The Journal of Laryngology and Otology
May 1982. Vol. **96.** pp. 439–450

Embolization in otolaryngology

By DEREK KINGSLEY and ALEC FITZGERALD O'CONNOR*
(London)

ANGIOGRAPHY is occasionally required in the investigation of patients with head and neck disease, but its role has been mainly to provide anatomical information prior to surgery or radiotherapy. With the development of more sophisticated imaging techniques, allowing macroangiography, a better appreciation of detailed vascular anatomy can be obtained and this has lead to the development of 'interventional radiology' providing an alternative and sometimes preferable method of treatment to conventional therapy in some conditions.

Therapeutic embolization is the deliberate injection of emboli into a vessel to occlude it. A wide variety of materials has been used, indicating that no single substance is entirely adequate (Allison, 1978). The ideal agent should be non-toxic, rapidly thrombogenic, easy to introduce, radio-opaque, permanent in its effect, available in different sizes, and easy to sterilize. Some materials are almost completely inert and achieve their effect by thrombosis alone; others induce a vascular reaction and tend to produce more permanent occlusion of the vessel.

Therapeutic embolization was first used in the management of acute gastro-intestinal bleeding (Rösch *et al.*, 1972), and selective embolization of the left gastric and duodenal arteries has now become an accepted method of treating peptic ulcers (Merland *et al.*, 1978). It has also been used in other situations, including acute traumatic (Katzen *et al.*, 1976) and post-operative (Lea Thomas and Lamb, 1977) renal haemorrhage, and bleeding colonic diverticulae. With gastro-intestinal haemorrhage embolization has lead to infarction and gut perforations because of the prevalence of end-arterioles (Goldman *et al.*, 1976). Bleeding oesophageal varices have been embolized using particulate matter or glues injected through a catheter introduced via the jugular (Goldman *et al.*, 1976) or portal (Scott *et al.*, 1976) veins. Vascular malformations, which are sometimes difficult to excise completely either because of their size or critical position, may be suitable for micro-embolization.

In the head and neck, embolization is generally limited to branches of the external carotid artery (Picard *et al.*, 1978), the anatomical area of concern to the otolaryngologist, but increasingly embolization of lesions supplied by the internal carotid artery is being undertaken (Berenstein, 1980; Bank *et al.*, 1981).

Department of Radiology and Otolaryngology, The London Hospital, Whitechapel, London E1 1BB.

* Now Consultant Otolaryngologist at St. Thomas' Hospital, London SE1 7EH

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

Methods of Embolization

Although techniques vary in detail, the general principles remain the same.

1. It is first necessary to undertake a detailed evaluation of the vascular anatomy of the lesion, identifying all feeding vessels, since limited embolization will result in the opening up of collateral supply. Rapid sequence films with subtraction are essential and macroangiography is usually necessary. Any supply from the internal carotid or vertebro-basilar territory will lead to incomplete embolization of a lesion primarily supplied by the external carotid vessels. During embolization, connections between internal and external carotid territory may open, carrying a risk of emboli being deflected into intracranial vessels as the intravascular pressure rises within the lesion. Large vessels arising from the proximal internal carotid and vertebral arteries usually render satisfactory embolization impossible, but a balloon catheter can occasionally be temporarily inflated in the internal carotid artery distal to a large feeding vessel, to deflect emboli into the latter.
2. The tip of the catheter should be placed as close to the lesion as possible to prevent embolization of unnecessary vessels. Even so, as more emboli are injected, the resistance within the lesion rises and reflux may cause more extensive embolization than necessary. Extreme care must be taken to prevent emboli refluxing into intracranial vessels, but occasionally a double-lumen balloon catheter may be necessary to prevent backflow. Fluoroscopic visualization of the emboli during the procedure lessens the risk of reflux and, although radio-opaque emboli are usually injected in saline, non-opaque materials are best immersed in contrast.
3. In tumours and other lesions without a large arteriovenous shunt, small emboli should be injected initially to achieve adequate peripheral embolization, since early injection of large emboli may occlude the feeding vessel proximally, leading to subsequent dilatation of other vessels not visible on the initial angiogram. The emboli should be injected manually at a low pressure, continuing until reflux commences. Too rapid an injection increases the risk of retrograde flow of embolic materials.
4. After embolization of the external carotid territory, the catheter should not be used for contrast injections in more proximal vessels supplying the intracranial territory because of the risk of injecting residual emboli situated within the catheter system. The check angiogram should be undertaken after changing the catheter.
5. When skin lesions are to be treated, accurate evaluation of its blood supply can be demonstrated using coloured dyes such as Methylene blue.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

Materials

(1) *Autologous Blood Clot* has been used on its own, or mixed with Epsilonaminocaproic Acid (EACA). Thrombus is lysed from the normal arterial intima within a few hours but, when mixed with EACA, its life is prolonged for up to 24 hours although little remains after 3 days (Chuang and Reuter, 1975). In patients with clotting defects, the fibrinolytic process may be activated by the autologous clot and this in turn destroys the clot before it has time to produce its effect (Willis and Russell, 1979).

(2) *Sterispon (Gelfoam)* This material has become popular because it is readily available, cheap and non-antigenic (Hilal and Michelsen, 1975). Although vascular occlusion is seldom permanent (Barth *et al.*, 1977) gelfoam lasts longer than autologus blood clot (Chuangand Reuter, 1975). However, when more permanent effects are required, non-absorbable materials, although more difficult to introduce, are to be preferred.

(3) *Lyodura* is a freeze-dried preparation of dura mata. Although slightly more difficult to inject through a catheter system than gelfoam, it has all the advantages of the latter and produces permanent occlusion.

(4) *Silastic* can be used in the form of spheres, or as a liquid which is allowed to polymerize within the lesion (Hilal and Michelsen, 1975). The spheres, which come in various sizes between 1 and 2·5 mms. in diameter, are radio-opaque and are injected in physiological saline using a closed system. Liquid silastic may be used as an intravascular adhesive which can be impregnated with tantalum powder for easy fluoroscopic visualization (Berenstein, 1980). Polymerization of the dilute elastomer takes about 6 minutes after addition of a catalyst, stannous octoate, with a cross-linking substance.

(5) *Isobutyl II Cyanoacrylate* (IBC) is a liquid adhesive that polymerizes on contact with blood (Zannetti and Sherman, 1972), has a low viscosity and low toxicity in humans, is very stable, and can be used to occlude high flow arteriovenous malformations (Margolis, 1979). Supra-selective catheterization is necessary, to place the cyanoacrylate within or as close as possible to the lesion. It is technically difficult to use, since it rapidly sets and adhesion of the catheter tip to the vessel wall has occurred. Injection of IBC in a sandwich of 10 per cent dextrose prevents activation within the catheter system and reduces this risk (Merland *et al.*, 1978). Long-term effects have not yet been evaluated.

Many other materials have been used, including autologous muscle, stainless steel balls, oxycel, lead shot, etc. Detachable balloons, now extensively used in carotico-cavernous and vertebro-vertebral fistulae (Debrun *et al.*, 1978), are not discussed here since they have little place in Otolaryngology.

Indications

The indications for arterial embolization in Otolaryngology fall into 3 groups:

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

(1) Acute and uncontrollable haemorrhage.
(2) Vascular tumours
  (a) to reduce the blood supply prior to surgery or after radiotherapy
  (b) as specific treatment
(3) Angiomatous malformations.

(1) *Acute Haemorrhage*

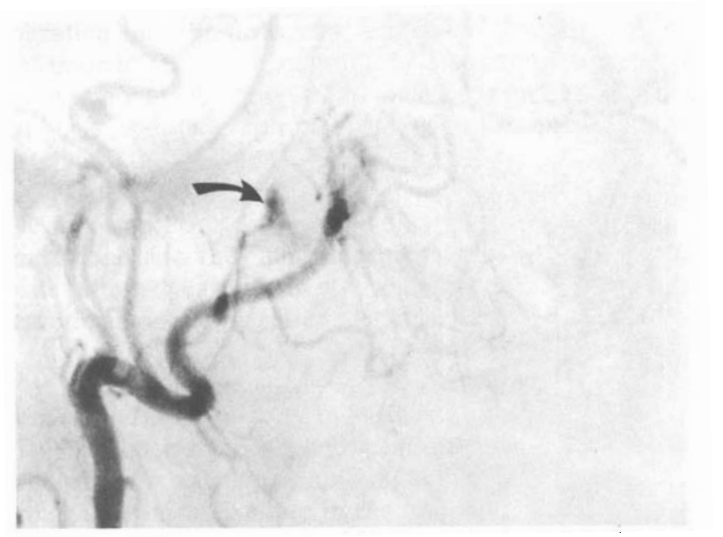
Idiopathic epistaxis. Epistaxis is common in otolaryngological practice, and is usually treated adequately by local cautery and nasal packing. Occasionally it is intractable, even after full anterior and posterior nasal packing, and may require life-saving measures. Trans-antral ligation of the maxillary artery is complex and time-consuming, especially in a debilitated patient, and ligation of the external carotid artery in the neck is less reliable. Percutaneous embolization offers an alternate and usually effective treatment. If the bleeding point is visualized, selective occlusion of the supplying vessel may be all that is required (Fig. 1), but when the actual bleeding point is not visible more extensive embolization is necessary (Lasjaunias *et al.,* 1979). Patients with epistaxis secondary to a bleeding diathesis are particularly suitable for embolization (Willis and Russell, 1979). In our hospital it is used in idiopathic epistaxis when traditional non-invasive methods have failed and before surgical intervention is contemplated.

Osler-Weber-Rendu Disease (Hereditary haemorrhagic telangiectasia). This condition is characterized by multiple skin and mucous membrane teleangiectases which frequently result in iron deficiency anaemia due to repeated haemorrhage. The variety of methods of treatment, including radiotherapy, nasal septal dermoplasty, and oestrogen therapy (Bradbeer, 1969), testify to difficulty of treating this condition by conventional means. Osborn (1978), in her exhaustive study of the angiographic appearance of the nasal arteries, described the typical telangiestases in the nasal fossa mucosa of patients with Osler's disease, but in clinical practice selective external carotid angiography may sometimes fail to outline the lesions when they are not opacified densely enough to be recognizable (Kendall *et al.*, 1977). Incomplete embolization may require either a repeat procedure or more extensive occlusion of the facial and internal maxillary arteries (Fig. 2). If lesions lie in the roof of the nose, their blood supply may arise from ethmoidal branches of the internal carotid artery and these cannot be embolized.

(2) *Vascular Tumours*

Naso-pharyngeal angiofibroma. These highly vascular tumours, occurring in childhood or adolescence, present in one or two ways, with:
(a) severe epistaxis, leading to profound anaemia, or
(b) nasal obstruction and a post-nasal space syndrome.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press



(a)

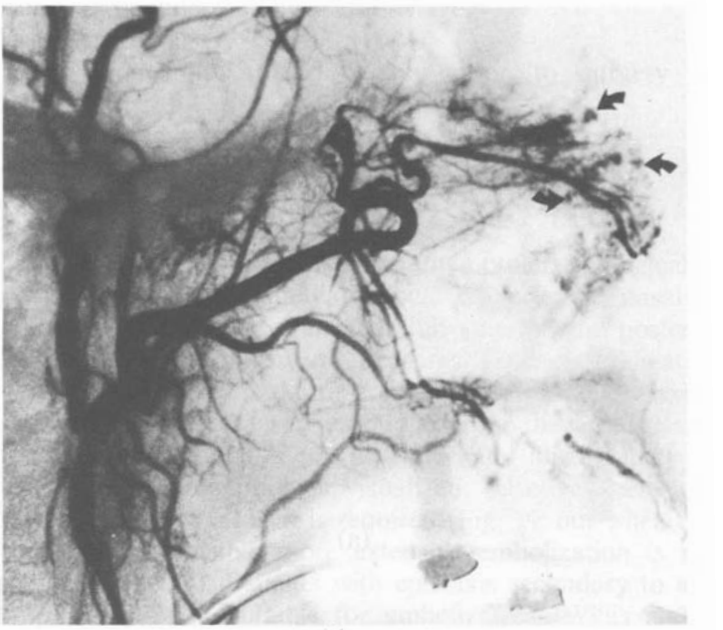


(b)

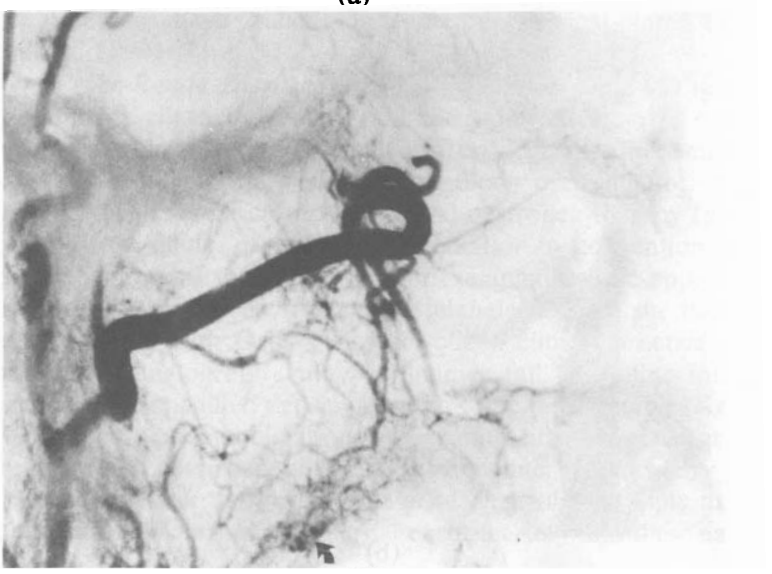
FIG. 1

Epistaxis. Male aged 25. Jehovahs Witness with severe epistaxis lasting 7 days leading to anaemia (Hb 7·6 gm%). Acute haemorrhage prior to angiogram with BP 100/60, pulse 120. (a) External carotid angiogram showing free blood in nasal cavity (arrowed) arising from internal maxillary artery. (b) After successful embolization of maxillary artery, there is now no evidence of haemorrhage. The patient recovered rapidly.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press



(a)



(b)

FIG. 2

Rendu-Osler-Weber disease. Male aged 67. Repeated epistaxis leading to chronic anaemia. (a) There are multiple telangiectases throughout the nasal mucous membrane (arrowed); (b) After embolisation of the maxillary artery there is obliteration of the telangiestases in the anterior part of the nasal cavity but further lesions are now visible on the soft palate (arrowed), which subsequently required embolization.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

Embolization may be necessary initially to stop the presenting catastrophic haemorrhage. In the non-urgent case the treatment of choice is total surgical removal, but embolization helps to reduce tumour vascularity prior to surgery. At angiography the main blood supply is usually from the ascending pharyngeal and internal maxillary arteries although, when the tumour is large, other vessels, both intra- and extra-cranial, may contribute (Newton and Potts, 1974). Although these tumours may appear to be localized to one side, they almost invariably receive a blood supply from the opposite external carotid artery, and bilateral selective internal and external carotid angiography should be undertaken routinely.

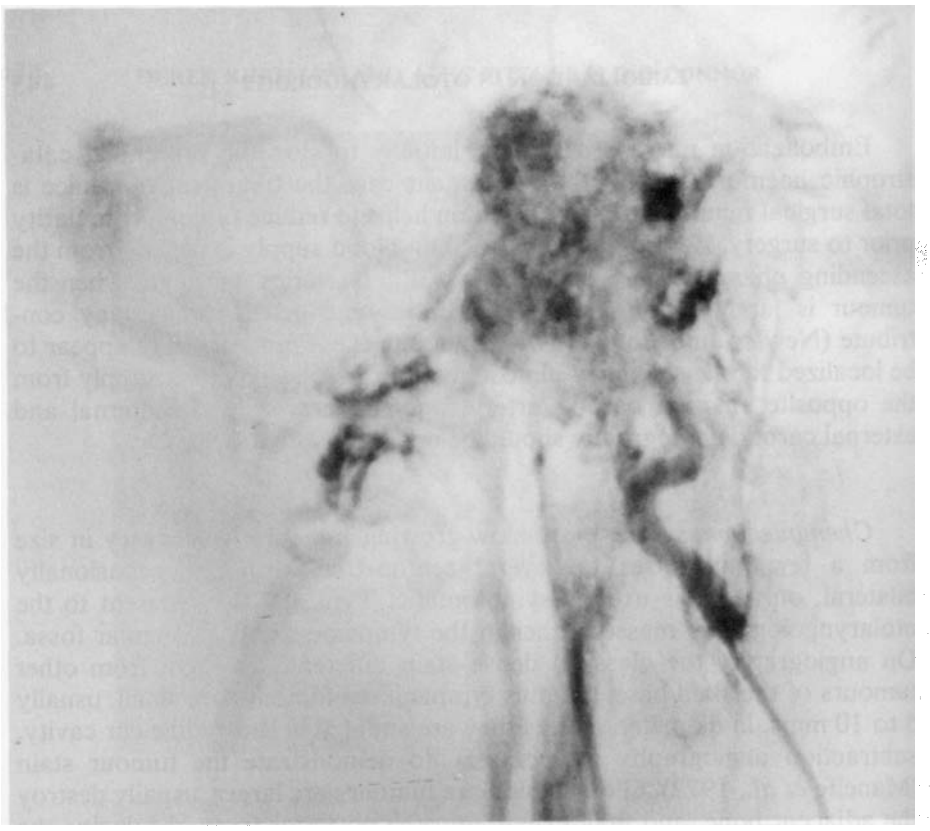
Chemodectomas. These are slow-growing tumours which vary in size from a few millimetres to several centimetres. Although occasionally bilateral, only one is usually symptomatic. Typically they present to the otolaryngologist as masses either in the tympanic cavity or jugular fossa. On angiography the classical dense stain differentiates them from other tumours of the skull base. Glomus tympanicum tumours are small, usually 5 to 10 mms. in diameter, and as they are situated in the middle-ear cavity, subtraction angiography is necessary to demonstrate the tumour stain (Manelfe *et al.*, 1972). Glomus jugulare tumours are larger, usually destroy the adjacent bone, and may extend into the posterior fossa, displacing the brain stem. The main blood supply is from the ascending pharyngeal artery, which is characteristically bowed forwards if there is a large cervical extension of the tumour. Any intracranial component may derive a blood supply from the vertebro-basilar system.

Conventional treatment has been surgery and/or radiotherapy but embolization now provides an alternative treatment. It may be used as the definitive treatment where the tumour is large and only palliation is indicated (Hekster *et al.*, 1973), but it can also be used in conjunction with surgery to reduce the vascularity (Simpson *et al.*, 1979; Gardner *et al.*, 1981), or with radiotherapy (Fig. 3). Symptomatic relief from troublesome tinnitus associated with glomus tumours has been achieved by embolization, although repeated treatment may be required (Harris *et al.*, 1979).

Radiotherapy has no direct cytotoxic effect in chemodectoma, but produces a vasculitis with a peak effect some weeks after the end of the treatment. It would seem logical to embolize the tumour immediately after radiotherapy when the maximum effect for both modalities may be expected to coincide.

Other vascular tumours which may present to the otolaryngologist include haemangiopericytomas, metastases and the rare extracranial meningioma, presenting in the paranasal sinuses or nasal cavity. Although surgical ablation, where possible, is the only curative treatment, preoperative embolization is similarly used to reduce mass and vascularity.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press



(a)



(b)

FIG. 3

Glomus jugulare tumour. Male aged 32 with multiple lower cranial nerve palsies. (a) Selective injection of dilated branch of the posterior auricular artery (the main supply) showing dense vascular blush within the petrous bone with early venous drainage; (b) After embolization there is free reflux into the maxillary and superficial temporal arteries, with occlusion of the posterior auricular artery and marked reduction of the tumour blush.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

(3) *Angiomatous Malformations*

These are abnormal collections of mature vessels which for convenience are most satisfactorily divided into fast- and slow-flow lesions (Djindjian and Merland, 1978).

Slow-Flow Lesions. Included in this group are capillary and venous angiomas, which sometimes present with haemorrhage. Although there may be early venous drainage, particularly in capillary angiomas, the flow-rate is usually slow and embolization is limited to occlusion of the undilated feeding artery. Capillary angiomas may occur alone or in association with Osler-Rendu-Weber Disease.

Fast-Flow Lesions. The majority of such lesions are arteriovenous malformations characterized by rapid shunting of blood from the arterial to the venous system, with enlargement of the arteries supplying the malformation. When extracranial they can be embolized in a similar manner to vascular tumours (Fig. 4).

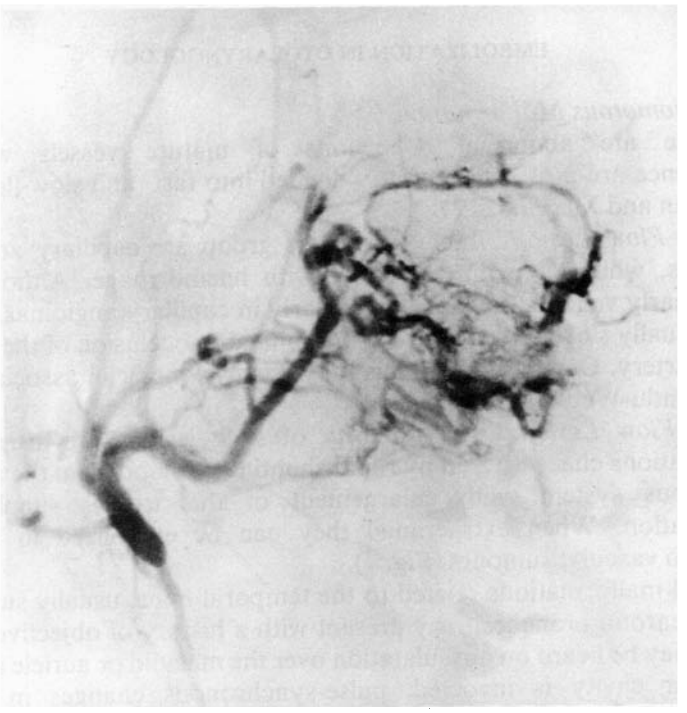
Dural malformations related to the temporal bone, usually supplied by external carotid branches, may present with a history of objective tinnitus. A bruit may be heard on ausculatation over the mastoid or auricle and, if the middle-ear cavity is involved, pulse-synchronous changes in acoustic impedence may be seen during tympanometry. Aberrant blood vessels may be seen coursing through the middle ear, yet it is not these vessels that produce the tinnitus but the dural abnormality. Cautery or excision, in an attempt to control the tympanic element, has only partial and temporary effect. Angiography alone may have a therapeutic effect; relief from tinnitus has followed the diagnostic procedure, possibly because of the slight changes of vascular dynamics resulting in a different sound-resonant quality of the blood flow, although thrombosis may occasionally occur spontaneously (Sartor, 1978). This improvement is not always permanent and patients may return with symptoms and paradoxically with or without the objective sign of tinnitus. Excision of the dural malformation is not without significant morbidity, but embolization may be curative if the blood supply arises from the external carotid branches and collateral supply does not develop. The risk of direct communication between external and internal carotid or vertebro-basilar arteries may limit embolization and have lead to reports of complications which are usually transient. Immediate results are usually good and improvement is maintained in about 80 per cent, but in the longer term only 40 per cent of the patients are without tinnitus (Harris *et al.*, 1979).

Complications

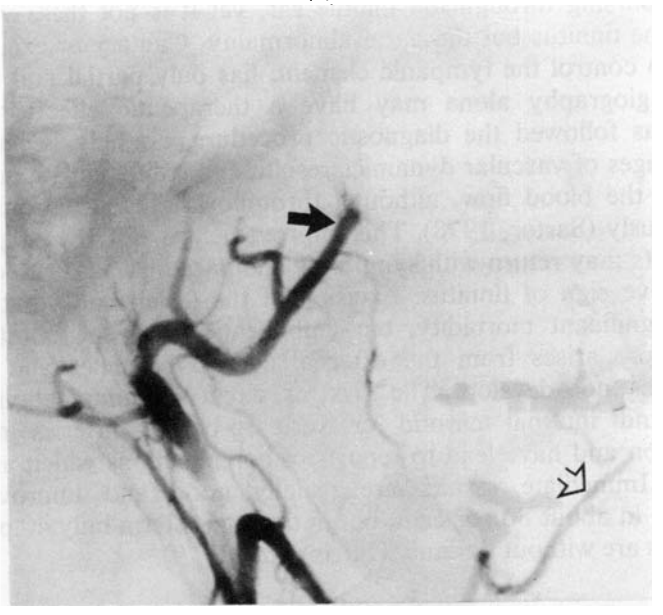
Embolization of the external carotid territory requires a meticulous technique and in experienced hands has low morbidity. Complications fall into two types, those which are transient and those which are serious and often permanent.

The most serious risk is inadvertent embolization of the internal carotid

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press



(a)



(b)

FIG. 4

Angiomatous malformation of the cheek. Female aged 21, with painful swelling in the face. (a) External carotid angiogram demonstrated a mainly cavernous angioma supplied by the maxillary and facial arteries (facial artery not shown); (b) After embolization of maxillary artery (black arrow) and facial artery (open arrow), the angioma no longer fills.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

territory, either by reflux or because of opening up of internal carotid or vertebro-basilar communications. Supra-selective catheterization and injection of the embolic material in contrast medium with continuous fluoroscopy reduces this risk. Accidental injection of a single embolus into the internal carotid artery usually results in a neurological deficit which is frequently transient, but may be catastrophic.

In high-flow lesions, where there is rapid shunting into the venous circulation, small emboli may pass rapidly through the lesion into the pulmonary bed, producing pulmonary infarctions.

The commonest transient side-effect is fever, and localized pain due to tissue necrosis. This is more common when external carotid vessels are tortuous and supra-selective catheterization is impossible. The more extensive the embolization, the more likely are local complications to develop. Over-zealous embolization, particularly of a large tumour, may also lead to tissue necrosis and infection.

Other complications, including sensitivity to the embolic material and contrast medium and general complications associated with angiography, are happily rare.

Conclusion

Although embolization has been shown to be of great value in many otolaryngological conditions, there is no firm agreement as to when it should be employed nor what material should be used. In some conditions repeated embolization may be necessary, either before satisfactory treatment is achieved or when lesions are continually developing. When employed prior to surgery, the maximum reduction in vascularity occurs 24 to 48 hours after embolization, and the delay allows any side-effects to become apparent before surgery is embarked upon. If radiotherapy is combined with embolization, the latter should perhaps be left until after radiotherapy has been concluded, on the grounds that conventional radiotherapy following embolization is less likely to be effective in an ischaemic environment; In addition, the maximum effect of radiotherapy and vascular embolization is likely to coincide when radiotherapy is undertaken first. The place of embolization in otolaryngological practice has not become firmly established, but the evaluation of patients for such a procedure obviously requires close co-operation between surgeon and radiologist.

REFERENCES

ALLISON, D. J. (1978) Therapeutic embolisation. *British Journal of Hospital Medicine*, **3**, 707–714.

BANK, W. O., KERBER, C. W. and CROMWELL, L. D. (1981) Treatment of intracerebral arteriovenous malformations with Isobutyl 2—Cyanoacrylate; initial clinical experience. *Radiology*, **139**, 609–612.

BARTH, K. H., STRANDBERG, J. D. and WHITE, R. I. (1977) Longterm follow up of transcatheter embolisation with autologous clot, oxycel and gelfoam in domestic swine. *Investigative Radiology*, **12**, 273–280.

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press

BERENSTEIN, A. (1980) Flow controlled silicone fluid embolisation. *American Journal of Neuroradiology,* **1,** 161–166.

BRADBEER, W. H. (1969) Treatment of Hereditary Telangiectasia. *Journal of Laryngology and Otology,* **83,** 667–681.

CHUANG, V. P. and REUTER, S. R. (1975) Experimental Diminuation of Spleenic function by selective embolisation of the spleenic artery. *Surgery, Gynecology and Obstetrics,* **140,** 715–720.

DEBRUN, G., LACOUR, P., CARON, J. P., HURTH, M., COMOY, P. and KERAVEL, Y. (1978) Detachable balloon and calibrated leak balloon techniques in the treatment of cerebral vascular lesions. *Journal of Neurosurgery,* **49,** 635–649.

DJINDJIAN, R. and MERLAND, J. J. (1978) Eds. in Superselective Arteriography of the external carotid artery. Springer Verlag—Berlin, Heidelberg.

GARDNER, G., COCKE, E. W., ROBERTSON, J. T., TRUMBULL, M. L. and PALMER, R. E. (1981) Glomus jugulare tumours—combined treatment. *Journal of Laryngology and Otology,* **95,** 567–580.

GOLDMAN, M. L., LAND, W. E., BRADLEY, E. L. and ANDERSON, J. (1976) Transcatheter therapeutic embolisation in the management of massive upper gastro-intestinal bleeding. *Radiology,* **120,** 513–521.

HARRIS, S., BRISMAR, J. and CRONQUIST, S. (1979) Pulsatile tinnitus and therapeutic embolisation. *Acta Otolaryngologica,* **88,** 220–226.

HEKSTER, R. E. M., LUYENDIJK, W. and MATRICALI, B. (1973) Transfemoral catheter embolisation a method of treating glomus jugulare tumours. *Neuroradiology,* **5,** 208–217.

HILAL, S. K. and MICHELSON, J. W. (1975) Therapeutic percutaneous embolisation for extra axial vascular lesions of the head, neck and spine. *Journal of Neurosurgery,* **43,** 275–287.

KATZEN, B. T., ROSSI, P., PASSARIELLO, R. and SIMONETT, G. (1976) Transcatheter therapeutic arterial embolisation. *Radiology,* **120,** 523–531.

KENDALL, B. E., JOYNER, M. and GRANT, H. (1977) Hereditary haemorrhagic telangiectasia: microembolisation in the management of epistaxis. *Clinical Otolaryngology,* **2,** 249–261.

LASJAUNIAS, P., MARSOT-DUPUCH, K. and DOYON, D. (1979) Radio anatomical basis of arterial embolisation for epistaxis. *Journal of Neuroradiology,* **6,** 45–53.

LEA THOMAS, M. and LAMB, G. H. R. (1977) Selective arterial embolisation in the management of post operative renal haemorrhage. *Acta Radiologica,* **18,** 49–53.

MANELFE, C., RONELLEAU, J., JULIAN A. and GUIDICELLI, G. (1972) Glomus Tympanicum Tumours. *Neuroradiology,* **4,** 226–232.

MARGOLIS, M. T. (1979) Cyanocrylate occlusion of a spinal cord arteriovenous malformation. Case Report. *Journal of Neurosurgery,* **51,** 107–110.

MERLAND, J. J., THIEBOT, J., TUBIANA, J. M. and ROCHE, A. (1978) Angiography and emergency embolisation of digestive haemorrhages. *Journal Belge de Radiologie,* **61,** 83–98.

NEWTON, T. H. and POTTS, D. G. (1974) Eds. in Radiology of the skull and brain Vol. **2,** p. 1287–1289. Mosby, St. Louis.

OSBORNE, A. G. (1978) Nasal Arteries. *American Journal of Roentgenology,* **130,** 89–97.

PICARD, L., MANELFE, C., ROLAND, J., TREIL, J., ANDRE, J. M., de KER-SAINT GILLY, A. and MOREL, C. (1978) Embolisations et occlusions par ballonnets dans les lesions vasculaires cranio-faciales. *Neuroradiology,* **16,** 393–394.

RÖSCH, J., DOTTER, C. T. and BROWN, M. J. (1972) Selective arterial embolisation. A new method for control of acute gastrointestinal bleeding. *Radiology.* **1.2,** 303–306.

SARTOR, K. (1978) Spontaneous closure of cerebral arteriovenous malformations demonstrated by angiography and computed tomography. *Neuroradiology,* **15,** 95–98.

SCOTT, J., LONG, R. G., DICK, R. and SHERLOCK, S. (1976) Percutaneous transheptic obliteration of gastro-oesophageal varices. *Lancet,* **2,** 53–55.

SIMPSON, G. T., KONRAD, H. R., TAKAHASI, M. and HOUSE, J. (1979) Immediate post embolisation excision of glomus jugulare tumours—Advantages of new combined techniques. *Archives of Otolaryngology,* **105,** 639–643.

WILLIS, P. I. and RUSSELL, R. D. (1979) Percutaneous embolisation to control intractable epistaxis. *Laryngoscope,* **89,** 1385–1388.

ZANNETTI, P. H. and SHERMAN, F. E. (1972) Experimental evaluation of a tissue adhesive as an agent for the treatment of aneurysms and arteriovenous anomalies. *Journal of Neurosurgery,* **36,** 72–79.

Address for correspondence:
Department of Otolaryngology, St. Thomas' Hospital, Lambeth Palace Road, London SE1 7EH

https://doi.org/10.1017/S0022215100092690 Published online by Cambridge University Press