually strikes adolescent males [1]. The principle feeding artery of NA comes from the internal maxillary artery, which is a branch of the external carotid artery. Sometimes, other branches from facial artery and ascending pharyngeal artery may be accessory contributing arteries [2]. Although it is pathologically characterized by a benign tumor located in posterior nasopharynx, it is locally aggressive with a propensity to spread along anatomic routes to adjacent areas and even destruct the skull base and orbital wall [3, 4].

Surgical excision is the most effective treatment for nasopharyngeal angiofibroma yet, although alternative treatments such as radiation and hormones therapy are also available [3]. However, surgical excision may be faced with a great risk of massive intra-operative hemorrhage due to vascular fragility of nasopharyngeal angiofibroma, which is short of perivascular elastic fibers and pain muscles in the vessels [1]. Blood affair usually makes unclear surgical exposure and incomplete excision of nasopharyngeal angiofibroma, and sometimes even progresses into life-threatening bleeding [5, 6].

One strategy to reduce intro-operative hemorrhage is preoperative devascularization by embolizing the feeding arteries, which was first reported in 1970s as an adjuvant therapy for nasopharyngeal angiofibroma [7]. Although this procedure has evolved for decades in some aspects such as superselective techniques and embolic agents, serious neurological complications are still reported in some

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institutions [8–10]. In light of the rarity of nasopharyngeal angiofibroma, data are limited about the efficacy and safety of preoperative arterial embolization (PAE) and available data are mainly from case reports or case series [6, 11, 12]. It remains not to reach a consensus about extent of devascularization and choice of embolic agents. Therefore, we present our institution's experience in preoperative arteries embolization for nasopharyngeal angiofibroma.

Materials and methods

Study population

This study was approved by our institution's review board. Written informed consent before the procedure was obtained from all patients. We retrospectively reviewed the medical records registry at our institutions and identified all patients diagnosed with NA, which is confirmed by definite pathological examination. A total of 27 patients underwent endoscopic surgical excision between August 2006 and September 2018. Of the 27 patients, 17 patients received PAE followed by surgical excision; 10 patients received surgical excision alone. The decision of applying PAE or not was made by otolaryngological surgeons in-charge, who also took each patient's compliance into account.

Clinical data were retrieved from medical records, including age, sex, disease staging, procedure of preoperative arterial embolization, intra-operative blood loss, surgical time. All tumors were completely resected under endoscopic surgery. After surgical resection, all patients received regular endoscopic examination at outpatient visits and postoperative MRI or CT scan more than one year.

Procedure of angiography and embolization

The 17 patients underwent angiography and superselective embolization following a standard protocol. The femoral artery was catheterized under local anesthesia. Selective catheterization and angiography of bilateral common carotid arteries were, respectively, performed with 5-F Headhunter catheter (Terumo, Tokyo, Japan). Characterization of the two common carotid arteries was studied on both anteroposterior and lateral views. when an abnormal tumor staining was found, the 5-F Headhunter catheter was manipulated into the external carotid artery on the side of the abnormal tumor staining. To avoid the precipitation of arterial spasm, no attempts were made to advance the 5-F catheter more selectively. Intra-arterial contrast material was then injected to create a digital road-map image. A micro-guidewire and micro-catheter system (Terumo, Tokyo, Japan) was introduced coaxially into the internal maxillary artery and manipulated as close as possible to the tumor staining. When an optimum micro-catheter position was achieved, embolization was performed. Embolic agents were absorbable gelfoam particles with a range size of 150–710 μm. Gelfoam particles were mixed with contrast material to provide opacification before being injected into target vessels. Post-embolization angiography was performed to confirm the devascularization of the abnormal staining (Fig. 1).

Arteriovenous fistulas or early draining veins were not found in our study. All of the 17 patients received embolization of only the internal maxillary artery, which was sufficient to achieve more than 80% of devascularization.

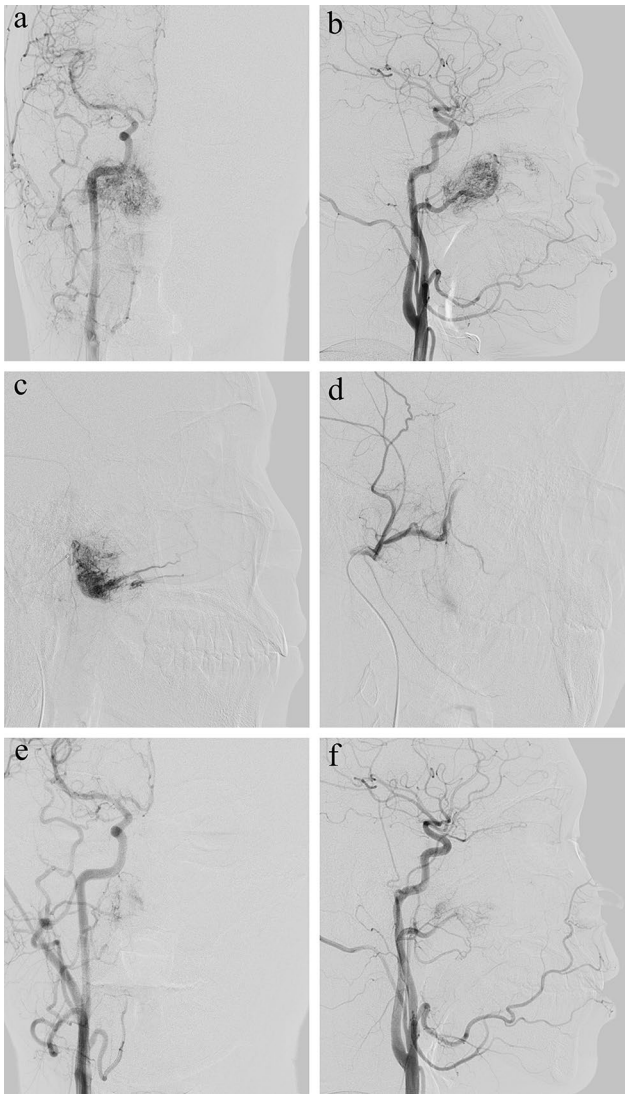

Fig. 1 Angiography of right common carotid artery before embolization (**a** anteroposterior, **b** lateral). Angiography of the right internal maxillary artery in the presence of the tip of micro-catheter close to tumor staining. Superselective catheterization avoids non-target embolization (**c**). Angiography of the proximal internal maxillary artery after complete embolization (**d**). Repeated angiography of the right common carotid artery showed the presence of less than 20% of residual tumor staining (**e** anteroposterior, **f** lateral)

Our study obviated the need of absolutely complete devascularization to embolize accessory feeding arteries, such as ascending pharyngeal artery or facial artery. In particular, branches from internal carotid artery such as ophthalmic artery evaded embolization.

Statistical analysis

Continuous data were summarized using mean values ± standard error (SE), and any difference between the two group was tested using independent two-sample *t* test. Categorical data were presented as number (*n*) or percentage, and any difference between the two groups was analyzed by Chi-squared test. Alternatively, Fisher's exact test or continuity correction was used when Chi-squared test was violated. All of the statistical tests and *P* value were two-tailed and *P* values of <0.05 were considered significant. All analyses were performed using the SPSS 16.0 software (Chicago, USA).

Results

Of the 27 enrolled patients, 17 patients received PAE followed by surgical excision (PAE group); 10 patients received surgical excision alone (Non-PAE group). Surgical excision was performed within 48 h after embolization in 2 patients, and within 24 h in 15 patients. All patients were male with a mean age of 21.9 years (range 13–53 years). As is shown in Table 1, there was not a significant difference in mean age between the two groups ($P=0.567$). According to Radkowski classification system [3], the tumor stage of PAE group was generally higher than that of Non-PAE group although the difference was not statistically significant (stage II + III, 88% vs 60%, $P=0.231$).

Arteriovenous fistulas or early draining veins were not found in our study. All of the 17 patients received embolization of only the internal maxillary artery, which was sufficient to achieve more than 80% of devascularization. Our study obviated the need for absolutely complete devascularization to embolize accessory feeding arteries, such as ascending pharyngeal artery or facial artery. In particular, branches from internal carotid artery such as ophthalmic artery evaded embolization.

Table 1 Clinical characteristics between the two groups

Characteristics	Groups		*P*
	PAE	Non-PAE	
N	17	10	
Age (mean ± SE)	22.7 ± 2.55	20.6 ± 1.83	0.567
Radkowski staging, *n* (%)			0.231
Stage I	2 (11.8)	4 (40.0)	
Stage II	12 (70.6)	5 (50.0)	
Stage III	3 (17.6)	1 (10.0)	
Blood loss (mean ± SE) (ml)	385.3 ± 48.46	1215.0 ± 91.91	0.000
Surgical time (mean ± SE) (min)	205.0 ± 19.75	264.5 ± 21.79	0.064

Intro-operative blood loss and surgical time

The mean volume of intro-operative blood loss was 385.3 ml in PAE group, which was significantly lower than 1215.0 ml in Non-PAE group ($P<0.001$). The mean surgical time was shorter in PAE group than in non-PAE group, but the difference was not statistically significant (205.0 vs 264.5 min, $P=0.064$).

Embolization-related complications

Neurological complications such as facial palsy or vision loss or hemiplegia were not observed in PAE group. Angiography-related complications including catheter-induced vessel dissection and contrast media-associated allergy or nephrotoxic effect were not observed either.

Discussion

Nasopharyngeal angiofibroma is a histologically benign, locally aggressive and highly vascular tumor, classic symptoms of which refer to the triad of recurrent epistaxis, nasal obstruction, and nasopharyngeal mass [1]. In spite of its rare incidence, this tumor was documented by Hippocrates as early as the 5th century BC. It was not until 1940 that Friedberg was the first to coin the term of angiofibroma, which emphasized its richness and fragility in blood vessels and susceptibility to recurrent epistaxis [13].

Due to its high and fragile vascularity, surgical excision carries a high risk of massive intra-operative hemorrhage, which poses a challenge to surgical operators. Preoperative arterial embolization has been reported to offer an effective and minimally invasive devascularization to reduce intro-operative hemorrhage [2, 11]. Consistently, our present study showed that the mean volume of intro-operative blood loss was 385.3 ml in patients with PAE, which was markedly significantly lower than 1215.0 ml in the patients without PAE. A drier and clearer surgical field may permit a more complete removal of the tumor lesion, which could lower recurrence [14]. In addition, our study showed that the mean surgical time of patients with PAE was borderline significantly shorter than that of the patient without PAE, which is consistent with previous studies [6, 15].

The aim of preoperative embolization is to obliterate the tumor vascular bed, which is mainly constituted by

the internal maxillary artery. Other branches such as facial artery and ascending pharyngeal artery conspire to make up a small part of tumor vascular bed. Of note, devascularization in our institution is performed by means of embolizing the main contributing artery (i.e., the internal maxillary artery) rather than all contributing arteries. The former means could yield more than 80% of tumor devascularization, which was sufficient to reduce intro-operative blood loss and shorten surgical time in our experience and previous reports [7, 16]. The latter means is to try to obliterate tumor vascular bed completely by excessive embolization, which definitely renders the procedure of PAE more complex and difficult. Accordingly, incidence of PAE-related neurological complications increases proportionally [8, 10]. No PAE-related neurological complications occurred in our institution may be mainly attributable to embolization of only the internal maxillary artery.

Also noteworthy is that embolic agents used in our institution was absorbable gelfoam particles, which is the suitable candidate for a 24–48 h period of reliable temporary occlusion in the context of adjuvant PAE [2]. Multiple embolic agents, such as gelatin, polyvinyl alcohol (PVA), microcoil, liquid embolic agents, can be candidates for preoperative embolization. The choice of specific agents depends on a multiple factors, including location, ease of delivery, durability of occlusion, blood supply of nasopharyngeal angiofibroma, propensity for recanalization, and size [17]. Embolic agents can be categorized into two general classes (permanent and temporary) according to durability of occlusion. Permanent embolic agents (PVA, microcoil, liquid embolic agents) are usually used for progressive disease, whereas temporary embolic agents (absorbable gelatin) can offer a transient occlusion of target arteries to facilitate surgical operation. Utilization of permanent embolic materials including PVA, micro-coils and liquid embolic materials could raise the risk of neurological complications [2, 9, 14]. Another issue that should be considered is the size of embolic particles. Theoretically, particles size above a threshold of 100 μm could ensure that no significant shunting between internal and external carotid arteries occurs as there are no arteriovenous fistulas or early draining veins [17]. Utilization of temporary embolic agents with a proper size range might be another reason for no neurological complications in our institution.

In conclusion, our study showed that preoperative arterial embolization is an effective and safe adjuvant procedure for surgical excision of NA. Superselective internal maxillary artery embolization with gelfoam particles can yield a satisfactory devascularization without serious neurological complications. This retrospective study is limited by small sample size. Further prospective investigation of large sample size is needed.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

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