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Recovery of Olfactory Function after an Anterior Craniofacial Approach

ABSTRACT—We assessed recovery of olfactory function in five consecutive patients who underwent surgical resection of midline skull base tumors using an anterior craniofacial approach in which the cribriform plate was mobilized with the dura. Olfactory fuction was evaluated before and after surgery using an intravenous olfactory test with prosultiamine and also a standard olfactory acuity test. Before surgery, one patient showed anosmia attributable to obstruction of the nasal cavity and olfactory cleft, and four patients showed normal olfactory function. After surgery, one patient was irreversibly anosmic, probably because of intradural dissection of the olfactory tracts. The other four patients, including the patient showing anosmia preoperatively, reported subjective recovery of olfaction 3 to 8 weeks after surgery. Intravenous and standard olfactory acuity tests indicated recovery of olfaction to the normal range in three patients and decreased olfactory function in one. With careful preservation of the olfactory system and of the integrity of the nasal cavity, olfactory function was found to recover after skull base resections via the anterior craniofacial approach.

Wide bifrontal craniotomy with elevation of the frontal lobe above the cranial base can provide access to the deep midline region posterior to the cribriform plate.[1] Removal of the orbitofrontal bone segment further improves visualization of lesions and reduces the extent of frontal lobe retraction required.[2] In these approaches, elevation of the frontal lobe from the cranial base requires separation of the dura from the cribriform plate. Spetzler et al[3] have reported an anterior craniofacial approach aimed at preserving olfactory function, in which the cribriform plate is mobilized together with the frontal base dura mater. Although recovery of olfactory function has been reported after this maneuver, no quantitative data have been presented. This study was therefore performed using an intravenous olfactory test and a standard olfactory acuity test to examine recovery of olfaction following the cribriform plate mobilization.

METHODS

In five consecutive patients (Table 1), an intravenous prosultiamine test and a standard olfactory acuity test were performed before and after tumor resections via the anterior craniofacial approach. Patients were three women and two men, with age ranging from 17 to 43 years. Lesions treated included one chordoma, three chondrosarcomas, and one prolactin-secreting pi-

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Table 1. Characteristics of Patients and Results of Intravenous Olfactory Testing with Prosultiamine and a Standard Olfactory Acuity Test

Patient No.	*Age/ Sex*	*Diagnosis/ Removal*	*Subjective Recovery of Smell*	*Time of Examination*	*Prosultiamine Test (sec)*	*Standard Olfactory Acuity Test*	
						Mean Detection Scale	*Mean Recognition Scale*
1	43/M	chordoma/ total	6 weeks	preop	13 to 88	−0.6	2
				postop: 4 weeks	anosmia		
				6 weeks	5 to 60	1	2
2	25/M	prolactinoma/ partial	none	preop	7 to 75	1.2	2.8
				postop: 7 weeks	anosmia	anosmia	anosmia
3	20/F	chondrosarcoma/ subtotal	6 weeks	preop	10 to 85	0.6	1.4
				postop: 12 weeks	10 to 40	3.4	>5
				12 months		1.7	1.7
4	17/F	chondrosarcoma/ total	3 weeks	preop	5 to 55	anosmia	anosmia
				postop: 7 weeks	9 to 65		
				4 months		0.2	2.2
5	36/F	chondrosarcoma/ total	8 weeks	preop	10 to 60	1.2	2.2
				postop: 8 weeks	12 to 50		
				12 weeks		3	3.2

F, female; M, male; preop, preoperative; postop, postoperative.

tuitary adenoma. The tumors involved the posterior nasopharynx, posterior ethmoid sinus, sphenoid sinus, and upper portion of the clivus. The pituitary tumor had invaded the skull base, presenting with cerebrospinal fluid rhinorrhea. This lesion therefore was operated on for both tumor resection and dural repair.

In the anterior craniofacial approach, a bicoronal incision and a bifrontal craniotomy were followed by removal of frontonaso-orbital bone, including both superior orbital rims and orbital roofs. After circumferential osteotomy surrounding the cribriform plate and transection of the nasal mucosa and septum, the olfactory unit, including the cribriform plate and the olfactory mucosa, was elevated with the frontal dura. Using an epidural approach, the skull base lesion was resected. The skull base was reconstructed using either a frontalis galeal flap or a bipedicled temporoparietal galeal flap. The horizontal incision of the nasal mucosa was approximated, and a flat silicone tube was placed in each side of the nasal cavity from the nostril to the olfactory cleft to ensure patency of the nasal cavity. The cribriform plate, the frontonaso-orbital unit, and the bifrontal bone were repositioned and then affixed using wires and miniplates and microplates.[4]

In the intravenous olfactory test, 10 mg of prosultiamine, a derivative of vitamin B_1 with a strong garlic odor, was injected via a cubital vein, and intervals to the beginning and ending of reported smell perception were timed.[5,6] In normal subjects, the beginning time is around 5 to 10 seconds and the ending time is between 60 and 90 seconds. In the standard olfactory acuity test performed using a T & T olfactometer (Daiichi Yakuhin Sangyo, Tokyo), exponentially scaled concentrations of five standard preparations with odors of roses, caramel, sweat, peach, and vegetable garbage were inhaled through the nostril, and the lowest concentrations for odor detection and identification were recorded according to arbitrary detection and recognition scales.[5–7] Mean detection and recognition scores were calculated by averaging results from the five scents. A mean recognition score exceeding 2.5 on the scale is considered to represent hyposmia.

RESULTS

Table 1 summarizes patient characteristics and the results of preoperative and postoperative olfactory tests. Preoperative intravenous olfactory testing with prosultiamine showed normal detection times for four patients and a slightly shortened interval during which the odor was perceived by one. For the latter individual (patient 4), the standard olfactory acuity test showed no response, implying that anosmia largely resulted from occlusion of the olfactory cleft in the nasal cavity. In patient 2, the standard olfactory acuity test showed slightly impaired odor recognition (mean recognition score, 2.8). In the other three patients, results of the standard olfactory acuity test were normal (mean detection score, −0.6 to 1.2; mean recognition score, 1.4 to 2.8).

After surgery, four patients reported subjective recovery of smell sensation recovered between 3 and 8 weeks. In patient 2, olfactory function did not return. In other patients, subjective recovery was confirmed with the intravenous olfactory test and the standard olfactory acuity test. The intravenous prosultiamine test showed normal detection times in patients 1 and 4 and a short interval of perception in patients 3 and 5. The standard olfactory acuity test revealed normal thresholds for detecting and recognizing odors in patient 1 and 4 and increased thresholds in patient 3 and 5. In patient 3, follow-up examination at 12 months revealed further recovery of olfactory function, with results in the normal range.

ILLUSTRATIVE CASES

Patient 1

A 43-year-old man presented with a 2-month history of right oculomotor palsy. Computed tomography (CT) and magnetic resonance imaging (MRI) demonstrated a tumor in the posterior ethmoid and sphenoid sinuses that was compressing both cavernous sinuses and the pituitary gland (Fig. 1, A and B). The intravenous olfactory and standard olfactory acuity tests showed normal olfactory function (Table 1). The tumor was totally removed using an anterior craniofacial approach (Fig. 1C). The pathological diagnosis was chordoma.

Postoperatively, the right oculomotor palsy resolved. Olfactory function did not recover subjectively until 6 weeks after surgery. An intravenous olfactory test performed 4 weeks after surgery did not show recovery of olfaction. At 6 weeks, when subjective recovery was reported, the two quantitative olfactory tests confirmed functional olfactory recovery (Table 1, Fig. 2).

Patient 4

A 17-year-old woman was admitted with a 16-month history of nasal obstruction and anosmia but with no other neurological deficits. CT and MRI revealed a large tumor involving the nasal cavity, the posterior ethmoid and sphenoid sinuses, and the clivus (Fig. 3, A and B). The intravenous prosultiamine test showed a slightly shortened interval of perception, and the standard olfactory acuity test showed complete anosmia (Table 1). The tumor was totally resected using an anterior craniofacial approach (Fig. 3C). The pathological diagnosis was chondrosarcoma.

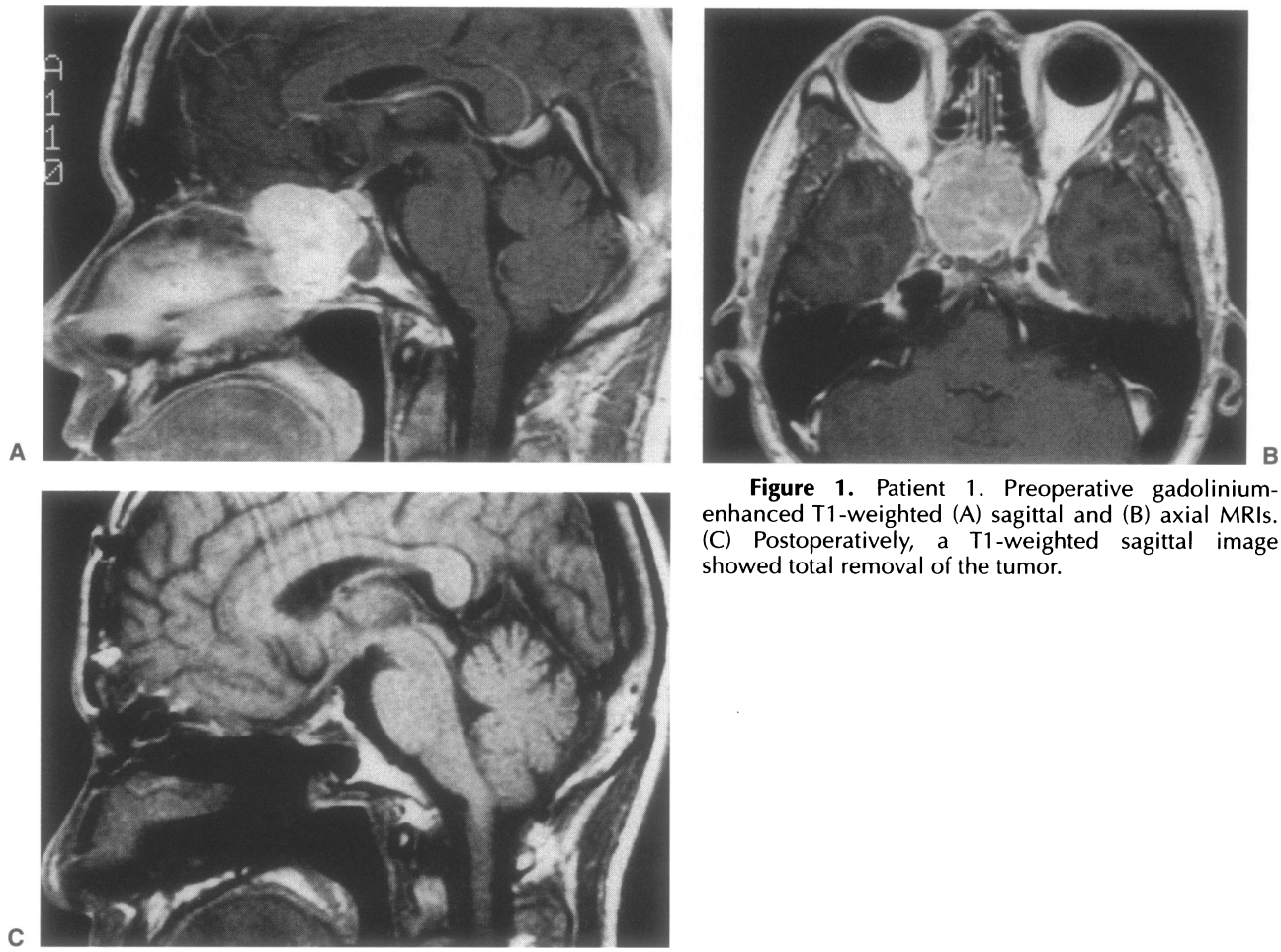

Figure 1. Patient 1. Preoperative gadolinium-enhanced T1-weighted (A) sagittal and (B) axial MRIs. (C) Postoperatively, a T1-weighted sagittal image showed total removal of the tumor.

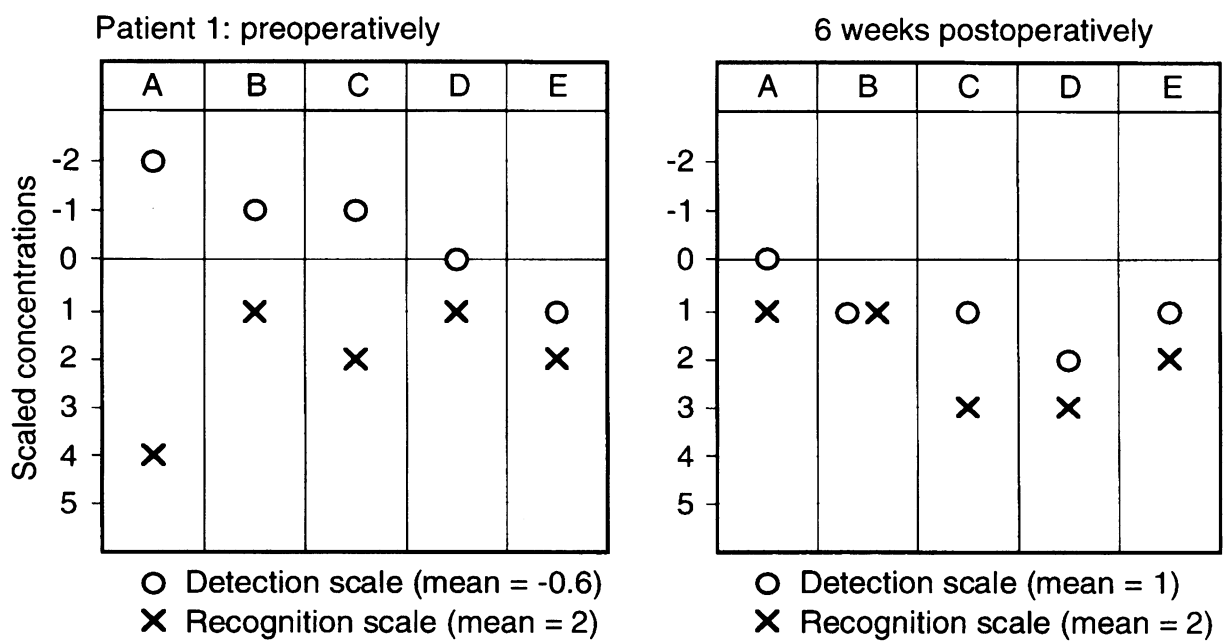

Figure 2. Patient 1. Both before and 6 weeks after surgery, the standard olfactory acuity test showed preservation of olfactory function.

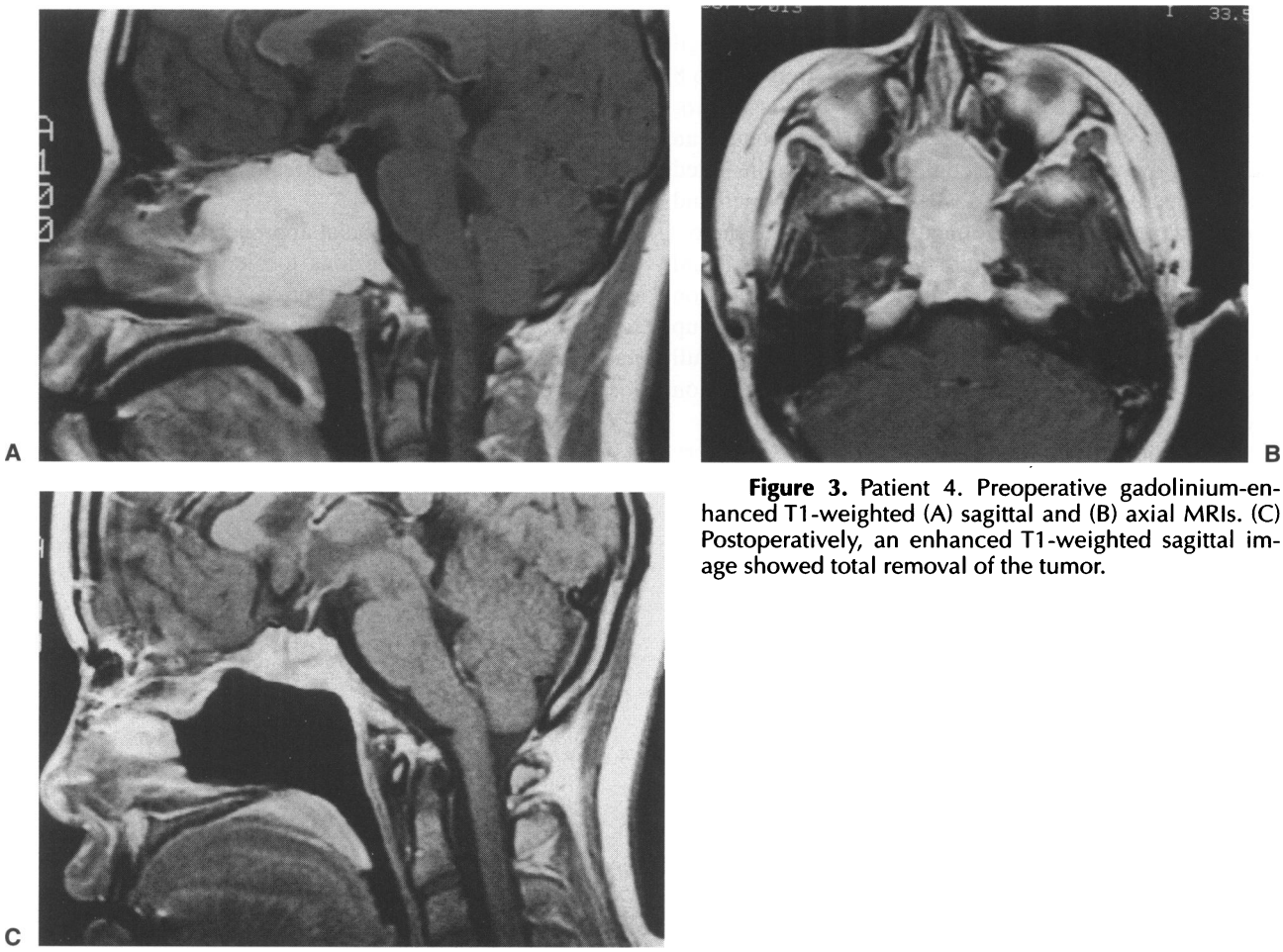

Figure 3. Patient 4. Preoperative gadolinium-enhanced T1-weighted (A) sagittal and (B) axial MRIs. (C) Postoperatively, an enhanced T1-weighted sagittal image showed total removal of the tumor.

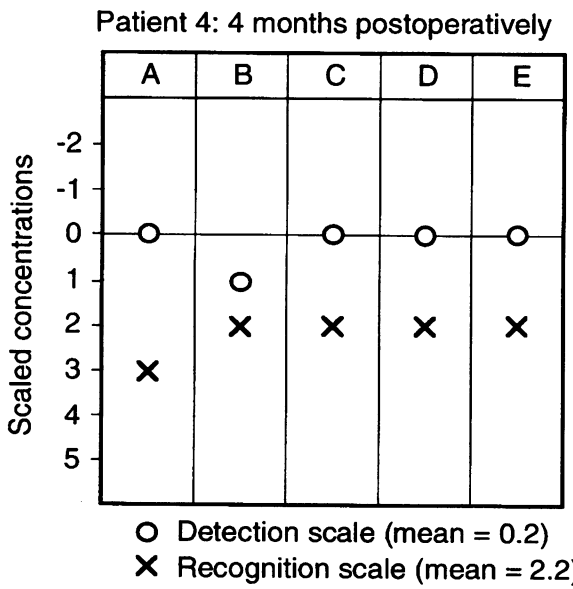

Figure 4. Patient 4. The standard olfactory acuity test 4 months after surgery showed recovery of olfactory function.

The postoperative course was uneventful. Subjective olfactory function was recovered 3 weeks after surgery. Intravenous olfactory and standard olfactory acuity tests also demonstrated normal olfactory function (Table 1, Fig. 4).

DISCUSSION

The anterior craniofacial approach provides wide and close access to an extensive area of the midline skull base from the planum sphenoidale to the clivus, extending laterally to the cavernous sinus and the medial portion of the middle cranial base.[3,4,8] Spetzler et al[3] have described four patients showing recovery of olfaction between 2 to 8 weeks after surgery as tested with coffee, perfume, tobacco, and orange juice. In this article, we have demonstrated recovery of olfactory function using two quantitative methods, an intravenous olfactory test with prosultiamine and a standard olfactory acuity test.

Olfactory function was preserved in our patients except for one. All patients, however, reported loss of smell sensation during the early postoperative period of 3 to 8 weeks. In patient 1, intravenous administration of prosultiamine 4 weeks after the surgery did not produce an olfactory sensation, which could not be demonstrated until subjective recovery at 6 weeks. Return of smell and functional recovery of the olfactory mucosa and the olfactory nerves seems to require weeks. In patients 3 and 5, quantitative tests showed decreased olfactory function at 8 to 12 weeks after surgery. Notably, that follow-up examination 1 year after surgery in patient 3 showed full recovery by the standard olfactory acuity test. Olfaction therefore may recover over several months.

To conserve olfactory function, the olfactory nerves and tracts should be preserved. Additionally, preservation of the olfactory mucosa, the patency of the nasal cavity and olfactory cleft, and the blood supply to the olfactory system (olfactory mucosa, olfactory nerve, and olfactory tract) is essential.[9] To prevent damage to the olfactory mucosa while transecting the nasal cavity, the nasal mucosa and septum should be incised 5 to 10 mm inferior to the cribriform plate. To keep the nasal cavity and olfactory cleft open, we approximated the horizontal incision of the nasal mucosa and placed a flat silicone tube in each side of the nasal cavity from the nostril to the olfactory cleft. The silicone tube prevents displacement of the nasal mucosa that results in closure of the olfactory cleft.[4]

In patient 2, we dissected the olfactory tracts to remove the intradural portion of the tumor, resulting in postoperative anosmia. Dissection of the olfactory tract alone does not necessarily damage olfactory function; such dissection is a standard procedure in a bifrontal interhemispheric approach, which can be performed without anosmia.[10] The olfactory system is supplied by the anterior and posterior ethmoid arteries and the anterior cerebral artery; these arteries anastomose in the area of the cribriform plate.[9,11] Because we compromised the anterior and posterior ethmoid arteries in the anterior craniofacial approach, postoperative anosmia in patient 2 probably resulted from sacrificing the blood supply from the anterior cerebral artery during dissection of the olfactory tracts. In the anterior craniofacial approach, intradural dissection of the olfactory tracts should be avoided if possible.

The anterior craniofacial approach is an indispensable route to epidural lesions located posterior to the cribriform plate. With careful preservation of the olfactory system, its blood supply and the integrity of the nasal cavity, skull base resection using the anterior craniofacial approach is able to preserve olfactory function.

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