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Endonasal Endoscopic Transsphenoidal Approach to Lesions of the Sellar Region in Pediatric Patients

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Objective: Endoscopic endonasal (transnasal) transsphenoidal approach (EETA) for management of sellar lesions has gained popularity as a reliable and atraumatic method. Most reported studies of EETA have focused on surgical outcome in adult patients; and there are few reports to describe outcome in pediatric patients. The authors report our early experience of 11 patients aged 14 to 18 years managed with EETA to evaluate the safety and effectiveness of EETA in the pediatric.

Methods: Retrospective review of hospital records of 11 pediatric patients who underwent endonasal endoscopic transsphenoidal approach for resection of sellar region lesion over 2 years. Age, sex, symptoms, tumor size, extent of tumor resection, clinical outcome, and surgical complications were reviewed.

Results: Total resection was achieved in 9 (81.8%) patients, subtotal resection in 2 (18.2%), and no patient had partial or insufficient resection. All (100%) patients achieved visual remission, 7 (87.5%) of 8 patients with hyperhormone preoperative had endocrinological remission. Two (18.2%) patients incurred temporary diabetes insipidus (DI) postoperatively. One (9.1%) patient incurred postoperative cerebrospinal fluid (CSF) leakage which resolved following lumbar drainage. Three (27.3%) patients developed hypopituitarism needed hormone replacement therapy. There were no cases of meningitis, intracranial hematoma, or death.

Conclusions: Endoscopic endonasal (transnasal) transsphenoidal approach (EETA) provides a safe and effective surgical option with low morbidity and mortality in pediatric patients.

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Since Apuzzo et al[1] reported their experience with an angled endoscope for transsphenoidal surgery in 1977; endoscopic endonasal (transnasal) transsphenoidal approach (EETA) has become a mainstay for management of tumors of the sellar region in many centers. Global experience of surgical resection of lesions of the sellar region via endoscopy or endoscopy combined with microscopy has been reported, and most reports describe only adults. There is a paucity of information about outcomes and complications of EETA in adolescence patients. We report our early experience of tumor resection in the sellar region lesion using purely EETA.

MATERIALS AND METHODS

Experimental Design

We retrospectively reviewed hospital records of 214 patients admitted to Qilu Hospital of Shandong University; and who underwent endonasal endoscopic transsphenoidal resection between January 2012 and December 2013. Eleven pediatric patients aged ≤18 years at the time of diagnosis were identified. Records were reviewed for age, sex, symptoms, tumor size, extent of tumor resection, clinical outcome, and surgical complications. Patients who underwent a bifrontal transbasal approach or a craniotomy assisted by the endoscopic endonasal transsphenoidal approach were excluded. The protocol for this study was reviewed and approved by the Ethics Committee of Qilu Hospital of Shandong University (No. KYLL-2013-010).

Surgical Technique

Magnetic resonance imaging (MRI) imaging was obtained preoperatively to make presurgical plan in all patients (Fig. 1). Each patient received prophylaxis with third-generation cephalosporin intraoperatively. Under general anesthesia with orotracheal intubation the patient was placed supine with slight rotation of the head toward the right shoulder for comfortable surgical access. We did not routinely use Mayfield–Kees rigid 3-pin skeletal head fixation unless neuronavigation was needed. Usually the right lateral thigh was prepared for harvest of fascia lata, fat or muscle to repair skull base as needed. The nasal mucous membranes were decongested with injection of 1% lidocaine with epinephrine (1:100,000 dilution).

The procedure was performed with a 0° endoscope, 4 mm in diameter and 18 cm in length. The endoscope was routinely inserted into the right nostril. The middle turbinate was located and pushed laterally to gain more surgical room, and then the endoscope was angled upwards about 1.5 cm to reach the sphenoid opening—a key anatomic landmark. The posterior nasal septum was dissected and the anterior wall of the sphenoid sinus was opened widely—exceeding

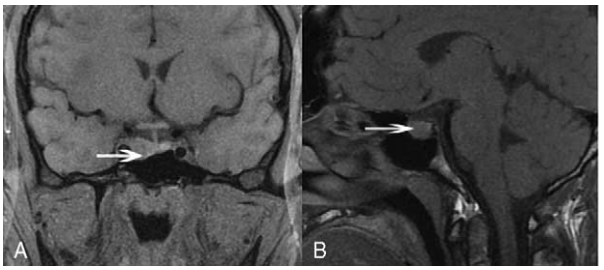

FIGURE 1. Findings of MR imaging preoperatively. Sagittal (A) and coronal (B) T1-weighted MR imaging of a 17-year-old man presented with gigantism and severe headache, the imaging shows tumor extending into the right cavernous sinus.

the sphenoid opening. After removal of sphenoid sinus septations the sellar floor was opened (Fig. 2) with a high-speed microdrill.

After cruciate dural opening tumor in sella turcica was removed with a curette or with suction. Suprasellar tumor often dropped down into view due to cerebrospinal fluid (CSF) pulsations and was removed easily. After resection of the central portion of the tumor with the 0° endoscope, a 30° endoscope was used to detect and to remove residual tumor. The surgical cavity was filled with Gelfoam®. If an intraoperative CSF leak was confirmed or suspected, an autologous fat or fascia lata graft was placed within the dural defect as an inlay graft, and a synthetic dural graft was applied as an overlay graft. Fibrin glue was applied over the synthetic dura. Then the sphenoid sinus was filled with Gelfoam and the nasal cavity was packed with pledgets.

Postoperative Management

The third-generation cephalosporin was continued for 3 to 7 days. Fluid intake and urine output were monitored. Hormone replacement therapy was applied in cases of postoperative hormone insufficiency. Magnetic resonance imaging (MRI) of the sella was performed postoperatively within 1 to 3 days, and at 3 months and more (Fig. 3) to evaluate the extent of tumor resection.[2] Nasal packing was generally removed endoscopically within 1 to 3 days after surgery. Patients were instructed to rest with their head elevated about 15°, and to avoid any activity that might raise intracranial pressure such as straining or nose blowing. Lumbar drainage was used for one patient who had CSF leakage postoperatively for more than 3 days. Early postoperative diabetes insipidus (DI) was treated with subcutaneous injection of Hypophysin for 3 days. Persistent DI was treated with daily administration of Minirin (desmopressin). We do not use controlled released vasopressin tannate because its effects may be difficult to control; and because it is inconvenient method of treatment of patients.

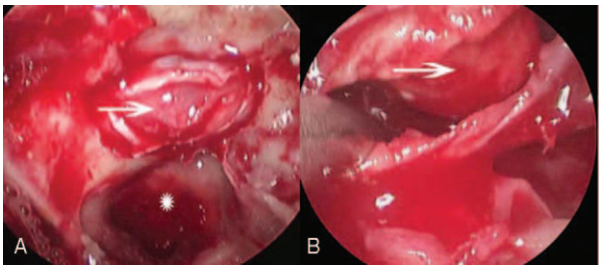

FIGURE 2. Endoscopic views. Intraoperative endoscopic views showed sphenoid sinus was pneumatized completely (asterisk) and tumor was explored with gray color (arrowhead) (A), and the tumor was removed completely and sellar diaphragm dropped down (arrowhead) (B).

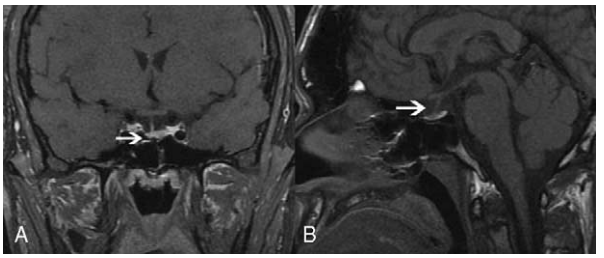

FIGURE 3. Postoperative MR imaging on the latest follow-up. Coronal (A) and sagittal (B) enhanced T1-weighted MR imaging showed no residual or recurrence of the tumor (arrowhead) during the following up period of 1 year.

RESULTS

Cohort consisted of 7 (63.6%) males and 4 (36.4%) females aged 14 to 18 years (mean 15.1 years). Period of follow-up ranged from 4 to 27 months (mean 13.2 months). The most common initial complaints were deterioration of vision (7/11, 63.6%) and headache (5/11, 45.5%), followed by premature development (4/11, 36.3%), and by amenorrhea and galactorrhea (3/11, 27.3%). Of the 11 patients 8 had macroadenomas and 3 had microadenomas (Table 1).

Total resection (TR) was achieved in 9 (81.8%) patients, subtotal resection in 2 (18.2%) patients, and no patient had partial or insufficient resection. All (100%) patients achieved visual remission, 7 (87.5%) of 8 patients with hyperhormone preoperative had endocrinological remission. Three (27.3%) patients developed hypopituitarism which required hormone replacement. Two (18.2%) patients developed temporary DI postoperatively. No patients developed permanent DI. One patient incurred postoperative CSF leakage which resolved after lumbar drainage. There were no cases of meningitis, intracranial hematoma, or death (Table 2).

DISCUSSION

The origin of transsphenoidal surgery extends back 5000 years to Egypt. During the mummification process ancient Egyptians extracted the brain through the nose with dedicated tools that traversed the skull base through a sphenoethmoidal breach.[3,4] In the early 1900s, based on Davide Giordano's anatomic study of sella turcica,[5] Schloffer[6] made the first superior nasal transsphenoidal approach to remove a pituitary tumor. Then Halstead[7] from Chicago described a sublabial transsphenoidal approach to sellar region. It was not until the late 1970s, after Apuzzo et al[1] reported the first use of endoscopy in the microscopic transsphenoidal approach for resection of pituitary tumor, which endoscopic transsphenoidal approach began to be adopted by neurosurgeons. In 1992, Jankowski et al[8] reported a series using a pure endoscopic transsphenoidal approach to resect sellar tumors. Increasingly neurosurgeons have applied endoscopic techniques for resection of sellar lesions in the last 2 decades. Most prior studies of endoscopic transsphenoidal approach focused on adults, and little information exists regarding endoscopic resection of lesions of the sellar region in pediatric patients. Reasons for the paucity of published experience with endoscopic approaches to lesions of the sellar region in pediatric patients might include:

1 Tumors of the sellar region in pediatric patients are primarily craniopharyngiomas and pituitary adenomas are relatively infrequent.[9]
2 Anatomic features of the piriform aperture and of the sphenoid sinus in pediatric patients restrict surgical indications for endoscopy. Tatreau et al[10] demonstrated in a radio-anatomic cross-sectional survey of pediatric patients that the width of the piriform aperture in patients under 7 years of age was

TABLE 1. Clinical Characteristics of 11 Pediatric Patients

Case	Age	Sex	Presenting Symptoms	Tumor Type	Pathological Type
1	18	M	Deterioration of vision, dizziness	Mic	RCC
2	16	M	Cushing disease, cephalgia	Mic	ACTH
3	16	M	Polydipsia, polyuria, hyperglycemia	Mac	Germ cell tumor
4	16	F	Amenorrhea, galactorrhea, deterioration of vision	Mac	PRL
5	15	F	Amenorrhea, galactorrhea, deterioration of vision	Mac	PRL
6	15	F	Amenorrhea, galactorrhea, cephalgia	Mic	PRL
7	15	M	Developing fast at age, deterioration of vision, cephalgia	Mac	GH, PA
8	14	M	Developing fast at age, deterioration of vision	Mac	GH
9	14	M	Recurrent pituitary adenoma, deterioration of vision	Mac	GH
10	14	M	Cephalgia, developing fast at age	Mac	GH
11	14	F	Cephalgia, deterioration of vision	Mac	Hypophysitis

ACTH, adrenocorticotropic hormone; GH, growth hormone; Mac, macroadenoma; Mic, microadenoma; PA, pituitary apoplexy; PRL, prolactin; RCC, Rathke cleft cyst.

significantly smaller than that in adults. Also pneumatization of the sphenoid sinus is not complete until 10 years of age. Therefore, endonasal endoscopic approach may be generally excluded in patients younger than 7 years.

3 The age that is applied to define "pediatric" has been reported inconsistently with the upper age limit varying from 16 to 20 years.[11] Therefore, the incidence of lesions of the sellar region ascribed to pediatric populations is affected by the upper age limit applied to define "pediatric." For example, pituitary adenoma is relatively rare in childhood, and the incidence increases during adolescence which extends through 19 years.[12]

In this study, pituitary adenomas (8/11, 72.7%) accounted for the majority of pediatric sellar lesions, while Rathke's cleft cyst, germ cell tumor, and pituitary phlogosis each occurred in 1 (9.1%) patient, respectively. All pituitary adenomas were secretive, most commonly growth hormone (GH) secreting adenomas (4/8, 50%) followed by prolactin (PRL) secreting adenomas (3/8, 37.5%). These findings were consistent with reported results by Kunwar and Wilson.[13] The remission rate postoperatively was up to 90.9% which is comparable to published results.[14] One patient with presurgical symptoms of polydipsia and polyuria continued to have similar symptoms postoperatively, which suggests that the tumor might have caused permanent dysfunction of the hypothalamic–posterior pituitary axis.

The rate of TR was 81.8% (Table 3), comparable with reported rates of 77.8%[15] and 81.5%.[16] Narrow nares and incomplete pneumatization of the sphenoid sinus pneumatization common in younger pediatric patients did not restrict resection of tumors of the sellar region via EETA in this series. From an anatomic standpoint the sphenoid sinus is well pneumatized in patients above 10 years of age,[10] and sphenoidal septations in pediatric patients older than 14 years are comparable to sphenoidal septations in adults.[17] In this study, all patients were over 14 years old and none of them had incomplete pneumatization of the sphenoid. Also the nares in some patients with GH secreting tumors were wider than the nares of adults. From a technical standpoint the absence of a nasal retractor maintained surgical freedom that would be lost with a nasal retractor. The 4 mm diameter endoscope applied through one nostril allowed significant freedom to use instruments.

Optic chiasm and optic nerve compression from pituitary adenoma lead to deterioration of visual acuity and visual field[18,19] in this study, 7 (63.6%) of 11 patients had deterioration of vision. Timely and effective decompression of optic chiasm and nerve is crucial for recovery of vision. All patients were treated with endoscopic endonasal transsphenoidal resection of sellar tumors, 3 (42.9%) of 7 patients who had visual defect preoperatively normalized after surgery, the remaining 4 (57.1%) patients improved significantly, the rate of visual remission up to 100%, which compared with reported rates in adults. In our opinion, this better rate of visual remission benefited from panoramic view provided by the endoscope, together with meticulous and precise manipulation of the surgeon. Endocrinological remission also an important index for sellar tumors, in presented series, hormone evaluation were used for the patients with hormonal secretion in

TABLE 2. Surgical Outcomes of 11 Pediatric Patients

No.	EOR	Postoperative Symptom	Complications	Hormone Replacement
1	TR	Vision normalized	Transient DI	N/A
2	TR	ACTH normalized, cortisol decreased	Transient DI	Hydrocortisone
3	STR	Unchanged	N/A	Hydrocortisone
4	TR	Vision improved, prolactine decreased	N/A	N/A
5	TR	Vision normalized prolactine decreased	Hypopituitarism transient DI	Thyroxine
6	TR	Normalized	N/A	N/A
7	TR	Vision normalized, GH normalized	Hypopituitarism	Thyroxine, hydrocortisone
8	TR	Vision improved, GH normalized	Transient DI	N/A
9	STR	Vision improved, GH unchanged	N/A	N/A
10	TR	GH normalized	N/A	N/A
11	TR	Vision improved	Hypopituitarism, CSF leak	Thyroxine

CSF, cerebrospinal fluid; DI, diabetes insipidus; EOR, extent of resection; STR, subtotal resection; TR, total resection.

TABLE 3. Rates of Surgical Outcomes and Complications of 11 Pediatric Patients

	N	Rate (%)
TR	9/11	81.8
STR	2/11	18.2
Visual recovery		
Normalizated	3/7	42.9
Improved	4/7	57.1
Endocrinological recovery		
Normalizated	5/8	62.5
Increased	2/8	25
Unchanged	1/8	12.5
Transient DI	2/11	18.2
Permanent DI	0/11	0
Hypopituitarism	3/11	27.3
CSF leak	1/11	9.1

CSF, cerebrospinal fluid; DI, diabetes insipidus; STR, subtotal resection; TR, total resection.

24 hours after surgery. Seven (87.5%) of 8 patients with secreting adenoma had normalization or significant increase of hormone level postoperatively. This rate was comparable with 90% of rate of endocrinological remission reported by Tarapore et al.[20]

Cerebrospinal fluid (CSF) leakage is one of the most common adverse outcomes described for EETA. Published CSF leak rates in adults range from 1.3% to 15%,[21,22] and in pediatric patients range from 8% to 10.5%.[23,24] Many techniques and materials have emerged to reconstruct the skull base as an attempt to prevent CSF leakage following endoscopic transsphenoidal approach.[25] It was not until Hadad et al[26] introduced vascularized pedicled nasoseptal flap (PNSF) reconstruction for skull base repair that concordant improved prevention of CSF leakage began to be described in many centers.[27,28] In our study, CSF leakage rate was 9.1% (Table 3), comparable with reported rates in pediatric patients.[23,24] Higher CSF leakage rates in adults may be associated with greater subarachnoid dissection required to access the lesions.[29] We did not use PNSF because the defects of skull base were not large in this series; although PNSF is an option in this age group.[17]

Transient DI following surgery occurred in 2 (18.2%) patients (Table 3), and no patient had permanent DI. These results are consistent with reported transient DI rates ranging from 0.4% to 48.8%,[21,30,31] and less than reported permanent DI rates ranging from 2.3% to 8.1%.[21,31,32] DI after surgery of the sellar region is neurogenic from injury to the magnocellular neurons in the hypothalamus where arginine vasopressin (AVP) is produced and transported to posterior pituitary gland via the hypothalamo-hypophyseal tract. Factors including lesion size, adherence to surrounding structures, histopathology; and surgical approach can result in DI. Care should be taken in surgery to preserve neurovascular structures and to minimize injury to critical structures including the hypothalamus, the infundibulum, and the neurohypophysis during surgical approach.[33] In the current study, 1 patient with symptomatic polydipsia and polyuria preoperatively had no change of the symptoms postoperatively. It is possible that the tumor caused permanent damage to the hypothalamic–posterior pituitary axis.

Hypopituitarism occurred in 3 (27.3%) patients (Table 3), comparable to reported rates ranging from 1.4% to 19.8%,[2,21,22] and less than rates as high as 67% following transsphenoidal approach.[34] Hypopituitarism may be associated with dysfunction of anterior pituitary postoperatively; and may require hormone replacement therapy. Of 3 patients with hypopituitarism, 2 had hypothyroidism treated daily with thyroxine; and 1 hypocortisolism which was treated with hydrocortisone.

CONCLUSIONS

Endoscopic endonasal (transnasal) transsphenoidal approach (EETA) for tumors of the sellar region is a safe and effective surgical option with low morbidity and mortality in an older pediatric population. This study was limited by small cohort. Further investigations from multicenters with larger cohort may further delineate the efficacy of EETA in pediatric patients.

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