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Clinical Article

Endoscopic Surgery for Pituitary Tumor

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Objective : The purpose of this study is to assess the efficacy and advantages of an endoscopic endonasal approach for the treatment of pituitary tumors.

Methods : We retrospectively analyzed the records of 31 patients with pituitary tumors having endoscopic endonasal surgery between March 1999 and August 2003.

Results : Among 31 patients with pituitary adenomas, 25 (81%) patients exhibited gross total removal of tumor on postoperative MRI within 3 days after surgery. Among 6 patients removed subtotally, 2 had only radiosurgery, 3 have had periodic follow-up MRIs and one patient with large extended tumor (grade IV, Stage E) had secondary transcranial removal of tumor before radiosurgery. Postoperative complications included cerebrospinal fluid leak in 2 patients, sinusitis in 1 patient, and one patient died due to unexpected intracerebral hemorrhage on 5 days after surgery. Besides considerable experiences with this approach are needed because of narrow working channel to the sella turcica, the results of our study showed following advantages of this procedure : visualization of areas not seen with the operating microscope, elimination of oronasal complications, more functional and cosmetic outcome, and shortened operative time and hospital stay.

Conclusion : The authors consider that endoscopic endonasal transsphenoidal approach provides good results with minimal invasion for patients with pituitary tumors.

KEY WORDS : Endoscopic · Endonasa · Pituitary tumors · Minimal invasion.

Introduction

Since trans-sphenoidal approaches were developed in early 1900s by Cushing, Hardy's operation with microscope has been the most popular standard method for pituitary adenoma. However, recent advances in endoscopic surgery have developed an endonasal route suitable for pituitary surgery. In fact, some authors have reported the advantages of using an endoscope in pitutary surgery which include the lower morbidity and panoramic view of the surgical field[3,6,7,10]. We also have used the endoscopic endonasal transsphenoidal approach(EETA) for the removal of pituitary adenomas on 31 patients. To evaluate the efficacy and limitations of this approach to the sellar region, we retrospectively analyzed the records of 31 patients with pituitary adenomas approached endoscopically.

Materials and Methods

Patients population (Table 1)

Between March 1999 and August 2003, 31 consecutive patients with pituitary tumors underwent endoscopic endonasal transsphenoidal surgery in our institution. In all patients, preoperative evaluations including magnetic resonance(MR) imaging of the brain and sellae, a computed tomographic(CT) scan of the sellae and paranasal sinuses were performed. We classified 31 pitutary adenomas according to the classification of Hardy[4] and the amount of sellar involvement (Grade I-IV) and the extrasellar extension (Stage A-E) were assessed by radiological and intraoperative findings. Postoperative sellar MR images were obtained from all patients within 72 hours of operation and we evaluated the extent of resection of tumor according to the preoperative tumor extension and destruction of sellar floor.

Operative technique

The surgical procedure is performed under general endotracheal anesthesia with the patient supine. The head is cradled in a horseshoe head-holder and elevated 20 degree. Three-pin head fixation system and fluoroscopic C-arm are not routinely used. The operation was carried out through one nostril, chosen on the basis of the radiologic findings. The choice between the left or right nostril is determined upon anatomical or pathologic reasons, ie., a septal deviation or nasal polyps. If the tumor is located left we tend to go through the right nostril or vice versa, because of the oblique trajectory of the endoscope. We use rod-lens rigid endoscope that are 18cm in length, 4mm in diameter

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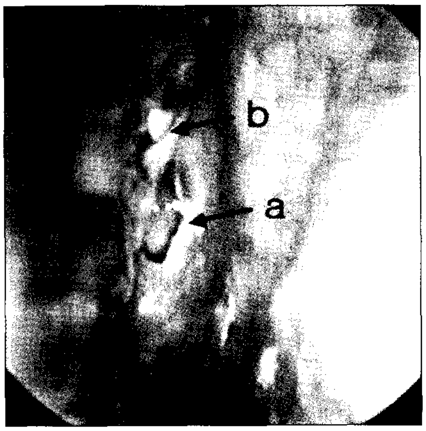

Fig. 1. Sphenoidal ostium (a) is visualized between superior turbinate (b) and nasal septum.

with 0-degree and 30-degree angled lenses connected to the three-chip camera system and light source (Karl Storz, Germany). The nasal procedure is performed with an endoscope held in one hand and a surgical instrument in the other hand. When a 0-degree endoscope is inserted into the nasal vestibule, nasal septum and middle turbinate are visualized. A paraseptal surgical corridor is expanded with insertion of several 10 × 50mm sized H_2O_2 soaked cotton patties between the middle turbinate and nasal septum. If the middle turbinate is gently moved away from the nasal septum, enough surgical space can be secured. Following the inferior margin of the middle turbinate, the endocope is advanced posteriorly and superiorly between the middle turbinate and the nasal septum until the anterior aspect of the superior turbinate is identified. The superior turbinate is gently compressed laterally until the sphenoidal ostium is identified just medial to the superior turbinate (Fig. 1). When the sphenoidal ostium is entirely ossified, we could find it using fluoroscopic C-arm and following anatomical parameters of nose ; in Korean, the mean distance between the nasal sill and the sphenoidal ostium is 63mm, and the mean angle between the line connecting nasal sill and the sphenoidal ostium and the horizontal line containing the nasal sill is 34 degree[11]. The mucosa at the sphenoidal ostium coagulated and divided using suction-monopolar-coagulator (bovie-suction) and small curette. The exposed bony ostium is widened in a medial and inferior direction to allow the insertion of up- and down-biting 1mm Kerrison rongeurs. Once the ipsilateral ostium of sphenoid has been removed, the sphenoid sinus is inspected with 0° and 30° endoscopes to identify several surgical landmarks, including the carotid protuberance (vertical and horizontal portion), optic eminence, caroticooptic recess, and clival indentation (Fig. 6A). The nasal septum and vomer are detached from the anterior wall of sphenoid sinus with septal breaker. The nasal septum is pushed contralaterally, and submucosal dissection is carried out at the contralateral sphenoidal ostium. Inferiorly, the vomer is sufficiently removed in order to handle the surgical instruments without struggling. After the

Table 1. Summary of 31 patients operated via endoscopic endonasal transsphenoidal route

Case	A/S	Types of adenoma	Tumor extension	Sella floor destruction	Large stØ (mm)	Postop. MRI (<72h)	Postop. Cx.	Op. time (mins.)	Hospital stay (days)
1	47/F	NFMA	A	I	30	NR	none	205	14
2	41/M	NFMA	B	II	35	R	none	185	12
3	52/F	ACTH	A	I	28	NR	none	175	25
4	24/M	NFMA	B	III	32	NR	none	230	10
5	42/F	Prolac.	A	II	13	NR	none	190	12
6	63/M	NFMA	B	III	15	NR	none	135	10
7	26/M	NFMA	B	III	32	NR	none	165	10
8	66/F	NFMA	C	IV	35	R	CSF	170	10
9	42/M	GH	A	I	8	NR	sinusitis	180	9
10	36/F	Prolac.	D	III	39	R	none	290	11
11	23/M	NFMA	B	II	28	NR	none	265	12
12	40/M	GH	B	II	32	NR	ICH	310	Died
13	46/M	NFMA	B	III	32	NR	none	240	11
14	49/M	NFMA	C	III	35	R	none	265	5
15	28/F	Prolac.	A	I	12	NR	none	100	8
16	43/M	NFMA	B	III	27	NR	none	140	7
17	67/F	NFMA	D	II	35	NR	none	140	23
18	39/F	Prolac.	B	III	25	NR	none	215	10
19	40/F	NFMA	E	IV	38	R	CSF	250	24
20	28/F	Prolac.	B	I	12	NR	none	145	9
21	34/F	Prolac.	A	I	10	NR	none	125	12
22	24/M	NFMA	E	IV	53	R	none	160	8
23	62/F	ACTH	B	II	30	NR	none	170	27
24	35/F	Prolac.	A	III	33	NR	none	130	5
25	28/F	Prolac.	A	II	15	NR	none	160	8
26	30/F	Prolac.	A	I	15	NR	none	90	9
27	60/F	NFMA	E	II	45	NR	none	175	17
28	40/F	Prolac.	A	I	10	NR	none	80	10
29	78/M	NFMA	C	III	37	NR	none	120	26
30	26/F	Prolac.	B	II	20	NR	none	100	7
31	26/M	NFMA	B	II	25	NR	none	85	5

A/S : age/sex, ϕ : diameter, Cx. : complication, NFMA : non-functioning macroadenoma, NR : no residual tumor, R : residual tumor, ACTH : adrenocorticotropic hormone secreting adenoma, Prolac. : prolactinoma, GH : growth hormone secreting adenoma

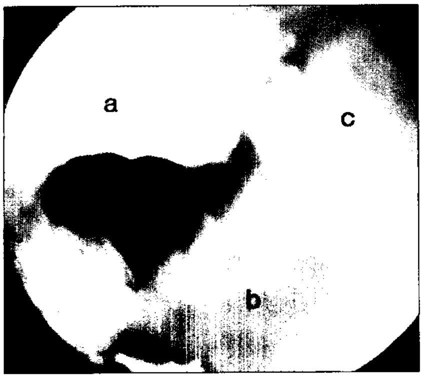

Fig. 2. Remnant tumor (a) and Normal pituitary tissue (b) are visualized under the dura mater (c).

Fig. 3. The anterior wall of the sella is reconstructed with a properly designed sheet of Teflon felt.

sphenoidal sinus cavity is exposed, the sphenoidal septum and sinus mucosa are removed using pitutary rongeur. The carotid and optic nerve impressions are identified, and sellar outline is determined. The floor of the sella is opened with a small curette, or if thick, a thin osteotome or high-speed drill is required. A bovie-suction is used to coagulate the dura. The dura is opened in a cruciate fashion with bayonet blade. Occasionally we encountered massive bleeding from adjacent venous sinuses, but simple compression on the dura using H_2O_2 or epinephrine soaked cotton patties for about 2 to 5 minutes was very helpful to control the bleeding from venous sinuses. The tumor is removed using ring curettes, suction, and pituitary rongeurs. Once the majority of the tumor has been removed, the endoscope is advanced into the sella for direct inspection (Fig. 2). Additional tumor is often visible along the lateral aspects of the sella and superiorly, and is removed under endoscopic vision. Only in cases when cerebrospinal fluid is seen during surgery, we packed sella and sphenoid sinus with abdominal fat, and fibrin glue. In most cases, there is no available bony fragments for sellar reconstruction, the anterior wall of sella was reconstructed with properly designed Teflon felt (Boston Scientific Meditech., USA) inserted between exposed dura and sellar floor (Fig. 3). Patients are observed in general ward and had a normal meal in the next morning. In most cases, patients were recommended to discharge on postoperative day 3.

Results

Among the 31 patients, 13 were male (42%) and 18 were female (58%). Average age of the patients population was 41 years, ranging from 22 to 78 years. The histological diagnoses included 31 pituitary adenomas, comprising 16 non-functioning adenomas (52%), 11 prolactinomas (35%), 2 Cushing's disease and 2 acromrgaly (6%) (Table 1). According to the amount of sellar involvement by the tumor, Grade I (focal bulging) was 8, Grade II (diffuse bulging) was 10, Grade III (focal destruction) was 10, and Grade IV (diffuse destruction) was 3 patients. And according to the extrasellar extension of the tumor, Stage A (up to suprasellar cistern) was 10, Stage B (up to third ven-tricular recess) was 13, Stage C (to entire third ventricle) was 3, Stage D (laterally extended but intradural) was 2, and Stage E (laterally extended and extradural) was 3 patients.

Fig. 4. Pre-operative (A, B) and post-operative (C, D) magnetic resonance image findings (MRI). The MRI study on the 3 days after surgery (C, D) showed the complete removal of the tumor.

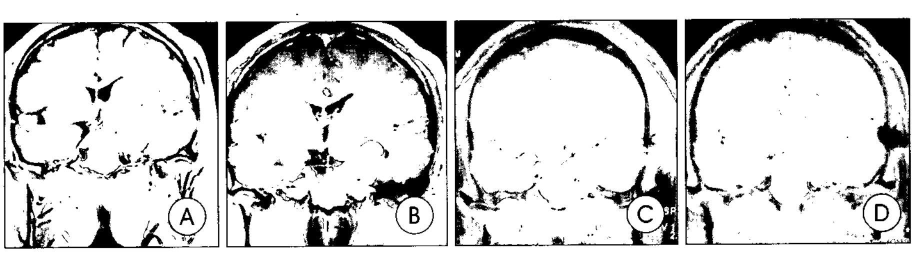

Fig. 5. A 27-year-old-man patient with extensively extended tumor on preoperative magnetic resonance image (A). B : Three days after endoscopic tumor removal, C : Two days after transcranial tumor removal, D : Six months after Gamma-knife radiosurgery.

All patients classified Grade I and Stage A exhibited gross total removal of tumor on postoperative MR imaging within 3 days after surgery (Fig. 4). In cases of Grade II Grade III and stage B, proportion of total removal was higher than 80%, but lower than 50% in Grade IV and Stage C, D, E, and only 33% in Stage C, E (Table 2). In 25 out of the 31 patients (81%) with pitutary adenomas, tumors could be removed totally (Fig. 4). They did not show recurrences at 6 and 12

Table 2. Extent of Tumor removal(Non-residual) according to Preoperative Grade and Stage of 31 cases

		No. of cases (N=31)	Postoperative MRI(<72h)		Non-residual(%)
			Non-residual	Residual	
Grade	I	8	8	0	100
	II	10	9	1	90
	III	10	8	2	80
	IV	3	0	3	0
Stage	A	10	10	0	100
	B	13	12	1	92
	C	3	1	2	33
	D	2	1	1	50
	E	3	1	2	33

months after operation. Among 6 patients (19%) removed subtotally, 2 had only radiosurgery, 3 have had periodic follow-up MRI and one patient with large extended tumor (Grade IV, Stage E) had secondary transcranial removal of tumor before radiosurgery (Fig. 5).

Postoperative complications included cerebrospinal fluid leak in 2 patients and sinusitis in 1 patient and one patient died (10 days after surgery) due to unexpected intracerebral hemorrhage on postoperative day 5 (Table 1).

Discussion

In our technique, all procedures are performed under endoscopic visualization with no use of microscope. Therefore, our technique requires no use of a sphenoid retractor or speculum. The use of these instruments limits operating space. Some authors recently reported trans-sphenoidal pituitary surgeries using only an endoscope[6,12]. But other authors demonstrated that the endoscope should be used in conjunction with operating microscope[1,2,5,13]. They mentioned that the operating microscope permitted binocular vision and bimanual technique. With increased experiences and the of aid of three-chip camera system which provides high-definition three dimensional view, we were gradually able to perform TSA using only an endoscope.

Some surgeons used both nostrils for EETA[12], but the surgery was done through only one nostril with no particular difficulty in our institution. We believe that one-nostril technique is less invasive, more comfortable for patient and more helpful to prevent various postoperative infections.

At the beginning of our experience with this technique, we performed all procedures of EETA without help of rhinologist because we believed that combined surgery between endoscopic rhinologist and neurosurgeon might be time consuming. We experienced a case of sinusitis postoperatively because we were not familiar with the sinonasal anatomy and overlooked that the middle turbinate is vital to sinonasal function. Once EETA is completed, the middle turbinate which was laterally displaced during the surgery must be placed back in its normal position so that maxillary sinus ostium kept patent after operation. Therefore, we consider that close communication with endoscopic rhinologist is essential in pre- or post-operative period. Intraoperatively, continuous bleeding from nasal mucosa led to difficulties in this procedure. The meticulous electro- coagulation of mucosal bleeding is essential part of this procedure in order to make it easy and clean. Futhermore, the use of a lens-cleaning irrigation system is helpful to eliminate impaired visualization due to bleeding. Actually, we used self-designed suction-irrigation device which was simple and useful for lens-cleaning in nasal cavity.

Jho et al. mentioned no foreign material is laid in the sphenoidal sinus or nasal cavity postoperatively[6]. But we packed nasal tampons soaked with antibiotic oint between nasal septum and middle turbinate and laterally to the middle turbinate for 1 day after surgery. We considered it is more helpful for preventing nasal bleeding and postoperative infection.

The EETA to the pitutary area is so minimally invasive that there is no available cartilaginous or bony fragments to be used to close the sellar floor window. So we used a sheet of Teflon felt which can be fashioned with scissors and cut to a size a little larger than that of the bone window. It is so flexible that it can be inserted in a bent-fashion and handled easily within the narrow surgical space.

Base on our experiences and other literatures, the advantages of EETA are as follows : excellent visualization of areas not seen with operating microscope (Fig. 6B), eliminations of oronasal complications, more functional and cosmetic outcome, shortened operative time and hospital stay, suitable for staged operation[9].

Smaller diameter working channel and off-center approach are the limitation of EETA. Early in our series, we experienced massive bleeding from the cavernous sinus which might be

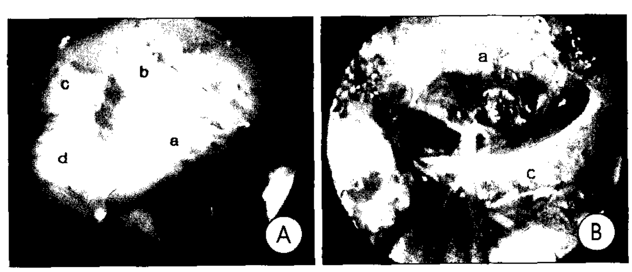

Fig. 6. A : Endoscopic view demonstrates anterior wall of sella (a), tuberculum sella (b), bony protuberance covering optic nerve (c), the cavernous sinus (d), carotid artery (e), and the clival indentation (f). B : Intrasellar endoscopic view demonstrates optic chiasm (a), pituitary stalk(b) and normal pituitary gland(c) after tumor removal.

penetrated because of the off-center approach. At first, it was a big problem to control the sinus bleeding using bipolar coagulator with one hand because of the narrow working space. Later, the bleeding from cavernous sinus was controlled using a suction- monopolar-coagulator (bovie -suction) or by simple compression with H_2O_2 or epinephrine soaked cotton patties. Also the endoscope-holding device (one-button controlled pneumatic powered holder) is helpful for surgeon to allow bimanual technique. But we did not use it routinely because a conflict between various instruments and the fixed endoscope frequently occurred. And we considered that it is essential to perform a sufficient bony removal of vomer and a wide sphenoidotomy to allow adequate manipulation of surgical instruments through the small nasal cavity.

Another limitation of EETA is the difficulty in removing tumor extending laterally. We were able to remove less than half of the tumor mass in 1 patient. In that case, the tumor mass was excessively extended superiorly and laterally up to the intracranial area and so firm in consistency. And he underwent secondary transcranial removal of tumor before radiosurgery[8]. Some authors reported a staged endoscopic trans-sphenoidal operation for removal of large pitutary adenomas[9]. But we considered that additional treatment modalities such as conventional radiotherapy or radiosurgery should be needed in a patient with laterally extended solid tumor with the invasion of cavernous sinus.

Conclusion

Endoscopic pituitary surgery is a major advance in minimally invasive neurosurgery. The EETA to the pitutary tumor has several limitations. But we believe that it could be overcome with increased experiences of this technique and developing surgical instruments. The author consider that the EETA provides good results with minimal invasion for patients with pitutary tumors.

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