Clinical Neurology and Neurosurgery 167 (2018) 129–140

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

# Extended endoscopic endonasal approach to the ventral skull base lesions

Murat Kutlay[a], Abdullah Durmaz[b], İlker Özer[a], Cahit Kural[a], Çağlar Temiz[a], Serdar Kaya[a], İlker Solmaz[a], Mehmet Daneyemez[a], Yusuf Izci[a,*]

[a] University of Health Sciences, Gulhane Education and Research Hospital, Department of Neurosurgery, Ankara, Turkey
[b] University of Health Sciences, Gulhane Education and Research Hospital, Department of Otorhinolaryngology, Ankara, Turkey

ARTICLE INFO

*Keywords:*
Endoscope
Skull base
Surgery
Ventral

ABSTRACT

*Objective:* With the use of multiple endoscopic endonasal surgical corridors, extended endoscopic endonasal approaches (EEEAs) are now being used to treat a wide range of ventral skull base lesions. Our aim was to present our experience with EEEAs to the ventral skull base lesions.

*Patients and Methods:* The study group consisted of 106 patients (57 men and 49 women) who underwent surgery for skull base lesions using EEEAs from 2010 to 2017. The EEEA was most commonly used for giant pituitary macroadenomas, sinonasal malignancies, cerebrospinal fluid (CSF) leaks, meningiomas, craniopharyngiomas, and fibro-osseous lesions. Four different approaches were used including transtuberculum-transplanum, transethmoidal-transcribriform, transclival, and transmaxillary-transpterygoidal.

*Results:* The overall gross total resection (GTR) rate for these diverse pathologies was 75.0% in 88 patients (excluding the operations performed for non-neoplastic pathologies). GTR was achieved in 100%, 77.8%, 75%, 75%, 72.2%, 62.5%, 60% of fibro-osseous lesions, giant/large pituitary adenomas, meningiomas, esthesioneuroblastomas, sinonasal malignancies, craniopharyngiomas, and chordomas, respectively. The overall rate of improvement in visual fields was 86%. The overall rate of CSF leak was 8.4%. Other surgical complications included intracerebral hematoma and tension pneumocephalus. The mortality rate was 0.9%.

*Conclusion:* EEEA is a safe, well-tolerated and effective surgical treatment modality in the management of ventral skull base lesions. It should be performed with close interdisciplinary collaboration. Appropriate case selection is mandatory. However, despite improved reconstruction techniques, postoperative CSF leakage still remains a challenge.

## 1. Introduction

The development of extended endoscopic skull base approaches in the last 2 decades provides an alternative to the traditional open approaches. In fact, the endoscopic endonasal approach was originally used to treat only sellar lesions [1–5]. Over this time period, improved understanding of the anatomic relationships, technological advancements in endoscopic equipment & microinstrumentation, neurophysiological monitoring, and the addition of the neuronavigation systems have allowed novel approaches to a variety of lesions involving the central cranial base from the crista galli to the foramen magnum [4,6–11]. Consequently, the accumulating experience has resulted in the development of the extended endoscopic endonasal approaches (EEEAs) [1,8,12–29].

Depending on the site of the lesions, several endoscopic endonasal surgical corridors and degrees of sinus dissection have been described to achieve adequate exposure [20,23–25,29]. These corridors correspond to the nasal sinuses and can be combined to reach a variety of targets. Therefore, they are also complementary to each other. The combination of these approaches has the potential to attain complete resections of extensive and complex pathologies while limiting morbidity [1,20,30,31].

Several studies have demonstrated the feasibility, efficacy, safety, and potential advantages of the EEEA for selected midline lesions of the skull base [4,5,8,11,14,15,17–19,21,22,24,25,29,30,32–36].The main advantages are more direct midline exposure from below, no need for any brain retraction or neurovascular manipulation, early devascularization of the lesion, and the ability to readily access deep-seated supradiaphragmatic, retrosellar, and clival lesions that traditionally have been difficult to access by standard transcranial approaches [8,15,18,37]. Furthermore, in coronal plan, EEEAs allow to address lesions of the middle and, partly, posterior cranial fossa [8,23,24,29,32,38]. Nowadays, in many worldwide neurosurgical centers, these approaches are now routinely used in clinical practice

* Corresponding author.
*E-mail address:* yusuf.izci@sbu.edu.tr (Y. Izci).

https://doi.org/10.1016/j.clineuro.2018.02.032
Received 15 January 2018; Received in revised form 13 February 2018; Accepted 19 February 2018
Available online 21 February 2018

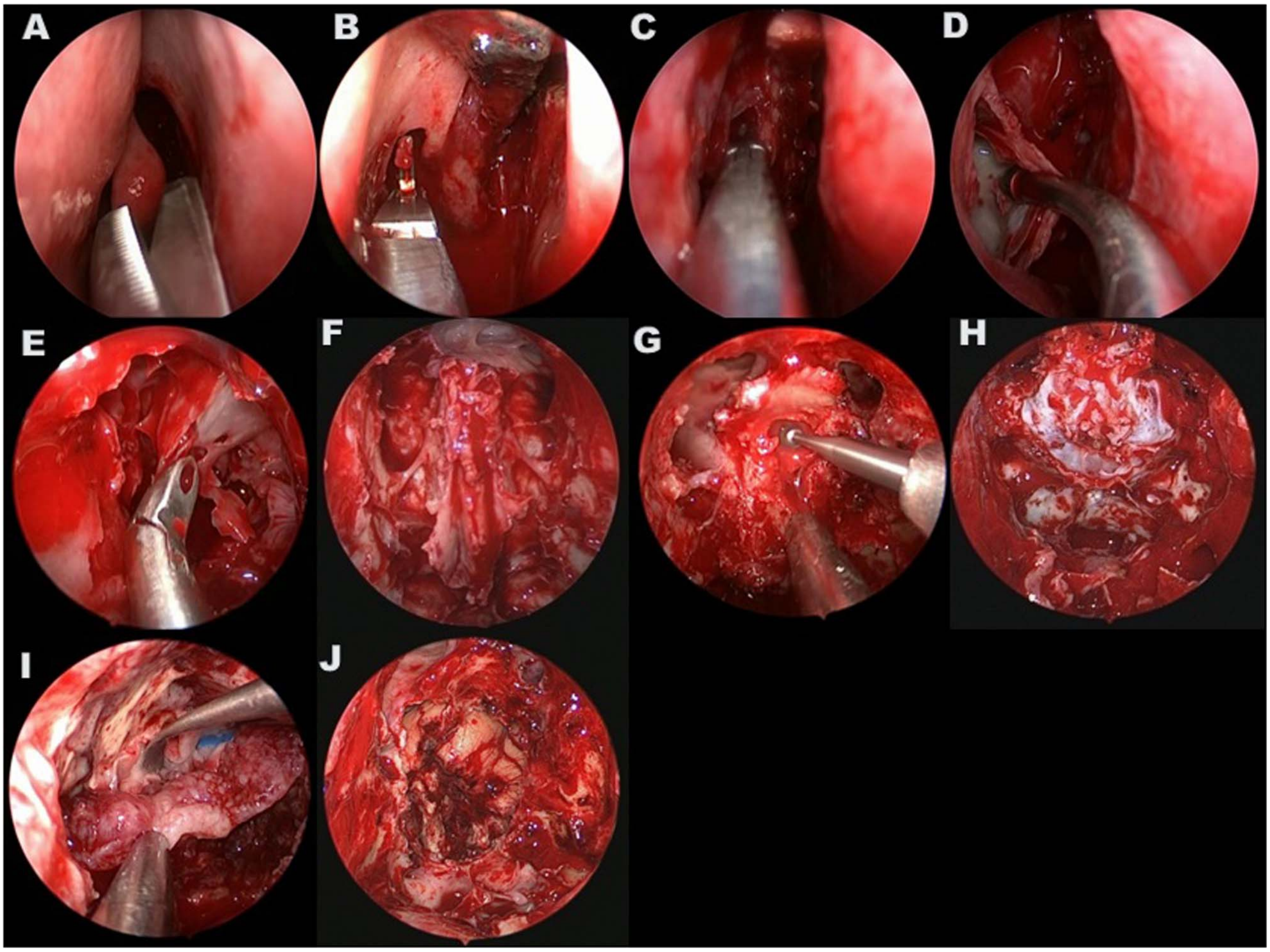


**Fig. 1.** The main surgical steps of the transethmoid transcribriform approach; Resection of the middle turbinate (A), uncinectomy to identify the ethmoidal bulla (B), removal of the ethmoid bulla (C), maxillary antrostomy to expose the orbital floor (D), anterior and posterior ethmoidectomies (E), identification of the anterior & posterior ethmoidal arteries (F), removal of the cibriform plate and fovea ethmoidalis (G), exposure of the fronto-basal dura (H). After intracapsular debulking, dissection of the tumor from frontal lobes using bimanual technique (I). Final endoscopic view of the surgical site after tumor removal (J).

[4,6,7,9–12,39–44].

Based on our experience with pure endoscopic pituitary and other transsellar surgeries, we proceeded to extend our indications. The EEEA evolved in our clinic in a gradual manner. In this study, we present our experience with the EEEA in ventral skull base lesions.

### 1.1. Patients and methods

One hundred and six patients underwent surgical treatment using EEEA for ventral skull base lesions at the Department of Neurosurgery, University of Health Sciences, Gulhane Training and Research Hospital. There were 57 men and 49 women. The patients' ages ranged from 19 to 74 years (median, 39.5 years). Patients who underwent standard transsphenoidal transsellar approach were excluded.

All lesions were preoperatively evaluated with magnetic resonance imaging (MRI). A computed tomography (CT) scan was also performed in all patients to evaluate the nasal, sphenoidal and ethmoidal anatomy, and the presence of calcification or hyperostosis. Additionally, angiographic studies were carried out to understand the vascular relationship in and around the tumor, including arterial encasement, blood supply, and venous drainage. For tumors invading the sellar or suprasellar region, a complete endocrinological assessment was performed in pre- and postoperative periods. All patients presenting with visual symptoms or with significant radiological optic apparatus compression, underwent formal ophthalmological examinations including visual field testing.

We routinely used frameless stereotactic image guidance (Stealth; Medtronic, Jacksonville, FL, USA) in all EEEAs. Additionally, if needed, a micro-doppler was very helpful for identifying the carotid arteries. Moreover, intraoperative cranial nerve monitoring was performed in selected cases according to the tumor size and location.

### 1.2. Operative techniques

The patient was placed in the supine position with the head fixed on the Mayfield 3-pin headholder and the back elevated to 30° under general anesthesia. The neck was tilted gently to the left. Depending on the surgical target area, the head was extended about 10–20° to facilitate access to the most anterior skull base and frontal sinus, or was slightly flexed to achieve a more posterior trajectory (as for clival or foramen magnum approach). We used a 2-surgeon, 3- or 4-handed binarial technique with a neurosurgeon and otolaryngologist. During the procedure, a 18 cm long rigid endoscope with a diameter of 4 mm (Karl Storz GmbH & Co. KG, Tuttlingen, Germany) was used. Most of the surgery was performed under view of a 0° endoscope. However, 30° endoscope was also frequently used to work around a corner and to visualize the extent of the lesion. At the beginning of surgery, a nasoseptal flap was harvested and stored in the nasopharynx or in the respective maxillary sinus after an antrostomy [45,46]. In patients with a history of previous radiation therapy or nasal-septal surgery, we used alternate flaps (ie, turbinate or pericranial).

Four approaches were used including transtuberculum-