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FULL PAPER

Embolization for the treatment of intractable epistaxis: 12 month outcomes in a two centre case series

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Objective: Embolization is a treatment option for intractable epistaxis; however, concerns regarding tissue necrosis, stroke and blindness persist in the literature.

Methods: A retrospective review of patients from September 2010 to January 2016 treated with embolization for epistaxis was performed. No patient was excluded. Follow-up was 12 months and no patient was lost.

Results: 62 embolizations on 59 patients occurred. 21 cases were taking anticoagulants, P2Y12 inhibiting agents or had a systemic coagulopathy. Embolized territories typically involved bilateral distal internal maxillary arteries with unilateral or bilateral facial arteries with polyvinyl alcohol particles. 60 cases had procedural general anaesthesia. There were no major complications. Six died of unrelated causes. Of the surviving 53 patients, excluding the 3 patients with hereditary haemorrhagic telangiectasia, 5 had recurrent epistaxis post-embolization. Four were taking

P2Y12 inhibiting and/or anticoagulants, none of which required surgery, prolonged packing or repeat embolization. This group had a propensity to recur compared with cases taking aspirin only or no antiplatelet/anticoagulant (77.8 vs 97.1%, $p = 0.04$). The fifth underwent repeat embolization after previously only having ipsilateral distal internal maxillary and facial arteries treated.

Conclusion: Embolization for epistaxis is safe and effective. Of those who had recurrent epistaxis post embolization, most were taking P2Y12 inhibition and/or anticoagulation. We prefer bilateral distal internal maxillary artery and unilateral facial artery embolization under general anaesthesia for optimal safety and efficacy.

Advances in knowledge: Embolization with this technique seems to facilitate superior outcomes without complications despite the large proportion of patients taking anticoagulating or P2Y12 inhibiting agents.

INTRODUCTION

Epistaxis is usually self-limiting, but a small proportion require medical attention. Posterior epistaxis is less common than anterior but is likely to require aggressive management.¹ Simple options include application of topical haemostatic or vasoconstrictive agents, cautery or packing. Invasive options involve interruption of blood supply via surgical ligation or endovascular techniques.²

The vascular supply to the nasal cavity includes external carotid artery (ECA) and internal carotid artery (ICA) branches. The ECA contribute the majority via distal internal maxillary artery branches, namely sphenopalatine arteries (SPA) and greater palatine arteries, with additional supply via facial arteries. The ophthalmic artery usually arises from the ICA and contributes anterior and posterior ethmoidal arteries.³

Embolization, first described in 1974,⁴ is now a well-recognized treatment for refractory epistaxis. The Royal College of Surgeons of England have set best practice standards stating that otorhinolaryngology departments should have a documented pathway for referral for embolization, but this is not frequently done.⁵

Published etiologies of epistaxis requiring endovascular intervention include idiopathic, traumatic, post-operative, aneurysms, arterio-venous malformations, fistulae, hereditary haemorrhagic telangiectasia (HHT) and neoplastic causes.⁶⁻⁹

METHODS AND MATERIALS

Study population

After obtaining institutional review board approval, a retrospective review was undertaken of cases of epistaxis that underwent endovascular management from September

2010 to January 2016. All patients are routinely followed up for 12 months. Patient demographics of hypertension, smoking status, anticoagulant or antiplatelet use and previous epistaxis history were recorded. Fisher's Exact test was used to identify statistical significance between anticoagulation and P2Y12 medication use. Admission status was deemed acute or elective and duration of epistaxis prior to embolization was divided into acute or chronic-intermittent pattern of bleeding. Length of stay post embolization, interventions preceding embolization and haematological parameters were recorded.

Success was pre-defined as having no further epistaxis which required medical intervention during follow-up. Failure, recurrent epistaxis post embolization (REPE), was defined as epistaxis post embolization which required any medical intervention (cautery, packing, repeat embolization, surgical ligation or transfusion for ongoing blood loss). Complications are divided into major and minor. Major complications include stroke, blindness, permanent nerve palsy or tissue loss. Minor complications include temporary headaches, self-limiting facial pain or non-operative groin complications.

Embolization technique

All cases were referred by otorhinolaryngology after failing some degree of hierarchical treatment, frequently with nasal packing *in situ*. Procedures were performed using biplane neuro-angiography equipment (Siemens, Erlangen Germany). General anaesthesia was routine unless assessed not to be fit for general anaesthesia.

Angiography was performed via the femoral artery with invasive monitoring. A 5Fr diagnostic, or 6Fr catheter (lumen. 038–0.070") was used and the ICA studied to ensure normal choroidal blush arising from the ophthalmic artery. Following this, the ECA branches were carefully studied looking for dangerous anastomoses with the ICA or eye, and for specific target lesions. If potentially dangerous anastomoses were identified, either a very distal embolization well beyond the site of the anastomoses was performed to prevent sequelae of inadvertent polyvinyl alcohol (PVA) particle reflux, or embolization was not performed on that side. This decision was made on a case by case basis by the operator and was dependent on the vascular supply to the nose seen on angiography and/or the clinical site of the most haemorrhage.

Through the guide catheter, a (0.021 lumen) micro catheter (Rapid Transit Codman, MA) was placed in the distal IMA under image subtraction and control angiogram confirmed no dangerous anastomoses. PVA particle (Boston Scientific, Cork, Ireland) size was determined by the operator; smaller particles were generally used for the distal IMA with larger particles for the facial artery. Particles were injected under a negative roadmap looking carefully for reflux or the appearance of new vessels until there was vessel stasis.

In the absence of a specific causative target lesion, three-vessel embolization was usually performed; the distal IMA at the level of the sphenopalatine vessels bilaterally and the FA at or above the level of the superior labial branch on the clinical side of the

most haemorrhage, or the largest facial artery. Two-vessel and four-vessel embolization were also performed, depending on target lesion and operator preference.

Following embolization, if otorhinolaryngology medical staff were available, examination under anaesthesia and pack removal occurred, otherwise the packs were removed the following day. All patients underwent a detailed neurological examination pre- and post- procedure by a medical staff member of the neuro-interventional unit to assess for complications.

RESULTS

A total of 62 endovascular procedures were performed on 59 patients, by four experienced interventional neuroradiologists at two tertiary hospitals over a 5-year period. 60 cases were performed with general anaesthesia. One patient, "Patient A", with idiopathic epistaxis was embolized twice and one patient with HHT was embolized three times. 72.6% were male, mean age was 59.0 ± 18.1 years, 61.3% had hypertension, 24.2% were current smokers and 45.2% were ex-smokers. HHT group excepted, none of whom were on antiplatelets or anticoagulation, 36.8% of cases were on systemic anticoagulation and/or P2Y12 inhibition or had a systemic coagulopathy.

Aetiology was idiopathic in 38 (61.3%), HHT in 5 (8.1%), traumatic in 7 (11.3%), post-operative in 8 (12.9%) and tumour-related in 4 (6.5%) (Table 1). The post-operative causes were all relatively minor sinonasal operations. Tumour-related epistaxis was one simple polyp and three squamous cell carcinomas (one pre-operative, one recurrent and one post-operative).

80.7% of cases had acute epistaxis and had bled continuously or intermittently for a mean of 6.2 ± 4.7 days, and 19.4% of cases were deemed chronic troublesome epistaxis who had bled for a variable time between 2 and 36 weeks.

Mean (98.3 ± 20.4 g l⁻¹) and lowest haemoglobin (86.2 ± 22.2 g l⁻¹) during admission were recorded. 58.1% of cases were transfused a median of three units of packed red blood cells (range 1–40). One case transfused 40 units had post-operative haemorrhagic complications following a hemicolectomy and developed a multifactorial coagulopathy prior to developing epistaxis on post-operative day 12. 36.1% of transfused cases received at least one unit post embolization, but none were triggered by ongoing bleeding.

Prior to embolization, all patients had failed hierarchical treatment. 17.7% of cases underwent acute surgical ligation of the sphenopalatine (11.3%), anterior ethmoidal (4.8%) or both (1.6%), in addition to packing. A further 3.2% had previous ligation. 74.2% of cases underwent packing and/or cauterization and 7.94% went straight to endovascular therapy, which was a reflection of subacute or chronic slow refractory epistaxis.

Embolization of one (6.5%), two (21.0%), three (43.6%) and four (29.0%) vessels, respectively was performed with PVA particles (Boston scientific, Cork, Ireland) (Table 2). Single vessel

Table 1. Results

Aetiology	Number of cases	Antecedent ligation	Number of vessels embolized				Relapse number	Time to relapse (days)
			1 ^a	2	3	4		
Idiopathic ± aspirin	20	5 SPA ^b	–	3	15	2	1	194
Idiopathic with P2Y12 or anticoagulation	18 (3 RIP)	1 SPA	–	4	6	8	3	12, 45, 231
Trauma/post-op ± aspirin	12	3 AEA and 1 dual SPA + AEA	1	4	2	5	0	
Trauma/post-op with P2Y12 or anticoagulation	3 ^c (1 RIP)	0	1	–	2	–	1	3
Tumour ± aspirin	4 (2 RIP)	1 SPA	2	1	1	–	0	
HHT	5	0	–	1	1	3	5	32, 41, 120, 183, 353

HHT, hereditary haemorrhagic telangiectasia; SPA, sphenopalatine arteries; AEA, anterior ethmoidal arteries; RIP, number of cases deceased during followup.

No tumour patient was taking P2Y12 inhibition or anticoagulation, and no HHT patient was taking aspirin or anticoagulation.

^aIndicates identifiable target for embolization.

^bOne additional case had a remote history of SPA ligation.

^cAll cases were post-operative.

embolization occurred only in four cases when a definite causative target was identified. (Figure 1).

PVA was used in all cases except one where glue was used for sole treatment of a pseudoaneurysm with active contrast extravasation. In five cases, adjunctive coils or glue was used in one or more vascular territories where additional devascularization was warranted. The first case had frank contrast extravasation post-operative sinus surgery and underwent adjunctive coil embolization of the distal IMA. The second case, with a nasal tumour presenting as epistaxis, underwent pre-operative embolization with PVA particles and coils to better occlude tumour supply. The third case had a post-operative pseudoaneurysm that was unable to be completely embolized with glue and coils, and underwent PVA embolization to further suppress vascularity. The fourth case had HHT and electively presented for her third embolization. On this occasion, an accessory meningeal artery supplying the septum and inferior turbinate was visible, and was glue embolized. The fifth patient represented with REPE following ipsilateral IMA and FA PVA embolization. A middle meningeal artery branch supplying the septum was demonstrated, which was coil embolized at the level of the foramen

rotundum, in addition to bilateral IMA and unilateral FA PVA embolization.

The distal IMA territory was embolized 117 times [PVA size 150–250 µm (33.3%), 350–500 µm (33.3%), 250–350 µm (26.5%) and 500–700 µm (10.3%)]. The distal FA was embolized a total of 63 times [PVA size 350–500 µm (49.2%), 500–700 µm (25.4%), 250–350 µm (22.2%) and 150–250 µm (4.8%)].

Choroidal blush from the ECA was seen in one case. Very distal IMA embolization was undertaken without evidence of PVA particle reflux. Angiography at the completion of embolization confirmed the unchanged nature of the blush. A second case had an occluded ICA with prominent collateralization with the ECA. Embolization was not performed on this side. In another case, collateralization of the ophthalmic artery was seen via anastomoses from the facial artery. Embolization of this facial artery was not performed.

The median length of stay post embolization was 2 days. Six patients died of unrelated causes during this time, otherwise no patient was lost to follow-up.

Recurrent epistaxis post-embolization

Three cases had pack trauma and required simple cautery at the time of pack removal. One case had his packs exchanged for thrombin coated packs immediately post-embolization due to supratherapeutic anticoagulation and a clinical need to continue anticoagulation. There was very minor ooze upon exchange.

Three HHT patients constituted five cases as one underwent a total of three embolizations over three and a half years. Increasing prominence of ethmoidal collaterals was noted at repeat angiography. These three patients had REPE requiring additional local treatment between 32–353 days.

Table 2. Vascular territories embolized

Vessels embolized	
Single vessel	6.5%
Ipsilateral IMA + FA	3.2%
Bilateral IMA	19.4% ^a
Bilateral IMA + unilateral FA	43.6% ^b
Bilateral IMA + bilateral FA	27.4%

FA, facial arteries; IMA, internal maxillary artery.

^aIncludes one case with additional middle meningeal artery.

^bOne case with additional accessory meningeal artery embolization.

Figure 1. Focal Target Lesion. Identification of focal target lesions is uncommon in idiopathic epistaxis; however, identification of such a lesion may modify technique. DSA image (a) lateral view demonstrates pseudoaneurysm formation (arrow) at the origin of SPA in a patient with persistent life threatening epistaxis following acute surgical ligation, treated with 150–250 μ m PVA. Lateral DSA (b1 and b2) of the SPA in early (b1) and late (b2) arterial phases in another case demonstrating a tiny pseudoaneurysm (arrow) of the middle turbinate treated with 150–250 μ m PVA. Lateral DSA (c) and digital angiogram (d) of distal internal maxillary branches in a patient with uncontrolled bleeding inverting papilloma demonstrates large, directly accessible pseudoaneurysms (c) (arrow) from greater palatine artery with glue cast (arrow) and tiny coil adjacent in post-embolization digital angiogram (d). DSA, digital subtraction angiography; PVA, polyvinyl alcohol; SPA, sphenopalatine arteries.

Other than expected REPE in HHT cases and those who died of other causes who couldn't therefore have long-term follow up, 90.4% had no REPE from the time of embolization to their follow up of 12 months. One patient who had REPE and then passed away of an unrelated cause during follow up remains included as a failure.

There were 21 total cases taking P2Y12 inhibition and/or anti-coagulation, or had a well-recognized significant coagulopathy (heparin induced thrombocytopenia in one case and coagulopathic liver failure with an international normalized ratio of above 6 in another).

Two cases had REPE in hospital at day 3 and 12; the former had metallic cardiac valves who was continued on therapeutic anti-coagulation throughout the peri- and post-embolization period. She was significantly supratherapeutic (APTT > 180 s) for

prolonged periods of time post-embolization and had REPE on post-embolization day 3 and required packing and cauterization under general anaesthesia. The second case was on warfarin for atrial fibrillation, was converted to intravenous heparin peri-procedure, and then subcutaneous enoxaparin post-procedure. He had REPE with self-limiting low volume epistaxis on post-embolization day 12 post which spontaneously resolved. The anterior aspect of the nasal cavity was subsequently cauterized. Two of the three cases with REPE post-discharge were taking P2Y12 inhibiting agents for recent coronary artery stents which were unable to be withheld. These cases had REPE at 45 and 231 days, respectively and were both treated with overnight packing. The fifth case, Patient A, only had a two-vessel embolization (ipsilateral IMA and FA) and had REPE at 192 days and underwent subsequent successful re-embolization of three vessels plus a middle meningeal branch supplying her septum. There was no further REPE during her subsequent 12-month follow up.

Overall 12-month success for patients taking P2Y12 inhibiting agents, anticoagulation or systemic coagulopathy was 77.8% and overall 12-month success for patients on no agent or aspirin alone was 97.1%. This reached statistical significance ($p = 0.04$, Fisher's exact test, one-tailed).

There were no major complications. Minor complications encountered were largely trivial. Six patients complained of self-limiting facial pain or headaches, and another two patients had a superficial groin haematoma, conservatively managed. One patient had subjective temporary dysesthesia in her right maxillary nerve distribution.

DISCUSSION AND LITERATURE REVIEW

Literature review: An English language Voids Medline search using keyword terms "epistaxis" and "emboli*" from 1 January 1995 to 28 Nov 2016. Full text articles of relevant case series were obtained and citation lists reviewed for further series. Case series of less than 20 were excluded. 16 articles met inclusion criteria and only three reported series have a larger number of cases than ours (Table 3).

Complications

Complications for epistaxis embolization are divided into major or minor. 11 of the 16 included case series report major complications relating either to non-target embolization or tissue loss. Rates of stroke, TIA or blindness is reported in 0–2%, with Santaolalla et al reporting a 10.7% stroke rate in 28 patients.¹⁰ Tissue necrosis is reported in four series,^{11–14} which describe necrosis involving the nasal tip (three cases), the palate (one case) and ulceration involving the lip and chin (one case). Three of the series used PVA particle size less than 300 μM , the fourth is not mentioned.

Minor complications are not always reported in the published case series or by patients, but can be up to 59%.¹⁵ 12.9% of our cases experienced minor complications, all but one were trivial, and include small groin haematomas, post-procedural groin pain, mild self-limiting facial pain or mild headache. One patient had subjective self-limiting dysesthesia in her right maxillary nerve distribution.

Vessels embolized and success rates

Published embolized territories vary and our preference is to embolize the distal internal maxillary artery bilaterally with one distal facial artery. The supply to the nose is rich with established or potential contralateral supply from distal IMA in particular and FA (Figure 2). Embolization of these contralateral vessels seem important, particularly the main supply to the posterior nasal cavity (SPA). Additional embolization of one facial artery, unless there are obvious collaterals, is reasonable in *de novo* cases to limit potential tissue necrosis and this is our preference. Leppanen et al¹⁶ exclusively embolized a single sphenopalatine artery and report a 78.4% long-term success. Elahi et al¹⁷ embolized the unilateral sphenopalatine artery in 80% of their subjects and report an 85.2% long-term success in their non-HHT patients; however, only 2% of their subjects were anticoagulated, which contrasts with our reported 97.1% for non-anticoagulated patients. Vokes et al¹⁸ embolized the unilateral sphenopalatine artery in 90% of their subjects and report an 86% 3-month success; anticoagulation/P2Y12 status is not mentioned. Fukutsuji et al¹⁵ embolized the ipsilateral sphenopalatine and facial arteries in 77.3% of their subjects, choosing only to embolize the contralateral IMA if rich flow was seen, and reported a 72.7% 12-month success. Further, Gottumukkala et al¹² report a linear decrease of REPE with an increasing number of vessels embolized. Taken together, these studies place weight on embolizing

Table 3. Outcomes of embolization from the 16 studies published from 1995 with at least 20 participants with mean follow up greater than 1 month

	N	Major complications (n)	Long-term success	Coagulopathic patients ^a
Current study	62	0	90.4%	36.8%
Wang 2016	43	1	Not clear	Not mentioned
Gottumukkala 2013	84	2	Not clear	23.8% ^b
Strach 2011	48	2	90.7%	Not mentioned
Santaolalla 2009	28	1	85.7%	28.6% ^b
Christensen 2005	70	1	Not clear	Not mentioned
Vokes 2004	28	0	86%	Not mentioned
Ricci 2004	22	0	81.8%	Not mentioned
Oguni 2000	37	0	Not clear	2.7%
Leppanen 1999	37	2	78.4%	Not mentioned
Moreau 1998	45	2	84.1%	6.7%
Tseng 1998	107	2	Not clear	3.7%
Elahi 1995	54	1	85.2%	1.9%

^aHereditary haemorrhagic telangiectasia subsets excluded.

^bIncludes aspirin use.

Figure 2. Bilateral nature of nasal blood supply. Bilateral IMA embolization is preferred and facial artery (FA) supply can also be bilateral. AP DSA of left SPA (a): respects the midline (arrow) with no contralateral supply, whereas AP DSA of Right SPA (b) demonstrates contralateral turbinate supply (arrow). AP DSA of right FA (c) respects the midline (arrow) with no contralateral supply, whereas AP DSA of Right FA (d) in another case demonstrates contralateral turbinate supply (arrow). AP, anteroposterior; DSA, digital subtraction angiography; FA, facial arteries; SPA, sphenopalatine arteries.

at least bilateral IMA in the absence of a specific target. Our only embolization failure (patient A) not taking P2Y12/anticoagulation was treated with only ipsilateral distal IMA and FA territory embolization.

Our 12-month success rate for idiopathic epistaxis without P2Y12 inhibition or anticoagulation is 97.1%. One out of our five cases with REPE required uninterrupted anticoagulation for mechanical heart valves and had significantly supratherapeutic values at the time of their REPE. One other was on subcutaneous enoxaparin for atrial fibrillation who had a self-limiting REPE.

Patients receiving ongoing P2Y12 inhibition or anticoagulation showed statistically significant propensity for REPE with a long-term success rate 77.8% ($p = 0.04$), none of which required prolonged packing, transfusion or surgical intervention.

5 of the 16 studies report long-term success as an independent metric of short-term success. It is not clear if early REPE requiring retreatment are included in their long-term success. We defined long-term success as no REPE requiring any medical treatment at 12 months, thus short-term success is a pre-requisite. This definition was pre-defined prior to undertaking this retrospective study. The three published series with more subjects than ours all report long-term success independently of short-term success, thus their long-term REPE figures are not directly comparable to our own.

Longer-term success is typically 5–10% lower as follow-up periods increase,^{9,10,12,14–25} and we observed the same trend. Our 1- and 3-month success, respectively is 96.3 and 94.4%.

Anticoagulation, P2Y12 inhibition and systemic coagulopathies of patients are not universally reported. We report on a higher rate of coagulopathic or P2Y12 inhibited cases than any other published series and found a statistically significant association between this and REPE ($p = 0.04$).

Epistaxis duration pre-embolization and length of stay post-embolization

Our mean duration of acute epistaxis prior to embolization was 6.2 ± 4.7 days and patients were discharged post-embolization after a median length of stay of 2 days. This is comparable to the reported 4.7–7 d mean duration of epistaxis prior to embolization^{12,14,16,19} with mean length of stay of 1.7–3.9 days post-embolization.^{9,12,14}

Pre-embolization ligation

17.8% of cases failed surgical ligation and we prefer patients not to have SPA ligation prior to embolization as the target tissue arterioles may not be accessed directly by PVA if ligation antedates the procedure. Only three endovascular series include ligation failures which comprised 8.0–11.4% of subjects.^{12,19,21}

CONCLUSION

Embolization for epistaxis is a very safe and effective treatment and facilitates early discharge from hospital. We routinely

perform three-vessel (bilateral IMA and single FA) or four-vessel embolization with PVA particles under general anaesthesia. In our contemporary series, there were no major complications. 12-month success for patients taking aspirin or

no antiplatelet/anticoagulation agent is 97.1%, and 12-month success for patients requiring uninterrupted anticoagulation or P2Y12 inhibition is 77.8%. 17.8% of patients had failed surgical ligation.

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