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Value of pre-operative embolization in surgery for nasopharyngeal angiofibroma

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Abstract
The value of embolization in surgery for nasopharyngeal angiofibroma is a controversial matter. We analysed retrospectively the results of surgical treatment in ten patients with a nasopharyngeal angiofibroma, the last five of whom underwent pre-operative embolization with Gelfoam®. Embolization reduced the intraoperative blood loss at primary surgery from an average of 1510 ml in the non-embolized patients to 510 ml in the embolized patients and transfusions from an average of 4.4 units to none. Seven reoperations were performed on four non-embolized patients on account of tumour recurrence, while no recurrences were diagnosed among the pre-operatively embolized patients. Blood loss in the reoperations averaged 4065 ml, and transfusions 7.1 units. The results indicate that embolization is effective in reducing intraoperative blood loss and contributes to improved surgical results. We recommend it as a routine pre-operative adjunct to surgery for nasopharyngeal angiofibroma.

Key words: Nasopharyngeal neoplasms, angiofibroma; Angiography; Embolization, therapeutic; Surgery

Introduction

Juvenile nasopharyngeal angiofibroma (JNA) is a benign, highly vascular tumour which arises almost exclusively from the nasopharynx of young males at puberty. It is locally invasive and has a marked tendency to recur if not completely removed (Bryan *et al.*, 1981; McCombe *et al.*, 1990). The symptoms are related to extension of the tumour into the nasopharynx, nose, sinuses, orbit and skull base, the most frequent initial symptoms being nasal obstruction and/or recurrent epistaxis (Lasjaunias *et al.*, 1980; Davis, 1987).

The tumour has a characteristic appearance in computed tomography (CT) and magnetic resonance imaging (MRI) which obviates biopsies (Weinstein *et al.*, 1978; Davis, 1987; Lund *et al.*, 1989). These imaging methods are also accurate for defining the extent of the tumour (Weinstein *et al.*, 1978; Lund *et al.*, 1989). The angiographic picture is also characteristic, and although angiography may not define the extent of the tumour as accurately as CT and MRI, it has the additional value of defining the blood supply to the tumour (Rosen *et al.*, 1966; Wilson and Hanafee, 1969) (Figs. 1–4).

Surgical removal is the most widely accepted mode of therapy (Batsakis, 1979; Jafek *et al.*, 1979; Waldman *et al.*, 1981; Ward, 1983; Witt *et al.*, 1983; Bremer *et al.*, 1986; Economou *et al.*, 1988), usually employing a transpalatal approach or transantral exposure with lateral rhinotomy (Steinberger and Wetmore, 1984; Bremer *et al.*, 1986; Economou *et al.*, 1988). As the tumour is highly vascular, surgery is frequently accompanied by significant intraoperative haemorrhage, which may contribute to incomplete removal and additional morbidity and mortality (Ward *et al.*, 1974; Lasjaunias *et al.*, 1980; Steinberger and Wetmore, 1984).

Roberson *et al.* (1972) were the first to advocate pre-operative embolization of the major feeding vessels as an adjunct or possibly a definitive or palliative therapeutic method, and since then embolization has been recommended by a number of authors (Pletcher *et al.*, 1975; Katsiokis *et al.*, 1979; Roberson *et al.*, 1979; Lasjaunias *et al.*, 1980; Ward, 1983; Natvig and Skalpe, 1984; Steinberger and Wetmore, 1984; Davis, 1987; Jacobsson *et al.*, 1988) to facilitate complete excision of the tumour and to minimize the risk of complications due to profuse haemorrhage during surgery. On the other hand, some authors consider pre-operative embolization to provide no benefit (Duvall and Moreano, 1987) or even to increase the risk of recurrence (McCombe *et al.*, 1990), and others regard it as being too dangerous (Piquet and Chevalier, 1989). We describe here our technique for embolization of a nasopharyngeal angiofibroma and compare the results in pre-operatively embolized patients and those treated with surgery alone.

Patients and methods

The series consisted of ten consecutive patients with a

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nasopharyngeal angiofibroma (all male; age range 11–16 years) treated surgically at our Department from 1971 up to the present. The first five patients, treated prior to 1986, were not embolized, while since 1986 the treatment protocol has included pre-operative tumour embolization (Table I). Six of the patients presented with nasal obstruction and epistaxis, two with epistaxis and two with nasal obstruction only. CT was performed prior to primary surgery in six cases, MRI in one and angiography in eight. CT or angiography was performed prior to the repeat surgical interventions in all cases. The tumours were staged retrospectively according to the system suggested by Chandler *et al.* (1984); stage I—tumour confined to the nasopharynx; stage II—tumour extending into the nasal cavity and/or sphenoid sinus; stage III—tumour extending in to one or more of the following: antrum, ethmoid sinus, pterygomaxillary and infratemporal fossae, orbit and/or cheek; stage IV—tumour extending into the cranial cavity (Table I).

Technique of embolization

A transfemoral route of catheterization was used in all five cases, four under local anaesthesia and one (case 10) under general anaesthesia. Imaging with digital subtraction angiography (DSA) was employed for all the embolizations. After aortic arch injection using a pigtail catheter, selective catheterizations were performed using a 4.1 Fr or 7 Fr catheter (Head Hunter or Simmons I/II). In four patients diagnostic angiography and unilateral embolization of the tumour were performed in the first session and contralateral embolization the next day, the side supplying less of the tumour being embolized first, and the main feeders on the other side the next day. In one case (case 10), diagnostic angiography and embolization were performed in one session (Fig. 4).

In all five cases diagnostic angiography included bilateral selective catheterization of the internal carotid artery (ICA) and external carotid artery (ECA) and selective catheterization of the internal maxillary artery (IMA). The angiograms were routinely obtained in lateral view, and frontal view was used in selected cases. After selective angiography of the IMA, the catheter was advanced peripherally as far into the IMA as possible and the position of its tip within the artery was ascertained with a hand injection of contrast medium or a new angiogram prior to embolization. Embolization was then carried out using gelatin sponge (Gelfoam, Upjohn Company, Kalamazoo, Michigan, USA) particles of approximately 1 mm in size as embolus material, mixed with saline or contrast medium. The IMA was embolized bilaterally in four cases and unilaterally in one (case 10). The progress of the vessel occlusion during embolization was monitored with repeated hand injections of contrast medium or new angiograms, and an angiogram was obtained at the end of the procedure with contrast medium injected into the proximal IMA or origin of the ECA (Figs. 1–4).

In one patient (case 6) the tumour was not supplied by any other arteries except for the IMA bilaterally, while in the other four the tumour blood supply arose partially from other vessels, unilaterally or bilaterally, i.e. the ascending pharyngeal artery (cases 7–10), the ICA (case 8), or the facial artery via the ascending palatine branches (case 9). These were not embolized.

The pre-operative therapeutic methods and surgical techniques are detailed in Table I. In four non-embolized cases the ECA was ligated unilaterally at the start of primary or repeat surgery, and in two cases (cases 1 and 3) primary surgery was performed elsewhere. Among the embolized patients, surgery was performed within one day of completing the bilateral embolization in three cases, within two days in one, and within four days in one.

Results

The duration of surgery, estimated intraoperative blood loss, transfusions given and clinical outcome are shown in detail in Table I.

The duration of primary surgery averaged 2 hours 45 minutes in the non-embolized cases and 2 hours 6 minutes

TABLE I
PATIENT DATA

Case/ age (years)	Year	Tumour stage	Prior therapy*	Surgical technique*	Duration of surgery	Blood loss (ml)	Transfusion (units)	Results of surgery
1./11	1971**	II	—	TP	1 h 55 min	1500	4	Recurrence
	1972	III	—	TP & LR	3 h 50 min	2400	6	Recurrence
2./18	1976	II	Ext.lig.	TP	2 h 45 min	1500	7	Recurrence
	1977	II	—	TP	2 h 40 min	3300	6	Cured
3./15	1977**	I	—	TP	1 h 45 min	1200	3	Recurrence
	1983	III	Ext.lig.	LR	1 h 55 min	1750	2	Partial resection
	1983	II	—	TP	2 h 25 min	5850	12	Cured
4./16	1980	II	Ext.lig.	TP	2 h 50 min	1400	3	Cured
5./11	1981	III	Ext.lig.	TP	4 h 30 min	1950	5	Recurrence
	1983	III	—	LR	3 h 30 min	4900	8	Recurrence
	1983	III	—	LR	2 h 55 min	5050	7	Recurrence
	1985	II	—	LR	1 h 25 min	5200	9	Partial resection
6./15	1986	II	Emboliz.	TP	2 h 5 min	450	0	Cured
7./15	1986	II	Emboliz.	TP	1 h 35 min	50	0	Cured
8./15	1988	II	Emboliz.	TP	1 h 30 min	800	0	Cured
9./13	1989	III	Emboliz.	TP & LR	4 h 15 min	750	0	Cured
10./11	1992	II	Emboliz.	TP	1 h 5 min	500	0	Cured

* Note: ext.lig. = ligation of the external carotid artery; emboliz. = embolization; TP = transpalatal approach; LR = transantral exposure with lateral rhinotomy.
**Operation performed elsewhere.

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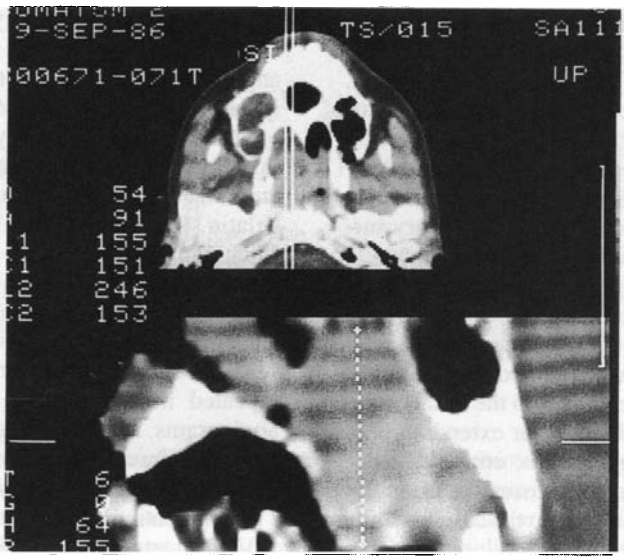

FIG. 1a

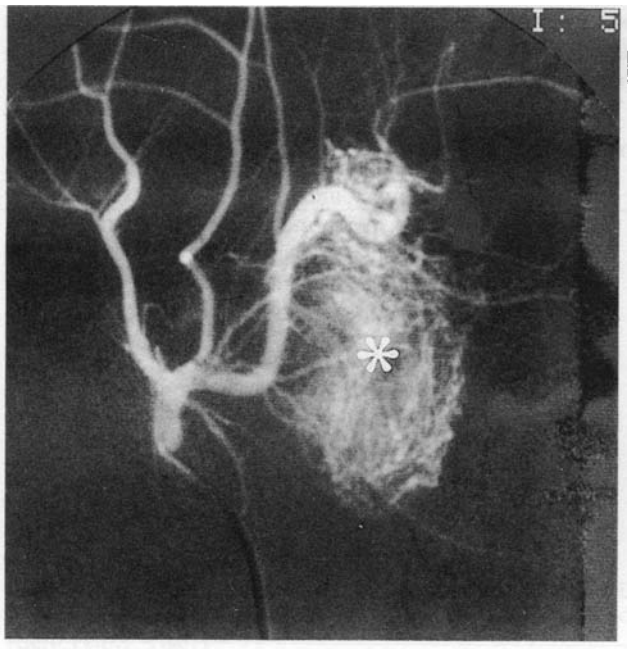

FIG. 1b

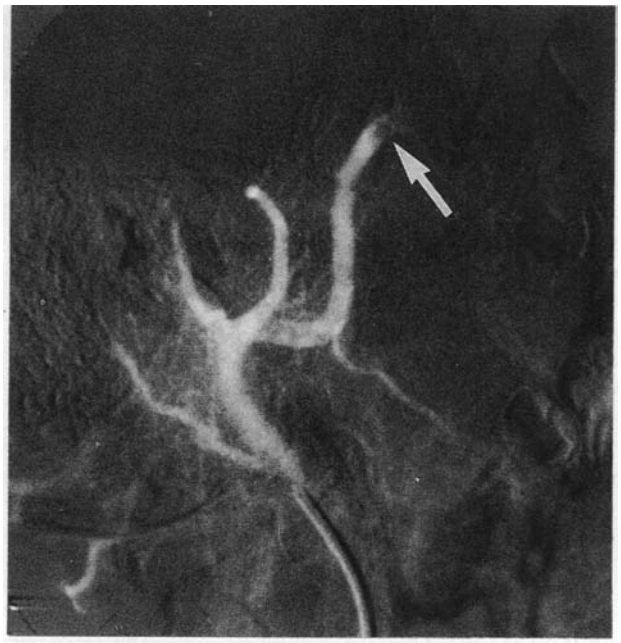

FIG. 1c

FIG. 1

Parasagittal CT reconstruction image of the nasopharynx after intravenous contrast medium enhancement (case 7)(a). DSA image of the right IMA (b), main feeder of the tumour, showing a typical angiofibroma (*). After embolization (c) the tumour is non-opaque on account of complete vascular occlusion (arrow). The left IMA was also embolized.

in the embolized cases, and intraoperative blood loss was 1510 ml and 510 ml, respectively. Transfusions were given to all five patients operated on without embolization (average 4.4 units in primary intervention and 7.1 units in repeat surgery) but to none of the pre-operatively embolized patients.

One or more surgical failures occurred in four non-embolized cases, leading to seven repeat surgical interventions in which intraoperative blood loss averaged 4065 ml. Reoperation had to be discontinued on account of profuse bleeding in one (case 3), and on account of profuse bleeding and subsequent circulatory collapse in another (case 5). In the latter case the residual tumour was treated with diethylstibestrol for six weeks, after which tumour regression was confirmed by CT. One patient (case 1) was diagnosed as having a non-symptomatic late recurrence 13 years after primary surgery, but a clinical check-up with CT showed spontaneous tumour regression. No recurrences were diagnosed in any of the pre-operatively embolized patients (clinical follow-up 1 year 10 months to 5 years 3 months in four cases and three months in the last case).

All five patients undergoing pre-operative embolization experienced mild to moderate local pain in the embolized vascular territory until surgery, while other minor transient complications of embolizations included nausea (n = 2), local subcutaneous oedema (n = 1) and slight temperature elevation (n = 1). One patient developed slight dysfunction of the contralateral upper extremity with reduced sensation and weakness a few hours after completion of the bilateral embolization. CT of the brain was normal the next day, and the symptoms had com-

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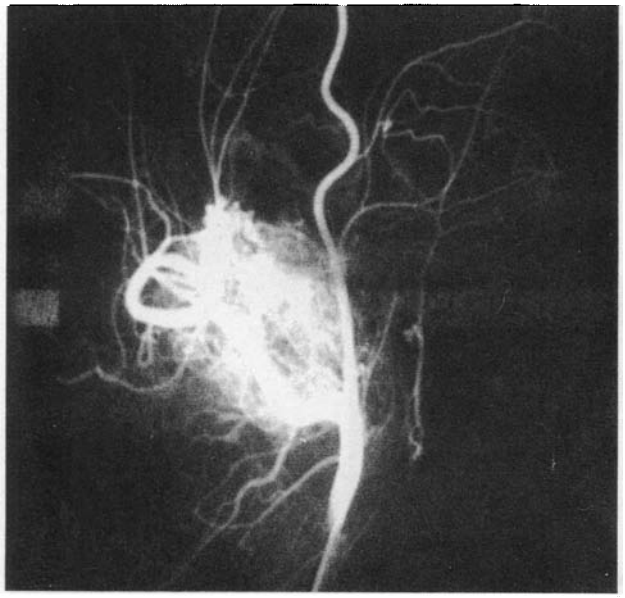

FIG. 2a

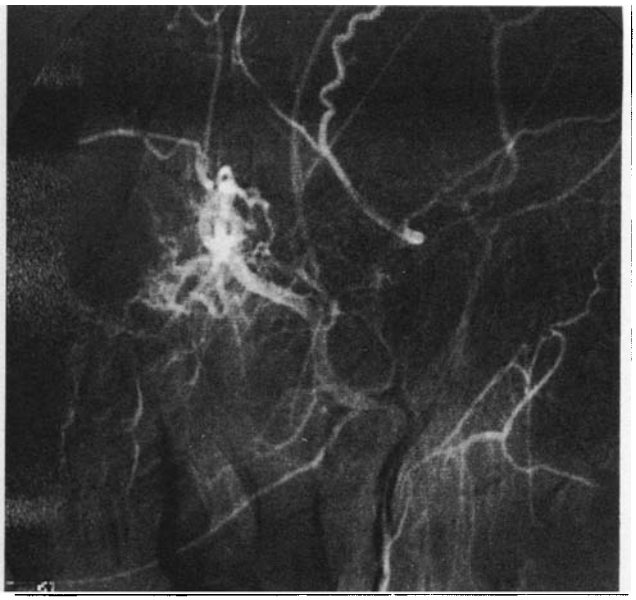

FIG. 2b

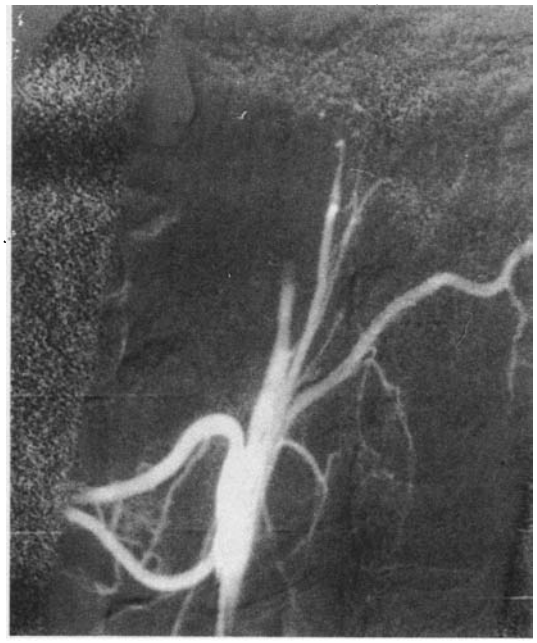

FIG. 2c

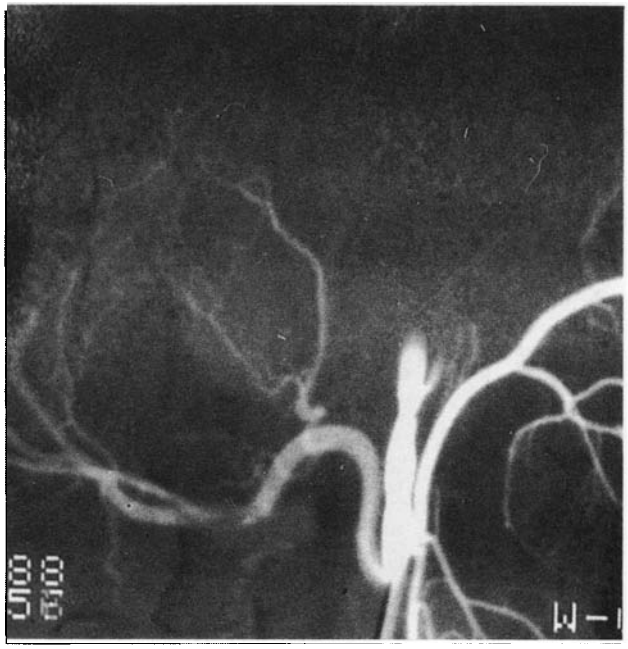

FIG. 2d

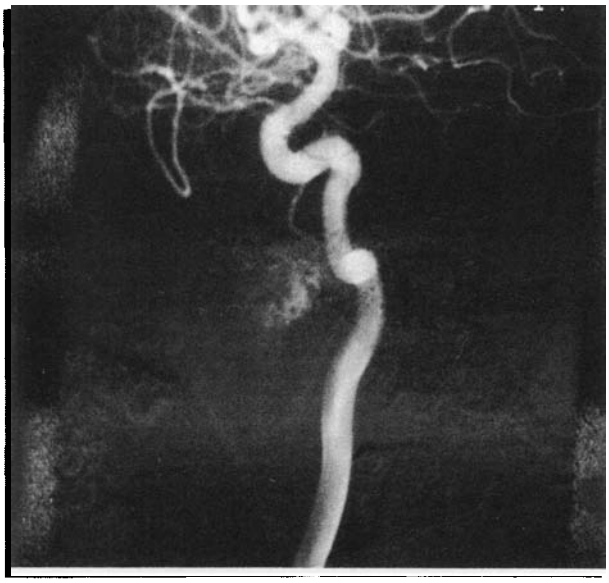

FIG. 2e

FIG. 2

DSA images prior to (a and b) and after (c and d) bilateral embolization of the IMA (case 8). The upper part of the tumour is supplied by the inferolateral trunk of the right ICA (e). The angiograms are in lateral view.

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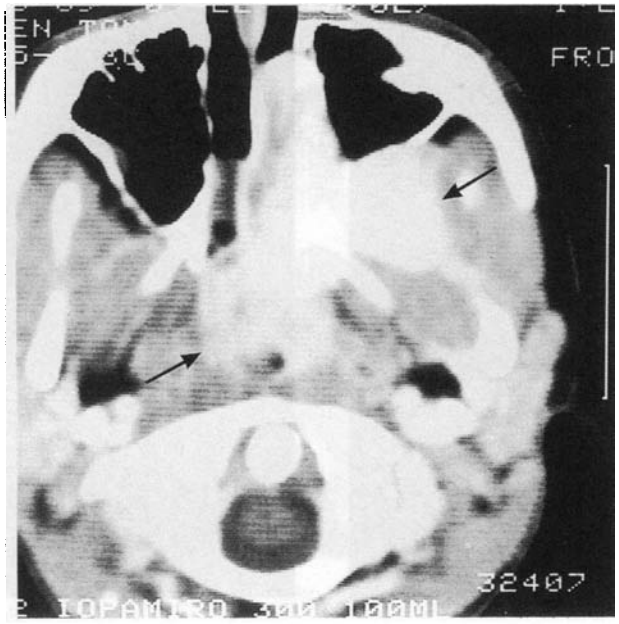

FIG. 3a

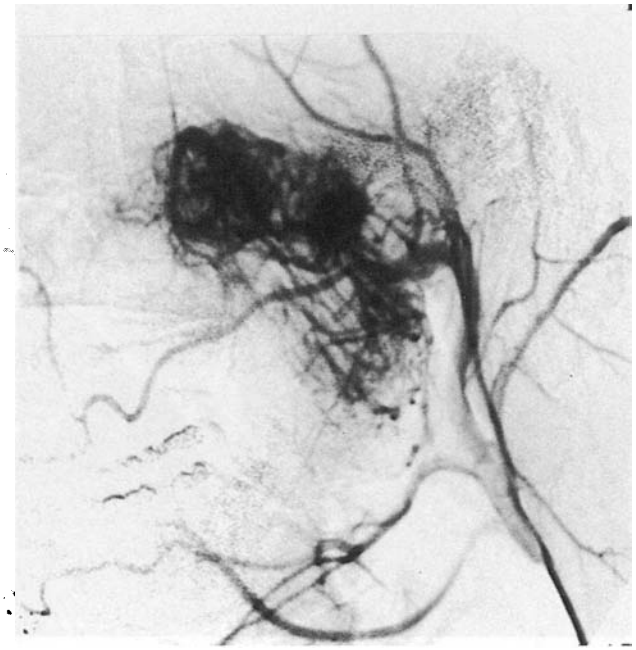

FIG. 3b

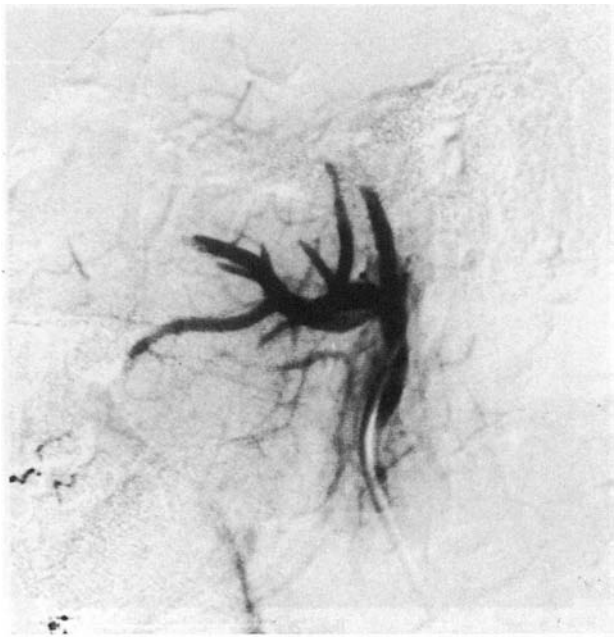

FIG. 3c

Fig. 3

Axial CT image of an angiofibroma (arrows) (a) after intravenous contrast medium enhancement (case 9). IMA angiogram before (b) and after (c) embolization of the tumour.

pletely resolved within 24 hours. One patient experienced reduced sensation in middle branch territory of the trigeminal nerve after surgery, but this disappeared within one week. No permanent complications attributable to surgery or embolization were observed.

Discussion

Surgical resection of an angiofibroma is often limited by significant intraoperative haemorrhage and the size of the tumour, resulting in a recurrence in 25 per cent to 60 per cent of cases (Lasjaunias *et al.*, 1980; Witt *et al.*, 1983; McCombe *et al.*, 1990). Several operations may be required, and the haemorrhage is often more profuse in reoperations, and to the extent that the operation may sometimes have to be discontinued, as shown in the present series. A review of the literature reveals many instances of morbidity and some of death due to profuse intraoperative bleeding (Ward, 1983). Operative mortality is hard to estimate on account of the small number of cases treated by most hospitals, but it is probably less than 5 per cent (Steinberger and Wetmore, 1984; Amedee *et al.*, 1989).

Haemorrhage can be reduced by ligation of the ECA or IMA (Waldman *et al.*, 1981; Chandler *et al.*, 1984; Bremer *et al.*, 1986), but earlier experiences (Ward, 1983) and present observations suggest that this may be insufficient and ineffective in reducing the recurrence rate. Arterial ligation, if not removed at the end of the surgical procedure, makes reoperations exceedingly difficult

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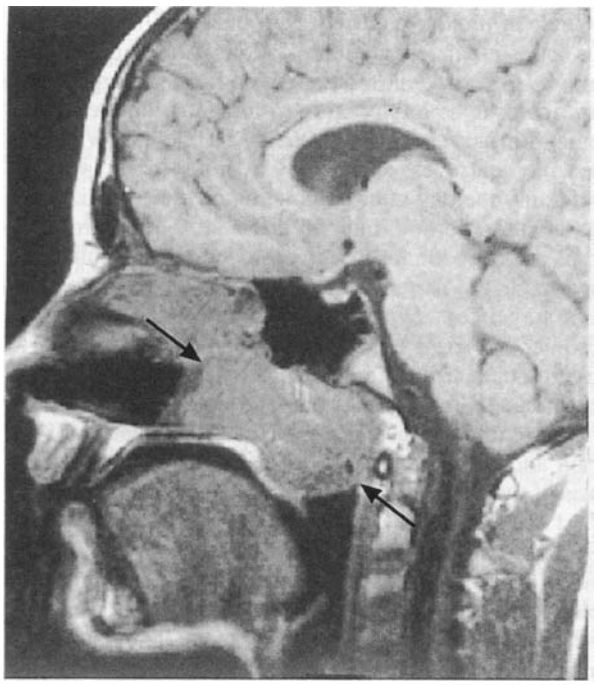

FIG. 4a

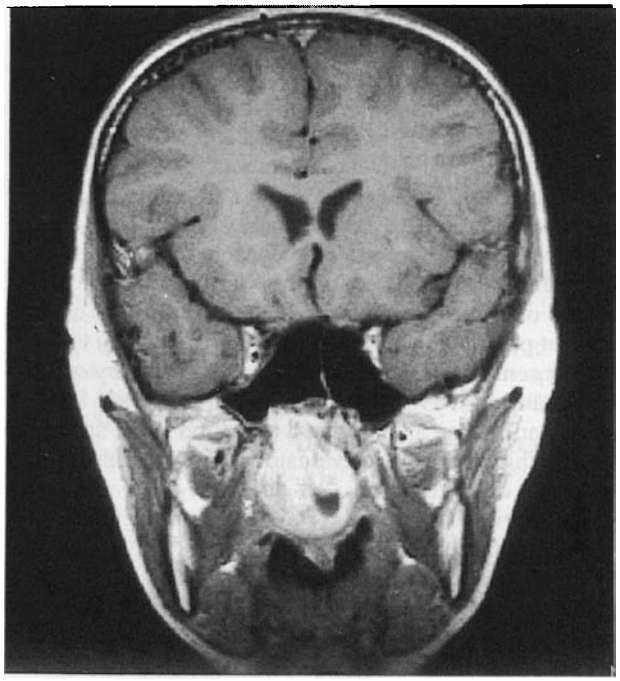

FIG. 4b

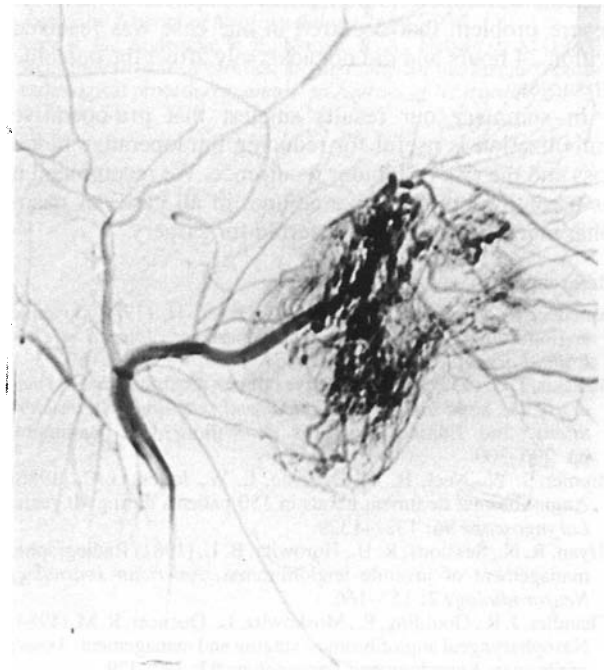

FIG. 4c

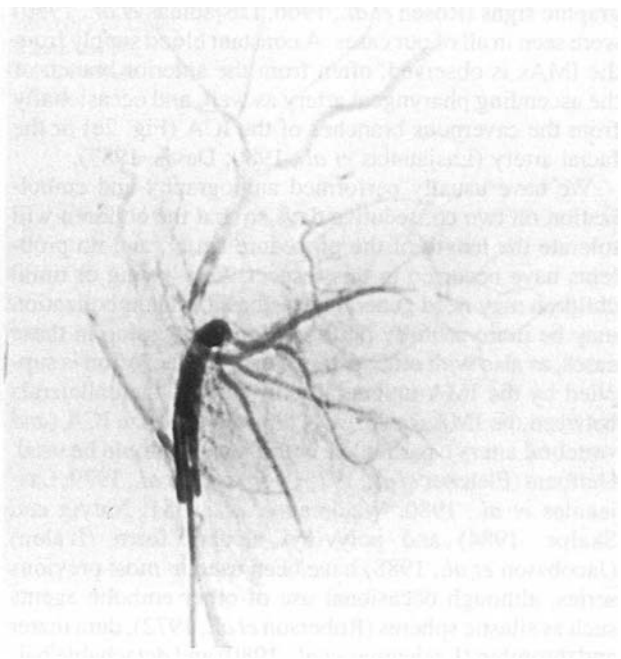

FIG. 4d

FIG. 4

Parasagittal T1-weighted (TR 500/TE 15) MRI image (a) of an angiofibroma (arrows) (case 10). The coronal image after intravenous Gd-DTPA injection (b) shows intense enhancement of the tumour attributable to hypervascularity. Angiography revealed the left IMA to be the main feeder (c), after embolization of which almost no tumour stain is seen (d).

because the recurrent tumour is supplied by anastomoses from the ICA and vertebral artery, the surgical ligation of which may be accompanied by massive haemorrhage (Wilson and Hanafee, 1969).

Embolization for the treatment of JNAs was first reported 20 years ago (Roberson *et al.*, 1972), the idea being, to reduce intraoperative blood loss by occluding the arteries supplying the tumour (Roberson *et al.*, 1979). A significant reduction in intraoperative blood loss (1150 ml → 510 ml) and transfusions (4.4 units to none) occurred in our cases of primary surgery, as also reported by Pletcher *et al.* (1975), Roberson *et al.* (1979), Waldman *et al.* (1981) and Economou *et al.* (1988), although the average intraoperative blood losses for the embolized patients in their series were higher, 1177 ml, 800 ml, 775 ml and 1000 ml, respectively. Our results show clearly that pre-operative embolization enables excision of the angiofibroma to be performed without transfusions in most cases, whereas transfusions are usually required when embolization is not performed. Haemorrhage con-

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trol is even more critical in repeat surgery, and the effect of embolization is probably similar, although it cannot be assessed from the present results.

Recurrences occurred during the follow-up period in 80 per cent of the present non-embolized cases, while there has been no clinical evidence of tumour recurrence in the embolized patients. Because most symptomatic recurrences occur during the first 12 months after primary treatment and they are rare after two years (Batsakis, 1979), the results thus indicate that embolization reduces the number of recurrences, and thus total eradication of the lesion at primary surgery should be possible in up to 90–100 per cent of patients as has been suggested by others (Waldman *et al.*, 1981; Steinberger and Wetmore, 1984). Embolization may also lead to a reduction in the surgical risks but this is difficult to evaluate on account of the small number of cases reported.

Since the introduction of CT and MRI, angiography has been performed not so much to confirm the diagnosis as to assess the blood supply to the tumour and identify any anomalous connections between the ICAs and ECAs that could interfere with safe embolization. DSA is the recommended method, as it improves control and reduces the time required for the diagnostic angiography and embolization (Sherry *et al.*, 1983). The characteristic angiographic signs (Rosen *et al.*, 1966; Lasjaunias *et al.*, 1980) were seen in all of our cases. A constant blood supply from the IMAs is observed, often from the anterior branch of the ascending pharyngeal artery as well, and occasionally from the cavernous branches of the ICA (Fig. 2e) or the facial artery (Lasjaunias *et al.*, 1980; Davis, 1987).

We have usually performed angiography and embolization on two consecutive days so that the children will tolerate the length of the procedure better, and no problems have occurred in this respect. Very young or timid children may need general anaesthesia, and embolization may be more usefully performed in one session in these cases, as also with older patients or when the lesion is supplied by the IMA unilaterally. In view of the collaterals between the IMA, other ECA branches and the ICA (and vertebral artery), particulate embolization should be used. Gelfoam (Pletcher *et al.*, 1975; Roberson *et al.*, 1979; Lasjaunias *et al.*, 1980; Waldman *et al.*, 1981; Natvig and Skalpe, 1984) and polyvinyl alcohol foam (Ivalon) (Jacobsson *et al.*, 1988) have been used in most previous series, although occasional use of other embolic agents such as silastic spheres (Roberson *et al.*, 1972), dura mater and thrombin (Lasjaunias *et al.*, 1980) and detachable balloons (Edner *et al.*, 1982) has been reported in a few cases. We used small Gelfoam emboli of approximately 1 mm in diameter, which are easy to inject through the catheter when mixed with saline or contrast medium. Polyvinyl alcohol foam causes more permanent vessel occlusion than Gelfoam, which is resorbed within a few weeks, allowing the IMA to recanalize partially or completely. This tendency for recanalization is not of critical importance if the patients are operated on within a few days of embolization. If a significant blood supply is derived from other ECA branches, the use of microcatheters through a guiding catheter may become necessary for injection of the Ivalon microparticles. The vessel occlusion produced by balloons and coils is too proximal and they are of no benefit relative to surgical vessel ligation.

The marked reduction in intraoperative bleeding and absence of tumour recurrences in the embolized cases in this series indicate that embolization with small Gelfoam emboli is effective in reducing blood loss at surgery and contributes to an improved short-term and long-term outcome. Similar results can probably be obtained with Ivalon microparticles as well. We prefer early surgery, preferably the day after completion of the embolization, although the optimal interval is a matter of controversy. Some of the poor results of pre-operative embolization reported in the literature may be due to a delay in performing surgery or technical factors such as failure to achieve peripheral arterial occlusion of the tumour bed due to large particle size or failure of catheterization of the significant supplying vessels.

Complications such as accidental embolization of the brain and ophthalmic artery, facial nerve palsy and necrosis of the skin and soft tissues may occur (Lasjaunias *et al.*, 1980; Soong *et al.*, 1982; Gay *et al.*, 1983; Davis, 1987), but the risk of severe effects can be minimized by means of a careful angiographic technique, appropriate selection of the embolization agent and peripheral catheterization of the embolized artery. The radiologist performing the procedure should be well familiar with the functional anatomy of the face (Russell, 1986). Our patients developed no permanent complications and the severe problem that occurred in one case was resolved within 24 hours and did not adversely affect the outcome of surgery.

In summary our results suggest that pre-operative embolization is useful for reducing intraoperative blood loss and the risk of tumour recurrence. We recommend it as a routine pre-operative adjunct in all cases of nasopharyngeal angiofibroma referred for surgery.

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