Rhinology, 43, 282-289, 2005

Endoscopic resection of juvenile angiofibromas – long term results*

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SUMMARY

Objective: To evaluate the long term outcome after endoscopic endonasal resection of juvenile nasopharyngeal angiofibromas (JNA).

Methods: *Retrospective study of a series of 21 consecutive patients undergoing endoscopic resection of JNA (type I – IIIa according to Fisch) at two Hospital Centers between 1993 and 2002. Mean follow-up was 51.7 months (range 5-120). Extension to the medial aspect of infratemporal fossa and retromaxillary space was no contraindication against an endonasal endoscopic approach. In three cases of type IIIa tumours a computer assisted intraoperative guiding system was applied (ENTrak, GE Medical, Lawrence, USA).*

Results: *Fifteen patients (71.4%) were free of disease after one endoscopic resection. Three patients (14.3 %) had an unmistakable recurrence with the need for further treatment at 6, 14, and 23 months, respectively. Two of the three recurrent tumours have been successfully resected endoscopically, one case was treated with gamma knife. In three patients (14.3%) postoperative MRI showed localized enhanced signal, presumably minimal persistent tumour tissue. Without further treatment all of these patients remained free of symptoms and MRI follow up showed no tumour growth over three, five and ten years, respectively. No postoperative long term sequela was observed.*

Conclusions: *Resection of nasopharyngeal angiofibromas type I-IIIa can be safely achieved endoscopically. The advantage of this minimally invasive technique is avoidance of external scars and low morbidity. The intraoperative computer assisted guiding system ENTrak was highly accurate and provided substantial help in selected cases.*

Key words: juvenile nasopharyngeal angiofibroma, endoscopic sinus surgery, embolization, computer assisted guidance

INTRODUCTION

Juvenile nasopharyngeal angiofibromas (JNA) are highly vascular tumours of the nasopharynx originating from the area of the sphenopalatine foramen [1]. This rare entity occurs typically in male adolescents and is characterized by slow but locally destructive growth. The morphology is characterized by architecturally irregular vessels ranging from capillary and sinusoidal-type vessels to muscular vessels set in a fibrous stroma [2,3]. Beham et al. [3] describe JNA as a tumour like vascular malformation. Schick et al. [4] explain the vascular component of JNA embryologically due to incomplete regression of the first branchial artery. This vessel arises between embryological days 22 and 24 and recedes completely during normal development. It temporarily connects the internal carotid artery and the vessels from the maxillary artery. Incomplete regression of the vascular plexus of this first branchial artery may form the vascular component of an angiofibroma arising due to growth stimulation at the time of adolescence. Therapy is often challenging due to tumour spreading into critical areas such as pterygopalatine and infratemporal fossa (Figure1), skull base, orbit or even intracranially. Cranial nerves, carotid arteries, cavernous sinus and dura can be infiltrated. Although spontaneous regression of the tumour has been reported [5,6] surgical resection is considered as therapy of choice. Surgical procedures include transpalatal techniques, lateral rhinotomy, midfacial degloving, infratemporal approaches and combined infratemporal and frontotemporal techniques [7-12].

The first reports about minimal invasive endoscopic resections were published during recent years [13-20]. Endoscopic resections of JNA were started as early as 1993 in Barcelona and

* Received for publication: August 8, 2004; accepted: December 1, 2004

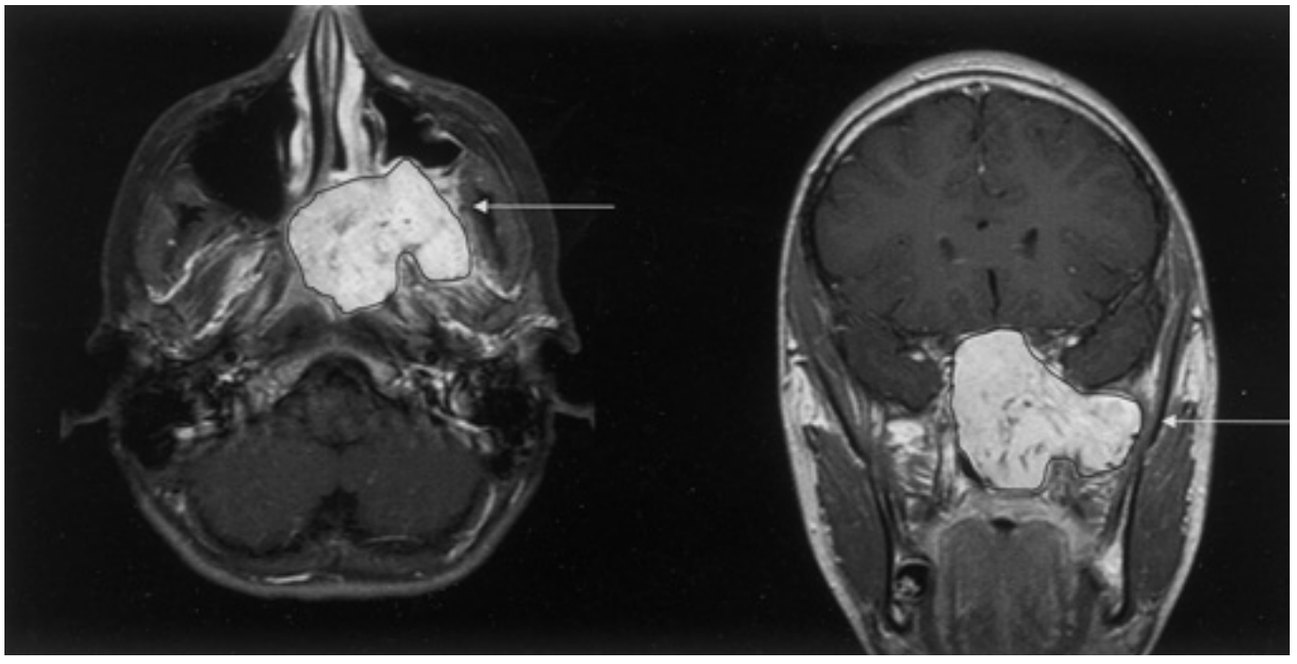

Figure 1. Axial and coronal MRI (T1 with contrast material) of a JNA involving the left infratemporal fossa (white arrow) (case 7).

1994 in Graz. This study presents a case series of twenty-one consecutive patients, who underwent endonasal endoscopic resection of JNA. A computer assisted intraoperative guiding system was applied in selected cases.

MATERIALS AND METHODS

We present a retrospective study of twenty-one patients undergoing endoscopic surgery for JNA in two different Hospitals between 1993 and 2002. Settings were the Departments of ORL, Medical University of Graz, Austria and Hospital Clinic, Barcelona, Spain. All patients were male, between 13 and 24 years of age. According to Andrews/Fisch [21] (Table 2), the tumours of this series were classified from I to IIIa (Table 1).

Preoperative angiography and embolization of tumour feeding vessels was performed in 19 out of 21 patients (Figures 3A+B). In all patients a combined endonasal and transoral endoscopic tumour resection was performed. For three type IIIa angiofi-

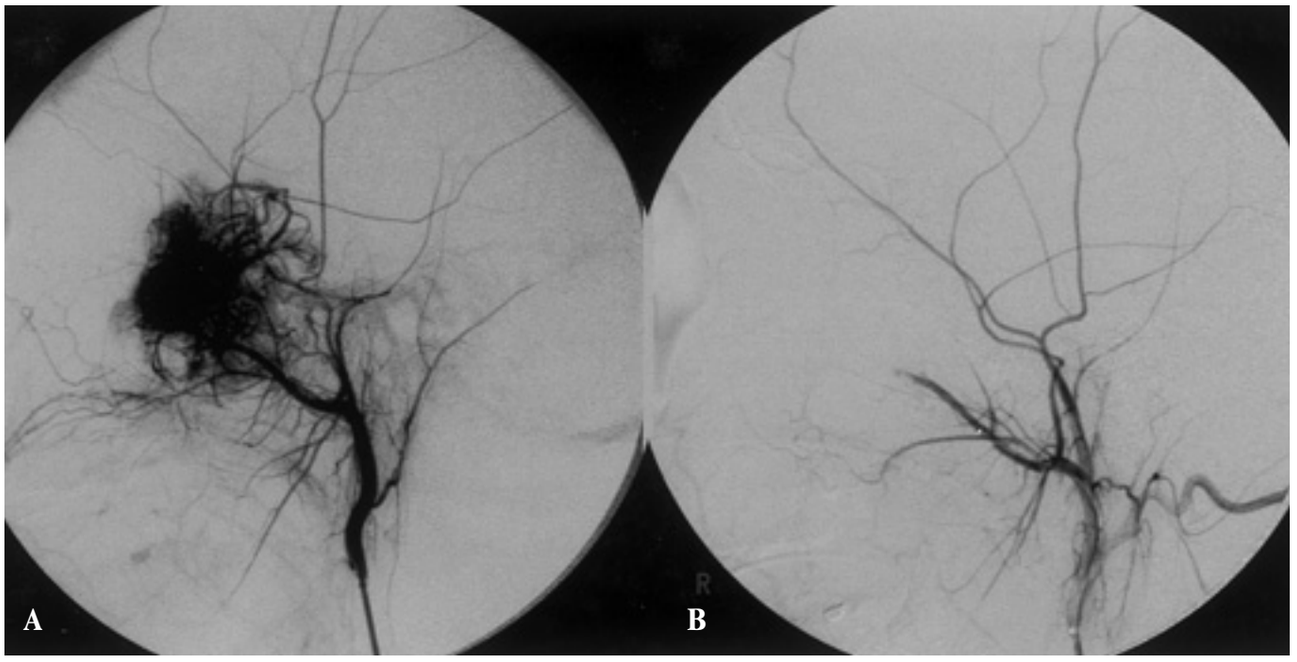

Figure 3. (A) The angiograhy shows the highly vascularized tumour with tumour feeding vessels fom the external carotid artery. (B) The tumour is devascularized after bilateral embolization of the maxillary artery and ascendant pharyngeal artery (case 7).

Table 1. The details of 21 cases undergoing endoscopic removal of JNA.

Nr	age	Fisch type	tumor involvement	approach	duration	blood loss	packing	postop. Hospit.	follow up months	MRI (postop.)	outcome
1	13	II	NPH, ppF, NPH	**Embol. + ESS** revision **ESS**	no data 3 h	100 ml. 450 ml.	Non 24 h	6 4	23 109	Recurrence NAD	Recurrence after 23 months, FOD
2	24	II	NPH, bil. ppF, max.+ethm. sin.	**Embol. + ESS**	2 h 45 min	100 ml	non	5	22	NAD	FOD
3	22	II	NPH, ppF, max. sin., cheek	**Embol. + ESS**, clipping of max. art.,	4 h 30 min	1500 ml.	24 h	7	84	not available	FOD
4	14	III a	NPH, ppF, max + ethm.+ sphen. sin., sphenoid	**Embol. + ESS**, clipping of max. art.	6 h.	300. ml.	24 h	14	14	recurrence invading skull base	recurrence (gamma knife therapy)
5	13	II	NPH, ethm + sphen. sin, floor of sphenoid	**Embol. + ESS**	4 h	400 ml.	non	4	61	residual tissue	FOS
6	15	III a	NPH, ppF, itF	**Embol. + ESS**	3 h 30 min	1000 ml.	24 h	6	31	NAD	FOD
7	15	III a	NPH, ppF, sphenoid, itF, orbit	**Embol. + ESS + intraop. guiding system,**	5 h 30 min.	1000 ml.	non	7	38	residual tissue	FOS
8	11	III a	NPH, ppF, itF	**Embol. + ESS + intraop. guiding system,** clipping of max. art.	2 h 16 min.	250 ml.	non	7	16	NAD	FOD
9	15	II	NPH, ppF, sphenoid, clivus	**Embol. + ESS**	1 h 30 min	50 ml.	non	3	12	not available	FOS
10	15	III a	NPH, ppF, sphen. sin., itF, orbit	**Embol. + ESS +** intraop. guiding system, clipping of max. art.	3 h	400 ml.	non	5	5	NAD	FOD
11	17	II	NPH, ppF	Embolization + ESS + clipping of max.art.	3 h 30 min	500 ml	48 h	5	108	NAD	FOD
12	22	II	Recurrence det 14 months after surgery abroad. NPH, ppF Recurrence: IIIa: infraorbital fissure + itF	(abroad: ligation of common carotid art.due to massive epistaxis) ESS + packing of lateral aspect of basisphenoid towards new vessels coming from the internal carotid art. (No embol.)	5 h	2000 ml	48 h	7	120	Resdual tissue	Reccurrence 6 months after ESS; FOS
13	19	II	NPH, ppF	ESS + clipping of max.art. (no embol.)	3 h 30 min	750 ml	24 h	3	77	NAD	FOD
14	20	II	NPH, ppF, sphenoid sinus, vomer	Embol. + ESS + clipping of max.art.	No data	No data	24 h	3	66	NAD	FOD
15	18	II	NPH, ppF,	Embol. + ESS + clipping of max.art.	No data	No data	24 h	3	59	NAD	FOD
16	17	II	NPH, ppT 1st rec: II (ppF) 2nd rec: II (ppF) 3rd rec: IIIa (itF)	Embol. + ESS + clipping of max.art. Embol. + ESS Embol. + ESS Intratumoral embol. + ESS	2 h 30 min 1 h 30 min 1 h 1 h 45 min	500 ml 750 ml 300 ml 200 ml	none 24 h none none	3 3 3 3	6 7 7 36	Res. tumor Res. tumor Res. tumor NAD	Recurrence within 6, 7 and 7 months respectively, needed 3 ESS to achieve FOD
17	16	II	NPH, ppF, vomer	Embol. + ESS + clipping of max.art.	2 h 45 min	450 ml	none	3	57	NAD	FOD
18	18	IIN	PH, ppF, sphenoid sinus, vomer	Embol. + ESS + clipping of max.art.	2 h 30 min	350 ml	none	3	48	NAD	FOD
19	16	II	NPH, ppF	Embol. + ESS + clipping of max.art.	3 h	450 ml	none	3	42	NAD	FOD
20	19	II	NPH, ppF	Intratumoral embol. + ESS + clipping of max.art.	1 h 45 min	250 ml	none	3	36	NAD	FOD
21	18	I	NPH	Embol. + ESS + clipping of sphenopalatine art. at the sphenopalatine foramen	1 h 30 min	400 ml	none	3	24	NAD	FOD

Embol. = Embolization
NPH = Nasopharynx, ppF = pterygopalatine fossa, itF = infratemporal fossa
ESS = endosopic sinus surgery
NAD = no abnormality detected, FOS = free of symptoms, FOD = free of disease

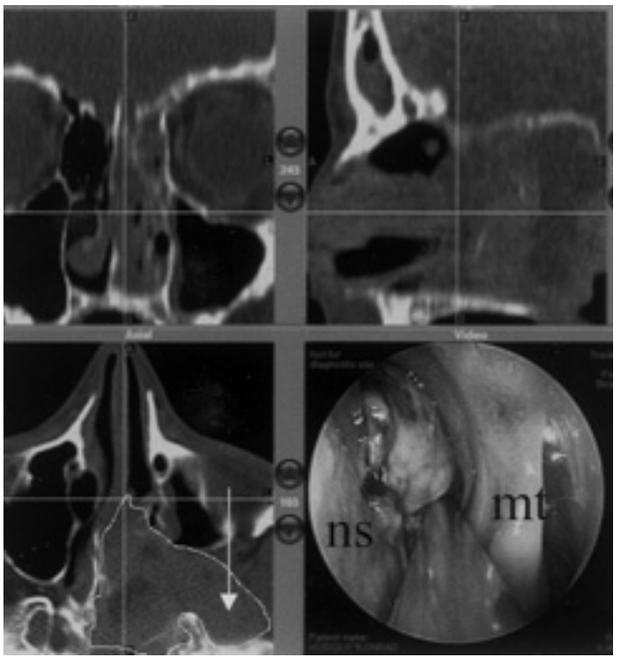

Figure 4. Intraoperative Computer assisted navigation CT of IIIa nasopharyngeal angiofibroma. In the axial CT scan the white line shows the tumour extension with infiltration in the left infratemporal fossa (white arrow). The grey cross indicates the tip of the suction device while using computer assisted navigation (case 7). nS = nasal septum, mT = middle turbinate.

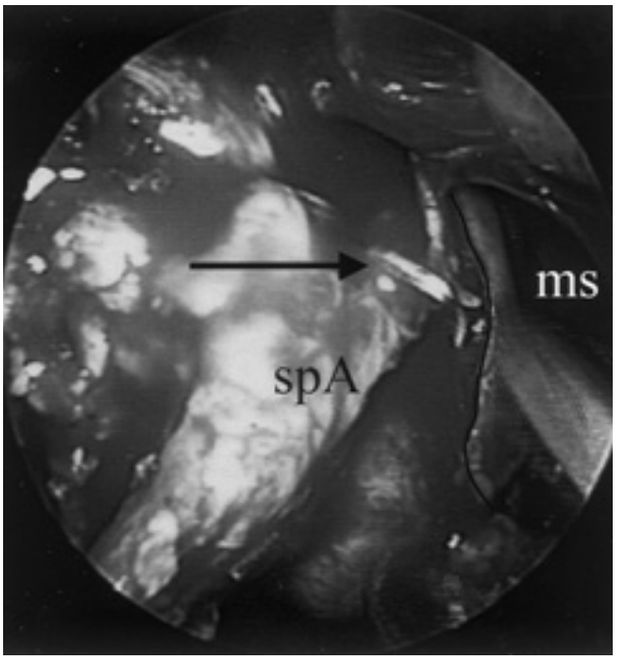

Figure 5. The left sphenopalatine artery was clipped (black arrow) on the edge to the pterygopalatine fossa. The black line indicates the posterior wall of the left maxillary sinus. spA = , sphenopalatine artery, mS = maxillary sinus.

bromas an intraoperative computer assisted guiding system was applied (ENTrak, GE Medical, Lawrence, USA) in Graz (Figure 4). Postoperative follow up included nasal endoscopy and Magnetic Resonance Imaging (MRI). Mean follow up was 39.1 months (range 5 months to 9 years) in Graz and 63 months in Barcelona (range 3 to 10 years), respectively.

Endoscopic surgical technique (according to Stammberger)

All patients were operated using the same endoscopic principles with modifications adapted to the individual case. A combined transnasal and transoral endoscopic approach was used:

Patients were positioned on their back, intubated transorally and the upper body and head elevated 10 degrees. A tongue depressor (standard tonsil spatulum) was inserted and a velotractor applied transnasally and the soft palate thus elevated. This allowed for alternating or even simultaneous transnasal and transoral endoscopic approaches. For maximum vasoconstriction, pledgets (SugomedÆ, Kettenbach, Germany) soaked in Adrenalin 1:1.000 and well squeezed out were applied to the mucosa of the nose and the epipharynx. In special cases an intraoperative guiding system (ENTrak, GE Medical, Laurence, USA) was used (Figures 4, 6, 7, 8). Four mm telescopes of 0o, 30o, 45o and 70o (Karl StorzÆ Endoscopes, Tuttlingen, Germany) were used together with standard FESS-instrumentation. Bipolar suction-cautery forceps proved essential for the technique, the straight one being used transnasally and the curved one transorally.

The first step in most cases was aimed at the sphenopalatine foramen and/or the sphenopalatine artery respectively: a subperiostal plane was identified and if possible, the stem of the artery identified and resected as far laterally as possible (Figure 5). In cases of considerable lateral extension of the lesion, the internal maxillary artery was exposed and clipped in thirteen patients through a wide middle meatus antrostomy, which enables access to the posterior wall of the maxillary sinus (ten Fisch type II and three Fisch type IIIa lesions).

When infiltration of posterior segments of the septum were present, the latter was transsected anterior to the infiltration, from there the lesion was pushed down into the nasopharynx, as even with piece-meal resection technique, portions of the angiofibroma would usually be too large to allow for transnasal removal.

Table 2. Classification of Nasopharyngeal Angiofibromas according to Andrews/ Fisch [21].

Type I:	Tumor limited to the nasopharynx and nasal cavity. Bone destruction negligible or limited to the shenopalatine foramen.
Type II:	Tumor invading the pterygopalatine fossa or the maxillary, ethmoid, or sphenoid or sinus with bone destruction.
Type IIIa:	Tumor involving the infratemporal fossa or orbital region without intracranial involvement.
Type IIIb:	Tumor invading the infratemporal fossa or orbit with intracranial extradural (parasellar) involvement.
Type IV:	Intracranial intradural tumor with infiltration of the cavernous sinus, pituitary fossa or optic chiasm.

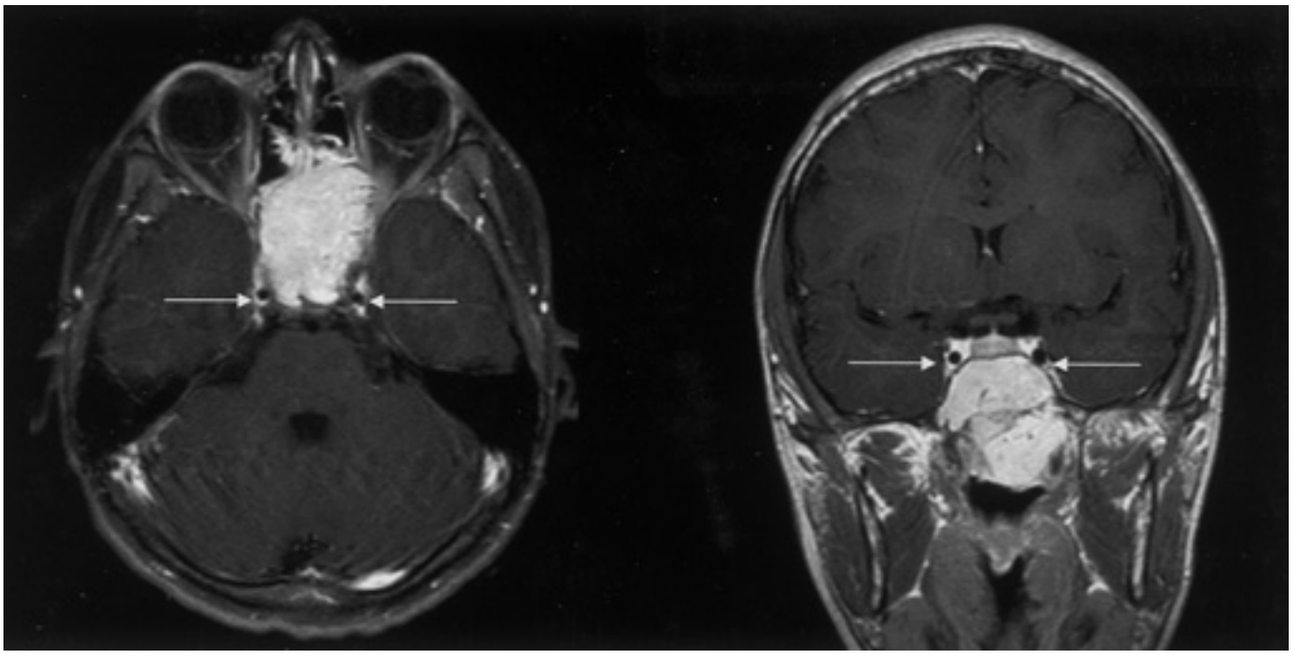

Figure 2. The tumour is attached to both internal carotid arteries (white arrows). On the left side the bony wall of the carotid artery is destructed (case 7).

In cases of sphenoid sinus involvement, a cleavage plane was identified between the tumour and the sinus walls and feeders from the internal carotid artery thus identified, cauterised and transsected. In all cases optic nerve and carotid artery could well be identified (Figure 7) and damage be avoided despite bony walls frequently missing there (Figures 2, 6, 8).

When the tumour had infiltrated and/or penetrated the floor of the sphenoid sinus, the angiofibroma components were followed from superiorly to inferiorly and "pushed" to the nasopharynx. We have not encountered a true infiltration of the cavernous sinus in our series, but frequently saw compression of the sinus by the angiofibroma.

Extensions to the infratemporal fossa were dealt with after partial or subtotal resection (including drilling) of the pterygoid process, usually the medial, but in two cases as well the lateral lamella. For retromaxillary extension, the posterior wall of the maxillary sinus was removed and the lesions thus exposed. External pressure with a finger behind the tuber maxillae in those cases helped to displace the lesions medially and thus make it accessible for endoscopic techniques (Figure 6). In all cases with retromaxillary lateral extension, the internal maxillary artery was identified and clipped as safety precaution.

The simultaneous inspection through the mouth with 30∞, 45∞ or 70∞ lens telescopes allowed for control of the surgical field, removal of the dissected angiofibroma components and good access for hemostasis.

Though technically the endoscopic approach to the infratemporal fossa and to the clivus was sometimes challenging, it was the nasopharyngeal extension that proved most time consuming to remove when there was a diffuse infiltration of this region. A clean cleavage plane sometimes could be difficult to achieve here, as visual distinction between lesion and the soft prevertebral tissue was very difficult. In some situations therefore, the deep fascia had to be identified for a safe cleavage plane.

Hemostasis was achieved with bipolar suction cautery and the surgical cavity covered with resorbable Oxicell pieces at the end of the procedure. It may be indicative of a learning curve, that in the last four cases, including three type IIIa angiofibromas, no packing was used at all in Graz. There were no complications associated with any of the surgical procedures.

Endovascular embolization (Medical University Graz)

Angiography and embolization were preceded by tumour evaluation by means of CT and/or MRI scans. A coaxial catheter system (Micro Therapeutics, Inc., Irwine, CA, USA) was introduced via a transfemoral approach. A superselective catheterization of the supplying external carotid artery and internal carotid artery branches was performed in order to devascularize the tumour. For embolization, either polyvinyl alcohol particles in solution of non heparinized saline or isobutyl-cyanoacrylate mixed with non ionic contrast medium were used. For intratumoural embolization puncture an intrathecal needle (gauge 20G) was positioned into the tumour under endoscopic control. Biological glues (GlubranÆ) mixed with lipiodol (to get an opacification) were applied (Figures 3A+B).

Two tumours with feeding branches from the internal carotid artery could not be fully embolized. One case with recurrent disease (case 12) had had (preoperatively) a common carotid ligation for massive epistaxis. Neovascularization coming from the internal carotid artery could not be embolized. Case 13 was not embolized preoperatively as the surgery was performed in

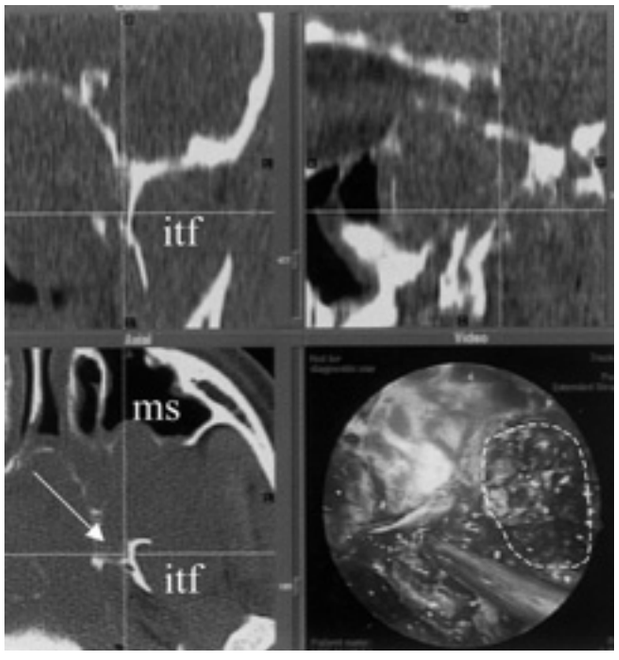

Figure 6. The interupted white line shows the area where tumour was resected from the medial aspect of the left infratemporal fossa. The grey cross indicates the tip of the suction device placed to the bony wall of the internal carotid artery (case 7). itF = infratemporal fossa, mS = maxillary sinus.

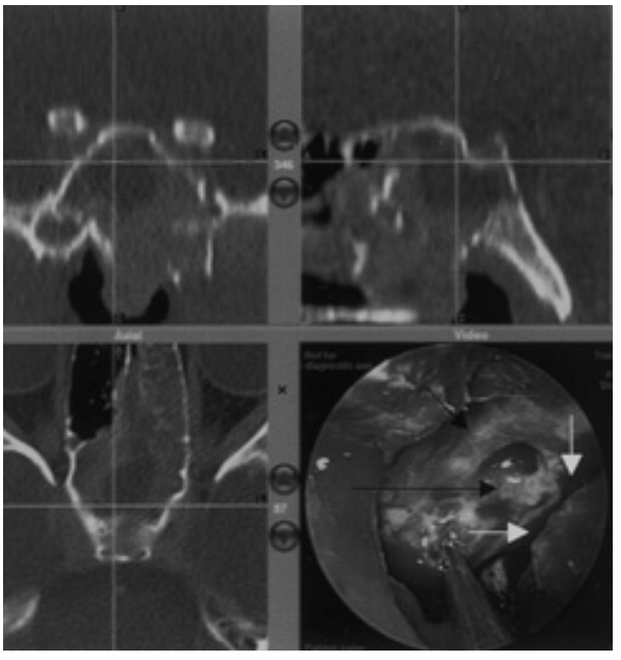

Figure 7. The tumour was resected from the sphenoidal sinus and is pulled downwards into the nasopharynx (white arrows). The bulge of the optic nerve (short black arrow) and internal carotid artery (long black arrow) are clearly visible (case 10).

another ENT-Department. Two cases (case 16 and 20) received additional intratumoural embolization, as the intra-arterial embolization was not sufficient.

One patient (case 3) suffered from temporary motoric aphasia after embolization due to connecting branches to the internal carotid artery. A MRI scan showed signs of ischemia of the region of the medial meningeal artery. Though neurological signs vanished after 72 hours surgery was postponed. Eight months later a second embolization was performed. Again the patient suffered from short time slowing of speech, but no ischemia of cerebral structures was detected on MRI. Endoscopic tumour resection without complication was performed 20 days later.

In one patient (case 4) with a recurrence invading the skull base embolization of the maxillary artery was followed by temporary partial motoric aphasia. A MRI scan showed ischemia of the thalamic area. No further surgical resection was attempted and the patient underwent gamma knife treatment.

RESULTS

Fifteen patients (71.4%) were free of disease after one endonasal endoscopic JNA resection. In three patients (14.3%) postoperative MRI showed localized enhanced signal, presumably minimal persistent tumour tissue. Further MRI follow-up showed no growth over 3, 5 and 10 years, respectively. All of these patients remained free of symptoms without further treatment.

Three patients (14.3 %) had an unmistakable recurrence with the need for further treatment at 6, 14, and 23 months, respectively. Two of the three recurrent tumours have been successfully resected endoscopically. In one of the two cases, three endoscopic revision surgeries for recurrent JNA were necessary after 6, 13 and 20 months, respectively (case 16). One patient with recurrence infiltrating the base of the skull was not operated on, due to embolization complications, but underwent gamma knife therapy.

In Graz in eleven endoscopic tumour resections with prior embolization median blood loss was 500 mL (range from 100mL to 1500mL), in Barcelona in 12 procedures (no data for two cases) median blood loss was 575 mL (range 200-2000mL). Three patients with blood losses of 1000-1500 mL received perioperative hemodilution (Graz). Three patients were given blood units, one of them with auto transfusion (Barcelona). In ten cases posterior packing was necessary for 24 hours postoperatively. Since 1998 no posterior packing was applied in four consecutive cases in Graz, including four IIIa JNAs and in six consecutive cases in Barcelona.

The mean surgical time for ten approaches (for 1 procedure data was not available) was three hours and 38 minutes (range from 1 hour thirty minutes to 6 hours) in Graz. For the last three consecutive cases, including two IIIa JNAs the mean operating time was 2 hours and fifteen minutes, indicating a ìlearning curveî. In two of these cases a computer assisted guiding system was used. The short operating time using this system suggests that this technique helps to save time in the operating theater despite the increased technical effort. In

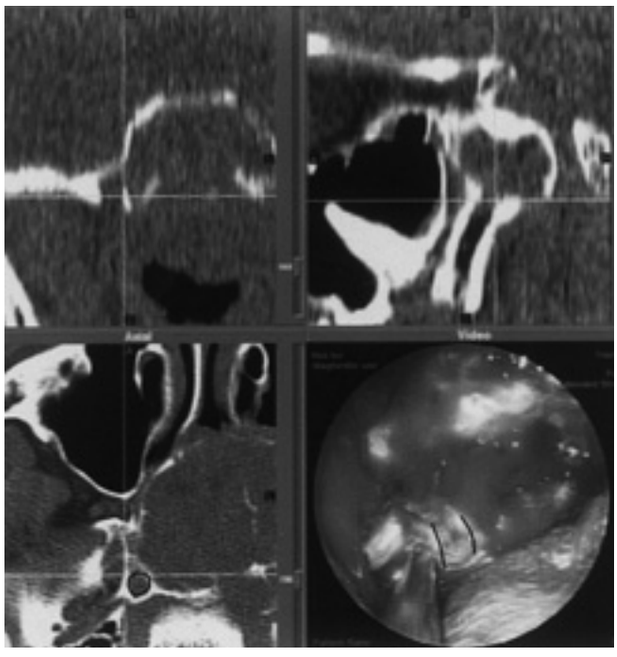

Figure 8. The tip of the suction device is positioned towards the right infratemporal fossa. The black lines indicate the right internal carotid artery (case 10).

Barcelona the mean surgical time for 12 procedures on 9 patients (no data available fort two patients) was two hours and 31 minutes (range 1 hour and 30 minutes to five hours). These 12 procedures included four revision surgeries.

DISCUSSION

Transfacial approaches like midfacial degloving or lateral rhinotomy are standard techniques for resection of juvenile angiofibromas with tumour extension to the nasopharynx, pterygopalatine fossa, sphenoid, and skull base. The infratemporal fossa approach enables optimal exposure of tumours with more lateral extension behind the pterygoid plates. Fisch [7] recommends his type C infratemporal approach for type III and IV juvenile angiofibromas. These techniques enable optimal tumour exposure, but side effects may include hypoesthesia of V2 and V3, serous otitis media and transient trismus after infratemporal approaches [6, 22]. Herman [23] reviewed 44 cases operated via lateral rhinotomy, midfacial degloving or Lefort I osteotomy and found late complications such as infraorbital nerve dysesthesia (5 cases), lacrimal duct stenosis (4 cases) and secretory otitis media (2 cases). He states that a transfacial approach helps to avoid neuralgia of the Vth nerve or trismus related to sectioning the pterygoid muscles during an infratemporal approach. External scars and interference with facial bone still in growth should be avoided if possible.

The evolution of endoscopes, special instruments and experience in sinus surgery allows for minimal invasive endonasal resection of tumours in the skull base area today [24]. The first reports about successful endoscopic resections of JNAs have been published since 1998 [13-20]. The only complication reported in literature was one case of optic nerve neuropathy, which was successfully managed with endoscopic decompression [17]. Draf et al. [25] successfully resected JNAs type I-II with an endonasal microendoscopic approach.

Endonasal endoscopic resections of JNA have been performed in the presenting departments since 1993 and 1994 respectively. Therefore we are now able to present long-term results of a case series of 21 consecutive patients up to ten years. Patients were followed up endoscopically and via MRI. The present series includes six type IIIa tumours with involvement of the infratemporal fossa. In all cases an exclusively endoscopic tumour removal via a combined endonasal and transoral approach was possible. Extension to the medial aspect of the infratemporal fossa and retromaxillary space was no contraindication for an endoscopic approach. Feeders from the internal carotid artery could well be dealt with endoscopically. No severe peri- or postoperative complication occurred. Two patients of the presented study suffered from intracerebral ischemia after embolization, but no long term sequelae were observed. One patient suffered from diffuse epistaxis of the nasopharynx 24 hous after surgery needing endoscopic revision with bipolar coagulation of minor vessels and donor blood transfusion.

In three cases a computer assisted guiding system (ENTrak, GE Medical, Laurence, USA) was applied, providing better orientation in critical areas, such as pterygopalatine fossa, infratemporal fossa or close to the internal carotid arteries. The technical system helps to orientate, but will never replace the surgeon's exceptional knowledge of this complicated anatomical area.

Long term studies on recurrence rates include tumours of different extensions and resection techniques and are therefore difficult to compare: Paris [12] reports a recurrence rate of 21% (43 cases, different non-endoscopic approaches), McCombe [9] of 34% (33 cases, lateral rhinotomy), Lloyd [1] of 39.5% (72 cases, non endoscopic techniques) and Fagan [10] of 37% (16 cases of advanced tumour stage, 3 endonasal endoscopic approaches, 13 non-endoscopic approaches). Risk for recurrence is reported higher if tumour involvement of the base of pterygoids, deep invasion of the sphenoid, cavernous sinus or infratemporal fossa is present [1, 11, 23]. Use of endoscopes in combination with a transfacial approach resulted in a decrease of recurrences in Herman's study [23].

When discussing recurrences, one has to differentiate true new tumour growth from asymptomatic, non- growing residual tumour tissue [26]. Minimal tumour remnants detected on MRI in asymptomatic patients may undergo involution after time [9, 10, 23, 26]. Therefore revision surgery to completely remove minimal, probable residual tissue is not mandatory in all cases. Regular follow-up, including nasal endoscopy and MRI or CT scans, are an alternative to early revision surgery. In the case of tumour growth further treatment is indicated.

Recurrent or residual growth seems to be related to the base of

sphenoid. Drilling of the sphenoid bone after tumour removal appears to provide a lower rate of residual tumours [11]. All cases from Barcelona underwent drilling of the base of sphenoid.

Type IV JNA, however, poses a clear limitation to exclusively endoscopic approaches, as do some forms of orbital fissure involvement. The low morbidity, short hospitalization and minimal invasive character of the endoscopic approach have clear advantages. It is a safe procedure in the hands of an experienced endoscopic surgeon, especially when an intraoperative guiding system is used.

CONCLUSION

Endoscopic resection of nasopharyngeal angiofibromas up to stage IIIa according to Fisch can be recommended for surgeons experienced in endoscopic sinus surgery. Advantages of the endoscopic technique are the minimal invasive character and low morbidity. Completeness of removal and low rates of recurrence compare favorably with traditional external approaches, without the disadvantage of the latter.

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