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## ENDOSCOPIC-ASSISTED CRANIONASAL RESECTION OF OLFACTORY NEUROBLASTOMA

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**Abstract:** *Background.* Cranionasal resection was first described in 1997 for the surgical resection of olfactory neuroblastoma. The endoscopic transnasal approach is used in cranionasal resection to replace the more invasive craniofacial resection. It has the advantages of avoiding the facial wound and its associated pain, swelling, and scar. The authors have routinely practiced cranionasal resection since 1996 for resection of all anterior skull base tumors in which the resultant skull base bony defect is limited to the nasal and sinus roof. The aim of this study was to review the results of cranionasal resection for olfactory neuroblastoma.

*Methods.* The results of cranionasal resection for olfactory neuroblastoma in six patients from 1996 to 2003 were reviewed.

*Results.* The Kadash stages were 3A, 2B, and 1C. None of the patients had postoperative complications. Postoperative radiotherapy was given only to the patient with Kadash stage C disease. There were no local recurrences. Two patients died of lung metastasis.

*Conclusions.* Cranionasal resection is a safe and adequate procedure. Postoperative radiotherapy is not necessary after clear resection of Kadash A and B tumors. © 2005 Wiley Periodicals, Inc. *Head Neck* 27: 488–493, 2005

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The commonly used techniques in the surgical resection of anterior skull base tumors are the craniofacial resection<sup>1,2</sup> and transcranial resection.<sup>3</sup> Craniofacial resection needs a transfacial approach to expose the anterior skull base and the lower part of the tumor in the nasal cavity. Transcranial resection is not popular because of the difficulty associated with resecting tumor in the nasal cavity.

Endoscopic transnasal sinus surgery is commonly practiced by ear, nose, and throat (ENT) surgeons in the management of nasal polyposis and sinusitis.<sup>4</sup> Endoscopic transnasal surgery has now been extended in its applications to anatomic regions beyond the nose and sinuses. Endoscopic transnasal surgery is now used in orbital decompression<sup>5,6</sup> and pituitary surgery.<sup>7</sup> In 1997, we first described a new technique of resection of olfactory neuroblastoma using combined transcranial and endoscopic transnasal videoendoscopic approaches.<sup>8</sup> We used the term “cranionasal resection” to distinguish it from “craniofacial resection”; this new approach goes only through the nose but not the face.<sup>8</sup> This new cranionasal resection technique can avoid the facial trauma

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of craniofacial resection and its associated facial trauma, pain, swelling, and scar.<sup>8</sup> Since 1996, we have used the cranionasal resection technique in the resection of all olfactory neuroblastomas and other anterior skull base tumors except in patients in whom free-flap reconstruction is necessary. This study is the follow-up evaluation of the results of cranionasal resection of olfactory neuroblastoma.

#### PATIENTS AND METHODS

Since the report of our first patient who had endoscopic-assisted cranionasal resection of olfactory neuroblastoma in January 1996,<sup>8</sup> the first author together with the three consultant neurosurgeons have routinely used the same cranionasal resection technique for surgical resection of all olfactory neuroblastomas and other anterior skull base tumors in which free-flap reconstruction is not necessary. Four male and two female patients underwent cranionasal resection of olfactory neuroblastoma between January 1996 and December 2003. The last patient was operated on in May 2003. In this same period, three other patients underwent conventional craniofacial resection of olfactory neuroblastoma in our hospital. These three patients were excluded from this study; two of them had extensive tumor involvement of the orbit that required free flaps to repair the nasal and orbital roof defect, and therefore cranionasal resection was not feasible; the other patient was operated on by another ENT surgeon at our hospital using the conven-

tional craniofacial approach. The data on the six patients are summarized in Table 1.

The surgical technique has been described in detail in our previous publication on cranionasal resection.<sup>8</sup> The same technique was used in all six patients. All patients had preoperative CT and/or MRI evaluation of the tumors. The Kadesh staging system is used.<sup>9</sup> Kadesh A is tumor confined to nasal cavity; Kadesh B is tumor with extension to paranasal sinuses; and Kadesh C is tumor with extension beyond the paranasal sinuses.<sup>9</sup> Figure 1 shows the CT scan of the fourth patient, with Kadesh B tumor infiltrating the right nasal cavity and ethmoid sinus. A standard bicoronal scalp flap and frontal craniotomy were performed to expose the frontal lobe of the patient. The frontal lobe with the dura was dissected off from the floor of the anterior cranial fossa up to the posterior part of the sphenoid sinus by the neurosurgeon. The transnasal part of the operation was then performed with video-nasoendoscopy with standard instruments in endoscopic sinus surgery. In some patients, the bulky tumors within the nasal cavity might have obscured the transnasal resection and were debulked by use of the debrider. The nasal septum was transected intranasally with backward cutting forceps from the posterior edge of the septum forward and then upward toward the floor of the frontal sinus. The anterior attachment of the middle turbinate was cut off from the lateral wall of the nasal cavity by use of cutting forceps. The uncinate process and the anterior ethmoid sinuses were removed with the biting

**Table 1.** Endoscopic-assisted cranionasal resection.

Patient no.	Patient sex/age, y	Kadesh stage	Operative time, h	Blood loss/transfusion, mL	Complications	Hospital stay, d	Radiotherapy/chemotherapy treatment	Site of recurrence	Last follow-up status
1	Male/72	B	5.5	500/0	Nil	13	Prior RT failure	Lung at 15 mo	Died at 18 mo
2	Female/28	A	6	1400/700	Nil	25	Nil	Nil	Alive at 72 mo
3	Male/35	A	6	600/0	Nil	12	Nil	Nil	Alive at 43 mo
4	Male/55	B	7	700/0	Nil	8	Nil	Nil	Alive at 34 mo
5	Male/47	C	6	2000/700	Nil	16	Postoperative RT	Bilateral neck at 2 mo, lung at 11 mo	Died at 18 mo
6	Female/69	A	3.5	400/0	Nil	17	Nil	Nil	Alive at 12 mo

Abbreviation: RT, radiotherapy.

forceps or debrider. The lateral attachment of the posterior ethmoid bony septa and the middle turbinate were dissected off from the orbit along their attachments on the orbital wall with cutting forceps. The area of lamina papyracea in contact with tumor was removed. The sphenoid sinus was widely opened. The entire tumor was removed en bloc by a combination of endoscopic-guided transnasal drilling of skull base from below by the ENT surgeon and from above by the neurosurgeon. The specimen was delivered from the cranial side. The resultant skull base defect was repaired by a galeal pericranial flap dissected off from the bicoronal flap. No other fascia or skin graft was used. Accurate inseting of the galeal pericranial flap was ascertained by the endoscopic view from the nasal cavity. The craniotomy skull bone was replaced and was fixed with a mini-plate. A nasal pack was inserted.

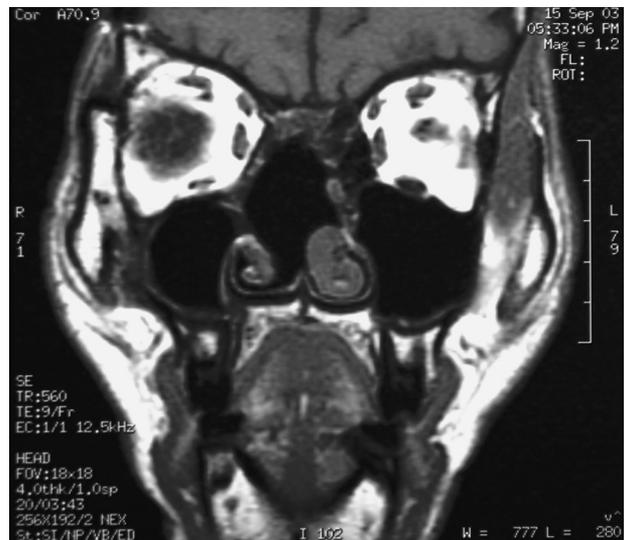
All patients were followed up in our hospital regularly. All patients had routine nasoendoscopy performed at every follow-up by the first author. All patients had postoperative CT/MRI assessment of local recurrence. The median follow-up period of surviving patients was 26 months (range, 12–72 months).

## RESULTS

The results of the six patients are summarized in Table 1. All patients were node negative at the time of operation. All six patients recovered uneventfully after the operation, with no compli-



**FIGURE 1.** Preoperative CT scan of patient 4, who had tumor involving right nasal cavity and ethmoid sinus.



**FIGURE 2.** Postoperative MR image of patient 4 obtained 3 years after the operation showing no local recurrence.

cations. The median operative time was 6 hours (range, 4–7 hours). The median blood loss was 650 mL (range, 400–2000 mL). The median duration of hospital stay was 14 days (range, 8–25 days). All six patients had complete removal of tumor grossly and clear resection margins in subsequent pathologic evaluations of the specimens. All patients with Kadash stage A and B tumors were treated by surgery alone. A patient with a Kadash C tumor was given postoperative adjuvant radiotherapy. Up to the last follow-up, no patients had local recurrences. Figure 2 shows the MR image obtained 3 years after surgery on the fourth patient. The first patient had lung metastasis develop 15 months after surgery and subsequently died at 18 months. The fifth patient had bilateral nodal metastasis develop 2 months after surgery and was treated with bilateral radical neck dissections and chemoradiotherapy; he had a lung metastasis develop, however, at 11 months after the cranionasal resection and died at 18 months. The 5-year actuarial local control rate was 100%, and the 5-year actuarial survival rate was 60%.

## DISCUSSION

Tumors over the floor of the anterior cranial fossa are conventionally removed with use of the craniofacial resection technique.<sup>2</sup> The results in this study showed that an endoscopic transnasal approach can be used to replace the lateral rhinotomy or mid-face degloving procedure of craniofacial resection. Cranionasal resection is

therefore a satisfactory alternative surgical technique that can be used safely for local control of olfactory neuroblastoma.

Cranionasal resection uses the techniques in endoscopic sinus surgery and endoscopic orbital decompression.<sup>4-6</sup> The bicoronal flap and frontal craniotomy facilitate exposure and resection of the tumor from above. The tumor can be removed from above by the neurosurgeon and from below by the ENT surgeon working simultaneously. None of our six patients had complications or local recurrences. Cranionasal resection has the advantage of avoiding facial trauma. Although the mid-face degloving approach can be used to avoid the facial scar of craniofacial resection, it is still an invasive procedure with trauma to the facial soft tissue and bony structures. Neither the lateral rhinotomy nor the mid-face degloving approach can avoid the facial trauma and the associated facial pain, swelling, risk of injuring the infraorbital nerve, and risk of minor distortion of the nose. Although there is no comparative study between cranionasal resection and craniofacial resection, all the patients in our study, especially the young female patient, were pleased with the operation without postoperative pain, swelling, numbness, and scarring on the face.

Since 1996, we have used the same endoscopic cranionasal resection technique for all anterior skull base tumors in which the skull base surgical defect can be reconstructed safely with the pericranial flap alone. The pericranial flap alone is adequate to repair the entire defect in the nasal and sinus roof. There is no need for any other fascia or skin graft to augment the repair. None of the patients had a cerebrospinal fluid leak develop. All olfactory neuroblastomas, irrespective of Kadash stage, can be treated with the same technique, as long as the skull base defect is limited to the nose and sinus roof.

We operated on two other patients during the same period using the traditional craniofacial resection mainly because of the more extensive resection to include orbital roof and eyeball. In these two patients, free flaps were necessary to repair the large skull base defect and to fill up the surgical cavity. Tumor with extensive involvement of the orbit is therefore a contraindication for endoscopic-assisted cranionasal resection, and the conventional craniofacial resection with either lateral rhinotomy or mid-face degloving approaches should be used.

The results of this study, with no local recurrences, demonstrate that cranionasal resec-

tion is an oncologically safe technique. All patients had complete removal of tumor with histologically clear resection margins. In our treatment protocol, postoperative radiotherapy was not necessary for all Kadash stage A and B tumors if the resection margin was clear. Postoperative adjuvant radiotherapy was indicated for only the patient with a Kadash stage C tumor.

Table 2 provides a summary of the literature on endoscopic transnasal resection of olfactory neuroblastomas. Devaiah et al<sup>10</sup> reported on seven patients who underwent cranionasal resection with use of a similar surgical technique; all seven patients were given postoperative radiotherapy, with one local recurrence. In view of the satisfactory local control with cranionasal resection alone for Kadash A and B tumors in our patients, we do not recommend routine postoperative radiotherapy. Postoperative radiotherapy is reserved only for patients with Kadash stage C or patients with positive resection margins.

Endoscopic transnasal resection of olfactory neuroblastoma had been reported by Liu et al,<sup>11</sup> Uger et al,<sup>12</sup> Cadmak et al,<sup>13</sup> and Casiano et al.<sup>14</sup> Twelve of the total 13 patients reported in these four articles were given postoperative radiotherapy treatment to secure local control. Transnasal resection must be a more difficult procedure than cranionasal or craniofacial resection to remove all tumor clearly and, therefore, the authors of all four of these articles recommended postoperative radiotherapy after transnasal resection. Because only one patient in these four articles was treated with transnasal resection without radiotherapy, we are not sure whether transnasal resection alone without radiotherapy is an oncologically adequate treatment option for patients with Kadash stage A and B tumors. Radiotherapy to the anterior skull base and facial region has significant morbidity. We have had patients who had frontal lobe necrosis, blindness, breaking down of facial wound, and extrusion of mini-plate develop because of external radiotherapy.

Olfactory neuroblastoma can occur in young patients, including patients in the pediatric age group. Our series included two young patients, aged 28 and 35 years old. There may also be increased risk of subsequent development of radiation-induced cancer for young patients if they are given radiotherapy. Combined transnasal resection and radiotherapy treatment of olfactory neuroblastoma is therefore not advisable, particularly in young patients. Cranionasal resection alone without radiotherapy is a better

**Table 2.** Literature review of results of endoscopic-assisted cranionasal resection and transnasal resection of olfactory neuroblastoma.

Authors, year	No. of patients	Kadesh staging	Operation	Complication	Postoperative chemotherapy/radiotherapy	Recurrence
Yuen et al. (present study)	6	3A	Cranionasal	Nil	RT for Kadesh C only	1 lung recurrence
		2B				1 neck and lung recurrences
		1C				4 no recurrence at 12–72 mo
Devaiah et al., 2003 <sup>10</sup>	7	3A	Cranionasal	1 cerebrospinal fluid leak	RT for all stages	1 local recurrence
		1B				1 neck recurrence
		3C				5 no recurrence at 24–83 mo
Liu et al., 2003 <sup>11</sup>	2	2C	Cranionasal	Nil	1 preoperative chemotherapy/RT 1 preoperative chemotherapy	2 no recurrence at 8–17 mo
		1				1B
Unger et al., 2001 <sup>12</sup>	6	3B	Transnasal	1 cerebrospinal fluid leak	Radiosurgery for all stages	6 no recurrence at 9–79 mo
		3C				
Cakmak et al., 2002 <sup>13</sup>	1	1B	Transnasal	Nil	RT for all stages	No recurrence at 24 mo
Casiano et al., 2001 <sup>14</sup>	5	1A	Transnasal	1 cerebrospinal fluid leak	RT for all stages	1 orbit recurrence
		3B				1 neck recurrence
		1 local recurrence*				3 no recurrence at 6–31 mo
				1 infraorbital nerve injury		

Abbreviations: RT, radiotherapy.

\*One patient was operated on for local recurrence after prior craniofacial resection and RT.

option than combined transnasal resection with radiotherapy for Kadesh stage A and B tumors, because it avoids unnecessary costs and morbidity associated with radiotherapy. Combined transnasal resection and radiotherapy might have an advantage for patients with Kadesh C tumors by avoiding the frontal craniectomy. Transnasal resection of Kadesh C tumor with invasion to the dura and frontal lobe, however, is a difficult procedure.

In conclusion, the results of this study suggest that cranionasal resection is a safe and oncologically adequate procedure for local control of olfactory neuroblastoma, with the advantage of avoiding facial trauma and its associated morbidity. Postoperative radiotherapy is not necessary after clear resection of Kadesh stage A and B tumors. Olfactory neuroblastoma is, however, a rare tumor, and recurrences may appear many years after primary treatment. It would be impossible to validate a treatment protocol with high level of confidence with the data from any

single center. Cranionasal resection is not a difficult surgical technique. We hope the management protocol can be adopted by more centers as an acceptable alternative surgical procedure to replace traditional craniofacial resection. It would then be possible to pool the data of publications from multiple centers for possible meta-analysis to validate the evidence in the future.

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