

Anaesthetic management of endoscopic resection of juvenile nasopharyngeal angiofibroma: our experience and a review of the literature

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Abstract

Background: Juvenile nasopharyngeal angiofibroma (JNA) is a rare, benign, vascular tumour in adolescent males with potential life-threatening complications. Advances in endoscopic surgery, invasive monitoring and hypotensive anaesthesia have made JNAs amenable to endoscopic surgical resection. We present the anaesthetic management of endoscopic resection of 14 JNAs, together with a review.

Method: The medical records of patients who underwent endoscopic excision of JNAs within the last seven years were reviewed retrospectively. Information was collected and analysed with regard to demographics, preoperative evaluation, intraoperative management, complications and postoperative course. Fourteen patients were included in the study. If the surgery needed to be converted to open surgery, the patients were excluded from the study.

Results: The age of the patients ranged from 10-18 years. Two patients had preoperative embolisation of the feeding vessel. Standard anaesthesia induction technique, together with invasive monitoring, was used. Controlled hypotension (mean arterial pressure of 60 ± 5 mmHg) was achieved with the help of inhalational anaesthetics, vasodilators and beta blockers. Mean duration of surgery was 197.14 ± 77 minutes, and median blood loss was 500 ml (100- 4 300 ml). Seven patients were extubated in the operating room. The other seven patients remained intubated for 24 hours owing to extensive surgery with a risk of postoperative bleeding, and were monitored either in the postoperative care unit (five patients) or the intensive care unit (two patients). There was no significant morbidity or mortality in any of the patients.

Conclusion: JNAs remain a challenge for anaesthesiologists because of excessive intraoperative bleeding. Anaesthetists should be aware of recent techniques to reduce tumour vascularity, such as embolisation of the feeding vessel and controlled hypotension. Invasive monitoring, together with multimodal blood conservation strategies, decreases blood loss and provides a clear field of vision for endoscopic surgery.

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Introduction

Juvenile nasopharyngeal angiofibroma (JNA) is rare, benign, but locally invasive tumour, with an incidence of 1:1 50 000.¹ It is one of the most common tumours of the nasopharynx, and accounts for 0.5% of all head and neck tumours.²⁻⁴ They are almost exclusively encountered in adolescent males. It is most common for JNAs to present with a classical triad of epistaxis, nasal obstruction and nasopharyngeal mass. The presence of other symptoms depends on the extent of tumour spread.⁵ Surgery is considered to be the gold standard JNA treatment.⁶ Other treatment options include

radiation therapy (external beam), chemotherapy and hormone therapy antiandrogen (flutamide).⁶

JNAs are enormously vascular tumours and open surgical resection is associated with significant blood loss and postoperative morbidity. Advances in radiological imaging, better preoperative identification of the feeding vessel of the tumour and angiographic embolisation performed before surgery, together with hypotensive anaesthetic techniques and blood conservation strategies, have revolutionised the management of these tumours. Recently, endoscopic excision has been widely employed for the excision of

small- and medium-sized angiofibromas. Nasal endoscopy is minimally invasive and provides a magnified view of the tumour. It is also associated with less postoperative morbidity and a low recurrence rate.⁴

Despite the advances, JNAs continue to be a challenge because of vascularity, their proximity to vital neurovascular structures, and their difficult anatomic location. The major problem with endoscopic surgery is that even minimal bleeding can interfere with endoscopic vision. Thus, hypotensive anaesthesia is required to assist in decreasing blood loss and providing a bloodless, clear field to facilitate surgery.

Little literature are available on the anaesthetic management of the endoscopic resection of JNAs. We present this retrospective analysis of perioperative anaesthetic management of patients who underwent endoscopic resection for JNAs at our institute over the last seven years, and reviewed the literature in the light of current evidence.

Method

The medical records of patients with JNAs who had undergone endoscopic excision of their tumours within the last seven years were reviewed retrospectively. Data were collected on the patient's age, sex, presenting symptoms, preoperative investigations, preoperative imaging and embolisation, and staging of the tumours according to size. Anaesthetic charts were reviewed and detailed information collected on the airway examination, associated systemic illness, anaesthetic technique, intraoperative monitoring, blood conservation strategy, deliberate hypotension technique, duration of surgery, blood loss, intraoperative fluid management, blood transfusion and any other complications. In addition, information on the postoperative period was also collected. Descriptive quantitative data were presented as mean \pm standard deviation range of values.

Results

The demographic profile of the patients is given in Table I. All 14 patients were male, with a mean age of 14.7 ± 2.5 years (10-18 years) and a mean weight of 44.93 ± 11.7 kg (28-65 kg). Unilateral nasal obstruction was the presenting symptom in 13 patients, and one patient presented with epistaxis. Five patients had a history of snoring and two patients were complete mouth breathers. The diagnosis of JNAs was made from the history and a computerised tomography (CT) scan finding pertaining to the nasal and paranasal

sinuses. Tumours were classified according to Radkowski's staging⁷ (Table II). Patients were categorised as Radkowski's stage I or II. None of the patients received preoperative blood transfusion, had other systemic illnesses, nor a predictable difficult airway. (The modified Mallampati score was between 1 and 2). Apart from standard routine laboratory tests (haemogram, prothrombin time, and liver and renal function tests), a CT scan, magnetic resonance imaging (MRI) and an angiogram were performed. None of the patients received adjuvant radiotherapy or hormonal therapy in the preoperative period. Two underwent embolisation of the feeding artery 24-48 hours before surgery to reduce intraoperative bleeding.

After a thorough preanaesthetic evaluation, patients were premedicated with an anxiolytic agent (benzodiazepine) the night before and on the morning of the surgery. In the operation room, routine standard monitors [an electrocardiogram (ECG), oxygen saturation (SpO₂) and noninvasive blood pressure (NIBP)] were applied, and base line values recorded. Anaesthesia was induced with intravenous fentanyl (1-2 μ g/kg) and propofol (1-2 mg/kg). Neuromuscular blockade was achieved with vecuronium (0.1 mg/kg). After securing the oral cuffed endotracheal tube, a throat pack was inserted. Two large-bore (16- or 14-gauge) peripheral venous accesses were secured, either in the upper or lower limb, depending on the size of the veins. The patients were placed supine, in a 30-degree, reverse Trendelenburg position, and the lower limbs elevated by placing pillows below their knees. Cephalic or basilic veins were used to measure central venous pressure (CVP), with a mean target CVP of 10 cm of water from a peripherally inserted central venous catheter. An arterial catheter was placed in the dorsalis pedis artery in 12 patients, and

Table I: The patients' demography, presentation and tumour staging

Patient no	Age (years)	Weight (kg)	Modified Mallampati score	Mouth breathing	Snoring	Preoperative haemoglobin (g/dl)	Radkowski's stage
1	14	40	I	+	-	13.5	IIc
2	14	32	I	-	-	12.8	Ib
3	16	45	I	-	-	13.7	Ib
4	12	40	II	-	-	12.4	Ib
5	12	33	II	-	-	11.1	IIa
6	15	45	I	-	-	14.6	IIc
7	18	55	II	+	+	14.9	Ib
8	13	28	I	-	-	10.7	Ib
9	15	65	II	-	+	13.5	Ia
10	17	45	I	-	-	13.1	Ia
11	19	60	II	-	+	13.6	Ia
12	14	49	II	-	+	12.9	Ia
13	17	60	I	-	+	13	IIc
14	10	32	I	+	-	13.7	Ia

+: mouth breathing present, snoring present

-: mouth breathing absent, snoring absent

Table II: Radkowski's staging

Stage	Extent of the tumour
Ia	Tumour is limited to the nasal cavity and nasopharynx
Ib	Tumour is in the nasal cavity, extending into one, or more, paranasal sinuses
IIa	There is minimal extension of the tumour through the sphenopalatine foramen into the pterygopalatine fossa
IIb	There is full occupation of the pterygopalatine fossa, with or without superior extension, through erosion of the orbital bones
IIc	Tumour extends into the infratemporal fossa, or is posterior to the pterygoid plates
IIIa	There is skull base erosion and minimal intracranial extension
IIIb	There is extensive intracranial extension, with or without extension into the cavernous sinus

in the radial artery in two, for invasive blood pressure measurements. A urinary catheter was inserted and axillary skin temperature measured with a skin temperature probe. An in-line warmer was used to infuse warm fluids. Before the start of surgery, the anaesthesia workstation was moved near the patients' feet. Anaesthesia was maintained, either with isoflurane or propofol, and neuromuscular blockade

guided by neuromuscular monitor. Intraoperative analgesia was administered with boluses of fentanyl (0.5-1 µg/kg) to six patients, and boluses of morphine (50-100 µg/kg) to eight patients.

The mean duration of surgery was 197.14 ± 77.7 minutes (60-360 minutes), and median blood loss, 500 ml (100-4 300 ml). Deliberate hypotension was provided to patients with a mean target arterial blood pressure of 60 ± 5 mmHg. The drugs used to provide deliberate hypotension, strategies employed to decrease blood loss, the total blood loss, and the amount of fluid and blood product transfused, are given in Table III. Of four patients who required blood transfusion, only one needed blood products (fresh frozen plasma and packed platelets) to be transfused. The urine output was maintained between 0.5 ml/kg/hour and 1.5 ml/kg/hour in patients. None of them developed hypothermia. Two patients experienced intraoperative hypotension. Patient number 3 and 13 were revision cases. The mean arterial pressure was less than 55 mmHg because of increased blood loss in them. As an institutional practice, endoscopic resection is not carried out in any revision surgeries for JNAs. There were no other intraoperative complications.

Table III: Blood conservation strategy, blood loss, and fluid and blood requirements

Patient no	Duration of surgery (mins)	Blood conservation strategy				Invasive monitoring (PICC and arterial line)	Blood loss (ml)	Fluid and blood transfusion	
		Preoperative embolisation	NP measures*	P measures	Surgical technique (bipolar cautery)			Fluid (ml)	Blood (no of units)
1	270	-	+	NTG infusion	+	+	500	3 000	-
2	60	-	+	Isoflurane	+	+	200	1 500	-
3	240	-	+	NTG infusion	+	+	3 500	7 000	4 RBC
4	90	-	+	Isoflurane	+	+	100	1 000	-
5	120	-	+	Esmolol infusion	+	+	500	1 000	-
6	165	-	+	Isoflurane	+	+	1 300	3 000	2 RBC
7	195	+	+	Propofol infusion	+	+	400	1 500	-
8	195	-	+	Isoflurane	+	+	1 600	2 500	2 RBC
9	210	-	+	Isoflurane	+	+	600	4 000	-
10	255	-	+	Esmolol infusion	+	+	500	2 500	-
11	150	-	+	Isoflurane and labetalol boluses	+	+	700	2 500	-
12	210	+	+	Isoflurane	+	+	300	2 500	-
13	360	-	+	Isoflurane	+	+	4 300	7 000	4 RBC
14	240	-	+	Propofol infusion and labetalol boluses	+	+	250	2 500	-

PICC: peripherally inserted central catheters, mins: minutes, NP: nonpharmacological, NTG: nitroglycerin, P: pharmacological, RBC: red blood cells
 *: reverse Trendelenburg position
 +: Preoperative embolisation, reverse Trendelenburg performed, bipolar cautery used, and arterial line for invasive monitoring placed
 -: Preoperative embolisation, reverse Trendelenburg not performed, bipolar cautery not used, and arterial line for invasive monitoring not placed. No red blood cells were transfused

Table IV: The postoperative operative course taken

Patient no	Extubation in the OR	Oxygen therapy	Postoperative monitoring	Pack removal under GA	Blood loss during pack removal
1	+	Face mask	PACU	-	Minimal
2	+	Face mask	PACU	-	Minimal
3	-	IPPV	ICU	+	(300 ml)
4	+	Face mask	PACU	-	Minimal
5	-	CPAP	ICU	-	Minimal
6	+	Face mask	PACU	-	Minimal
7	+	Face mask	PACU	-	Minimal
8	-	T-piece	PACU	-	Minimal
9	-	T-piece	PACU	-	Minimal
10	-	T-piece	PACU	+	Minimal
11	+	Face mask	PACU	-	Minimal
12	-	T-piece	PACU	-	Minimal
13	-	T-piece	PACU	+	Minimal
14	+	Face mask	PACU	-	Minimal

CPAP: continuous positive pressure ventilation, GA: general anaesthesia, ICU: intensive care unit, IPPV: intermittent positive pressure ventilation, OR: operating room, PACU: post-anaesthetic care unit

+: Yes, i.e. the patient was extubated in the operation room, and the pack was removed under general anaesthetic

-: No, i.e. the patient was not extubated in the operation room, and the pack was not removed under general anaesthetic

At the end of the surgery, anterior nasal packing was carried out. Three of the patients required a posterior nasal pack. Before reversal of the residual neuromuscular blockade, the throat pack was removed and laryngoscopic guided oral suction performed. The trachea was extubated in the operation room in seven patients when they were fully awake, and supplemental oxygen provided in the post-anaesthetic care unit (PACU). The remaining seven patients were kept intubated electively owing to prolonged surgery and the risk of re-bleeding. Of these, five were monitored in the PACU and oxygen provided by a T-piece. Two patients were shifted to the intensive care unit (ICU), one was electively ventilated because of massive blood loss and the risk of re-bleeding, while the other received continuous positive airway pressure (CPAP). Morphine 1mg/hour infusion was started for postoperative pain, sedation and tube tolerance in the intubated patients.

Information on the postoperative course taken is provided in Table IV. Patients received dexamethasone (0.1 mg/kg) intra-operatively on induction of anaesthesia and postoperatively (6-8 hourly), to minimise tissue oedema. Extubation was planned 12-24 hours after surgery, after confirming the absence of active bleeding and conducting a positive leak test with the cuff deflated. Three patients who had a posterior nasal pack in situ required general anaesthesia for pack removal and airway protection. One patient had 300 ml of blood loss during pack removal. The trachea was extubated in these patients after removal of the pack under anaesthesia. No other postoperative complication was noted in any of the patients. Patients were discharged between five and eight days after surgery. During follow-up, none of them had tumour recurrence until January 2013.

Discussion

JNAs are the most common benign neoplasm of the nasopharynx.²⁻⁴ Despite their benign nature, they have a locally destructive growth pattern and can cause bone erosion. JNAs can result in potentially life-threatening complications, such as fatal epistaxis, intracranial extension and intraoperative massive blood loss.⁴ The tumours consist of fibrotic and vascular elements. However, the vascular elements lack elastic lamina and elastic fibres, hence the vessels are unable to contract, resulting in severe bleeding during their removal.^{6,8} Management of JNAs is a challenge owing to their rich vascular supply, complex adjacent anatomical structures and aggressive growth pattern.

JNA are exclusively found in the young male population (10-24 years of age). The most common presentation is unilateral nasal obstruction, followed by epistaxis.⁹ Most patients do not have any associated systemic illness. A CT scan and MRI play a critical role in proper evaluation of the tumour. A CT scan provides information on the bony details, whereas MRI is crucial in supplying soft tissue-related information and the position of the tumour with regard to critical structures, such as the carotid artery and cavernous sinus.⁶ An angiography provides information on blood supply to the tumour, and also helps in decisions on the feasibility of preoperative embolisation. Branches of the internal maxillary artery, and a branch of the external carotid, provide the major blood supply to most JNAs, but, as these tumours grow, they may also develop a vascular supply from branches of the ipsilateral internal carotid artery and contralateral external carotid artery.^{10,11} In the present study, a CT scan, MRI and angiography were performed in patients for the preoperative evaluation. Preoperative details of the radiographic imaging help when planning anaesthesia.

Staging of JNAs is mainly based on the extent of the tumour and the amount of intracranial extension. Radkowski's classification is the most accepted one and has better predictability with regard to morbidity and prognosis. All of the tumours in the present study were stage I or II (Radkowski's classification). Patients with Radkowski's stage III tumours are not good candidates for endoscopic surgery.¹⁰

Primarily, treatment of JNA is surgical resection though other adjunctive therapies, e.g. radiation therapy, chemotherapy

and hormone therapy.⁶ External beam radiation is generally reserved for larger and/or irresectable and life-threatening tumours. Radiation may lead to complications such as growth retardation, temporal lobe radionecrosis, keratopathy and potential carcinogenic side-effects.^{6,12,13} Chemotherapy is not very effective.⁶ As JNA growth is androgen-dependent, antiandrogen therapy decreases the size and vascularity of the tumour.¹⁴ Oestrogen is not used because of its feminising side-effects and the risk of cardiovascular complications.^{12,14} There have been conflicting recommendations in different studies with regard to flutamide, an androgen receptor blocker, which has been found to have unproven efficacy. However, it is of particular interest in partial volume reduction.¹⁴⁻¹⁶ None of the patients in this study had adjunctive therapy for tumour size reduction. Anaesthesiologists must be aware of these treatment modalities and their side-effects. Prior radiation therapy makes laryngoscopy difficult owing to the noncompliant fibrosed submandibular space, and can lead to significant postoperative oedema owing to obliteration of the lymphatics. Patients on radiotherapy are more susceptible to infection and bleeding during airway manipulation because of epidermitides and oral mucositis.¹⁷

Preoperative selective arterial embolisation of the feeding vessels significantly decreased intraoperative blood loss and facilitated the resection of larger tumours.^{18,19} Embolisation is typically performed 24-48 hours prior to resection, as after several days the contralateral vessels may become the major contributor to the tumour. The transarterial technique of embolisation is associated with a significant risk of complications, such as numbness, facial palsy, strokes and occlusion of the ophthalmic artery.^{6,12} Recently, the injection of embolising material by direct tumoural puncture was advocated as it produces a greater degree of tumour devascularisation than the transarterial technique.²⁰ Apart from numbness, facial palsy, strokes and occlusion of the ophthalmic artery, minor side-effects like pain, increased leucocyte count and fever are more common, and may mimic acute infection in the preoperative period. In this study, two of the 14 patients, both with a Radkowski's stage I tumour, underwent preoperative embolisation of the feeding vessel which led to a significant decrease in blood loss of 400 and 300 ml (total blood loss was 14 850 ml). Fear of significant complications, and chances of incomplete resection of the tumour because of blunting of borders after embolisation, are major concerns in the routine preoperative use of embolisation of JNAs.^{21,22} There have been studies in which JNAs have been operated endoscopically, without significant bleeding in the absence of preoperative embolisation.^{23,24} The authors at our centre prefer surgical ligation of the feeding maxillary and sphenopalatine arteries, and consider it to be as effective as preoperative embolisation.

The open surgical approach is associated with significant intraoperative and postoperative morbidity because of

massive blood loss. The endoscopic approach overcomes the disadvantages of the open approach, and provides excellent magnified tumour visualisation. In addition, it also reduces intraoperative blood loss, length of hospital stay and recurrence rate.⁶ The present study was in accordance with previous reports which state that early-stage JNAs (stage I and II, and some stage III) can be removed using the endoscopic approach.^{6,23} Tumours with significant intracranial spread cannot be resected endoscopically, and preferably, this is avoided in revision surgery.

A haemodynamically stable patient, during and after surgery, is the main goal of anaesthetists. The prime anaesthetic concern in the resection of JNAs is prevention of the aspiration of blood, minimisation of blood loss and prevention of airway obstruction in the postoperative period owing to surgical manipulation. Ezri et al²⁵ have advocated rapid sequence induction to prevent aspiration during induction. In the present study, patients were induced in the standard manner, without complications. Rapid sequence induction may be preferred in patients with active epistaxis. In this study, after securing the cuffed endotracheal tube, a throat pack was inserted as an additional measure to prevent aspiration. Throat packs should be removed at the end of surgery before extubation to prevent airway obstruction.

In addition to standard routine monitoring (an ECG, SPO₂, NIBP and end-tidal carbon dioxide), invasive haemodynamic monitoring is essential in providing safe hypotensive anaesthesia. As access to the neck veins is limited, either the basilica or cephalic, or subclavian or femoral vein, can be cannulated for CVP monitoring. In the current study, cubital fossa veins were used to monitor CVP. Similarly, either the radial artery or dorsalis pedis artery can be used for invasive blood pressure monitoring. In order to be able to rapidly transfuse fluid and blood products, large-bore cannulae should be secured. Lower limb veins may be preferred for venous access because they are accessible intraoperatively as upper limbs are kept by the patient's side and are under the surgical drapes. Proper extension lines should be connected if upper limb veins are used.

Apart from preoperative embolisation in two patients, other blood conservation strategies used in this group were the reverse Trendelenburg position, deliberate hypotension and use of high-power bipolar diathermy. The reverse Trendelenburg position deviates blood away from the surgical field because of gravity, and thus decreases blood loss.^{25,26} It also facilitates better surgical exposure. The lower limbs should be elevated and the knees kept at heart level to ensure optimal venous return. One major concern with this position is the risk of venous air embolism (VAE), which has an incidence of 6-30% in the semi-sitting position.²⁶ Euvolaemia should be maintained and the surgical field flushed with saline by the surgeon to prevent VAE. End-tidal carbon dioxide was monitored in the patients, and in the present study, there was no significant incidence of VAE.

Deliberate hypotension, with a mean target arterial pressure of 60 ± 5 mmHg, was used in this study. Inhalational anaesthetic, vasodilators and beta blockers were effectively employed for this purpose. The disproportionately severe blood loss in two cases (case 3 and 13) occurred because of unfavourable patient factors, which caused difficult endoscopic access. Both cases had been operated upon previously. The authors abandoned endoscopic excision in the revision cases.

Similar to the previous study by Ezri et al,²⁵ a higher concentration of inhalational anaesthetic (isoflurane in 1.5-2.5% dial setting) was used in eight patients for controlled hypotension, of which three required blood transfusion. Propofol, nitroglycerin and esmolol were also given to two patients. In addition to primary therapy, labetalol boluses (propofol and isoflurane) were also used in two patients. The literature does not support any particular agent over another for this purpose. A most recent satisfactory and preferred technique is a combination treatment of remifentanyl, with either propofol or an inhalation agent (isoflurane, desflurane or sevoflurane), at clinical concentrations.²⁷ Total intravenous anaesthesia using propofol and remifentanyl was found to provide a drier surgical field than balanced general anaesthesia with esmolol in children undergoing functional endoscopic sinus surgery. However, both techniques are safe and effective in controlling hypotension.²⁸ When compared with the normotensive state, direct-acting vasodilators, such as nitroglycerin and nitroprusside, beta-adrenoceptor antagonists and calcium-channel antagonists, have clearly demonstrated a reduction in blood loss with controlled hypotension, but there are potentially dangerous complications with each agent (toxic metabolites, myocardial depression and arrhythmias).^{25,27}

Use of endoscopic bipolar cautery by surgeons has been found to be an effective adjunct to other techniques with regard to reducing blood loss.²⁶ In addition to these modalities, other techniques that can be used to reduce the need for allogenic transfusion are autologous blood transfusion, acute normovolemic haemodilution, intraoperative red blood cell salvage and intraoperative use of fibrin glue. As the surgery is performed on an priority basis, enough time may not be available to administer erythropoietin and to build up the haemoglobin and autologous blood collection. However, acute normovolemic haemodilution can be performed post induction for extensive angiofibromas that require massive blood transfusion. Red blood cell salvage is commonly used for procedures in which major blood loss is anticipated. However, its use for endonasal surgeries is controversial because the site of surgery and blood collection can be contaminated by the nasal flora.²⁹ Use of an intratumoural injection of fibrin glue has been described in a few case reports.²⁶

In comparison to the study by Ezri et al,²⁵ in which the open surgical technique was used, and the mean loss was 4 800

$\pm 1 600$ ml, the patients in this study experienced a median blood loss of 500 ml, but endoscopic surgical resection was used in these cases. Similarly, only 28.5% of patients (four) required blood transfusion, by comparison with 100% of patients in a previous study.²⁵ Although ordering at least 10 units of blood on standby in the preoperative period for JNA resection has been advocated, in the authors' opinion, such amounts may not be required with the use of multimodal blood conservation techniques during endoscopic resection, as was found in this study. Apart from blood loss, two patients experienced intraoperative hypotension because of the blood loss, which was managed by stopping the hypotensive measures, and administering a rapid infusion of fluid and blood and boluses of ephedrine. No other complications were experienced by patients in this study.

At the end of surgical procedure, a decision to extubate the trachea was taken only after consulting with the surgeon. Massive blood loss, extensive surgical dissection, suspicion of residual tumour, non-specific oozing of blood from the surgical site and in situ postnasal packs are conditions that preclude safe extubation. In such cases, the endotracheal tube is left in place for at least 24 hours, with close monitoring of the airway and haemodynamic status. In a study by Ezri et al,²⁵ tracheal extubation was deferred in patients (100%) who had open surgical resection of JNAs (eight), whereas two patients who underwent endoscopic resection were extubated immediately after surgery. By contrast, in the current study, extubation was delayed in only 50% of the patients (seven). Endoscopic resection of JNAs leads to less intraoperative bleeding and extensive surgical trauma. Hence, there is more chance of tracheal extubation in the operating room immediately after surgery. In the present group, five patients were kept in the PACU with the tube in situ, and two were transferred to the ICU. In the ICU, one patient required elective ventilation because of symptomatic anaemia, massive blood loss and related complications, while the other required CPAP owing to poor respiratory effort. All of the patients were extubated 24 hours postoperatively after ensuring haemostasis and conducting a positive leak test around the deflated cuff. The cuff leak test helped to identify patients at risk of developing post-extubation stridor due to laryngeal oedema. However, the discriminatory power of the cuff leak test is highly variable. While the presence of a cuff leak predicts successful extubation, a failed cuff leak test is not an accurate predictor of post-extubation stridor, and if used as a criterion for extubation, may lead to unnecessarily prolonged intubation, or to needless tracheostomy.^{30,31}

Bleeding can occur during removal of the pack, and it is advisable to conduct the procedure under general anaesthesia, with monitoring and resuscitation equipment nearby. In this study, three patients had a posterior nasal pack because of non-specific oozing and underwent delayed extubation after 24 hours under anaesthesia. One

patient had 300 ml of blood loss during pack removal, which was controlled with bipolar cautery. Pack removal in the other patients was uneventful. Pain relief postoperatively of morphine 1 mg/hour infusion and paracetamol 1 g three times daily was given to intubated patients. Fentanyl boluses of 1-2 µg/kg were given to extubated patients, if necessary.

Conclusion

Despite advances in surgical and anaesthetic techniques, surgery for JNA remains a challenge for anesthesiologists. The latter should be aware of advances in the management of these tumours, the latest drugs, monitoring modalities, blood conservation strategies, as well as anaesthetic techniques, which can help to provide optimal perioperative care of these patients. Preoperative embolisation and controlled hypotension are major factors used to decrease blood loss during endoscopic resection of JNAs. Multimodal blood conservation techniques, in combination with hypotensive anaesthesia, should be used to decrease blood loss and provide a drier field during endoscopic resection of a JNA. The authors recommend that early-stage JNAs (stage I and II, and some stage III) should be removed using the endoscopic approach, and that tumours with significant intracranial spread must not be resected endoscopically. Preferably, endoscopic resection should be avoided in revision surgery.

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