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Review Article:

Comparing Mononostril, Binostril, and One and a Half Nostril Endoscopic Transsphenoidal Approach for Treating Pituitary Adenoma

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ABSTRACT

Background and Aim: EETA (Endoscopic Endonasal Transsphenoidal Approach) is a preferred choice for pituitary tumors. EETA offers minimal invasiveness, fewer complications, and better outcomes than the sublabial or transseptal microscopic approach. EETA has three approaches: mononostril endoscopic transsphenoidal approach, binostril endoscopic transsphenoidal approach, and one and a half nostril approach. This study aims to compare three different EETAs and compare between microscopic transsphenoidal approach, transcranial approach and EETA.

Methods and Materials/Patients: To provide up-to-date information, we concisely reviewed these three EETAs. Using the keywords of "neuroendoscopy", "META" (Mononostril Endoscopic Transsphenoidal Approach), "OETA" (One and a half nostril Approach), "BETA" (Binostril Endoscopic Transsphenoidal Approach), "pituitary adenoma", "EETA", "endoscopy", "transsphenoidal approach", "transcranial approach for pituitary adenoma" and "microscopic transsphenoidal approach". We retrieved all the relevant articles from Google Scholar, PubMed, and Medline. Then, we reviewed them and critically analyzed them.

Results: In BETA there is free and easy movement of surgical instruments in the surgical field and a broader view of the sphenoid sinus and it is an excellent approach to resect large tumors. The META is suitable in tumors with limited involvement of the intra-sellar and supra-sellar area. The mononostril approach is not suitable and has some limitations for the following situations: a crowded narrow nasal cavity, a harder tumor with the invasive appearance or significant suprasellar extension, and lesions other than pituitary adenomas. The OETA provides a sufficient surgical corridor for a 2-surgeon/4 or 3-hands technique with a minimal injury of the nose and good operative results, free and easy movement of surgical instruments in the surgical field, low post-operative morbidity, and good post-operative quality of life.

Conclusion: In EETA, knowing the size and consistency of tumor, general versus invasive pituitary adenoma, and the extent of parasellar and suprasellar extension, is essential. If we cannot reach a pituitary macroadenoma with a trans-sphenoidal approach, then we can use a transcranial approach for the removal of the tumor. The microscopic transsphenoidal approach is suitable for pediatric pituitary adenoma.

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Highlights

• The transcranial approach is effective when resection of a pituitary macroadenoma cannot be done with the transsphenoidal route.

• Microscopic transsphenoidal surgery due to limitation of the endoscopic approach is suitable in pediatric patients and avoided wide anatomical deficit.

• For selecting suitable EETA as META or BETA or OETA, the size and consistency of tumor, general versus invasive pituitary adenoma, and the extent of parasellar and suprasellar extension is essential.

Plain Language Summary

Endoscopes create a good and extensive visualization of the surgical field. There are three types of transsphenoidal endoscopic approach to pituitary adenoma as: mononostril, binostril, and one and a half nostril. The main difference between these three approaches is the different ways to remove the nasal septal mucosa. From the technical viewpoint, the mononostril approach is a two-hand technique, and the binostril and one and a half nostril approach can be a three-hand or four-hand technique. We compared these three approaches and techniques and consider the short-term and long-term outcomes, benefits, and complications of these three approaches for pituitary adenoma surgery.

1. Introduction

Bushe and Halves introduced using an endoscope in pituitary operation in 1978. In the mid-1990s, the endoscope was an excellent choice for pituitary surgery with a spacious, bright, and excellent surgical view. A combined approach as an initial endoscopic approach to the sphenoid sinus joined with the standard transsphenoidal microsurgical approach for tumor removal was reported by Yaniv and Rappaport. Later on, Jho and Carrau described the most extensive series of patients with pure Endoscopic Endonasal Transsphenoidal Approach (EETA) [1-3]. EETA has three types of approaches: Mononostril Endoscopic Transsphenoidal Approach (META), Binostril Endoscopic Transsphenoidal Approach (BETA), and one and a half nostril approach (OETA). It is performed by two techniques: two surgeons (3 or 4 hands) technique and one surgeon (2 hands) technique.

In BETA, two surgeons work together (3-hand technique): an ENT surgeon and neurosurgeon. First, an ENT (Ear, Nose, Throat) surgeon creates surgical exposure, and then a neurosurgeon starts operation on binostril, with holding the suction in the non-dominant hand and a dissecting instrument in the dominant one as the ENT surgeon holds endoscope in the right nostril. In META, two surgeons work separately (2-hand technique) as the first an ENT surgeon makes exposure, and then a neurosurgeon starts the operation with an endoscope holder (hydraulic or mechanical) [4].

The mononostril approach creates less trauma to the nasal mucosa with fewer nasal complications such as crusting, loss of smell, and adhesion, with the main disadvantage as small working room, especially for invasive and extensive macroadenoma. In the one-and-a-half nostril and binostril approach, the integral part for better operative outcomes is the degree of freedom for the senior surgeon, and this occurs with working of the senior surgeon through both nostrils and the assistant surgeon through the right nostril for guiding the endoscope and elimination of the endoscope shaft [5]. From the viewpoint of nasal mucosal incision and removal, the following dissimilarities are present.

In META, the unilateral posterior nasal mucosa is incised, and the contralateral nasal mucosa is preserved. The main difference between these three approaches is the different ways to remove the nasal septal mucosa. In BETA, the dorsal region of nasal septal mucosa is bilaterally incised and removed, and in OETA, the nasal mucosa is unilaterally incised from sphenoid ostium to mucocutaneous junction of vestibule plus a contralateral mucosal incision. Theoretically, the incidence of nose bleeding and loss of smell are lower in OETA because of the preservation of the contralateral septal olfactory strip and the vascular pedicles. In this paper, we reviewed and compared 3 EETAs (META, OETA, and BETA) and considered the short-term and long-term outcomes, benefits, and complications of these three approaches.

2. Methods and Materials/Patients

To provide up-to-date information on these three approaches, we concisely reviewed these three approaches and their pros and cons. Using the keywords of "neuroendoscopy", "META", "OETA", "BETA", "pituitary adenoma", "EETA", "endoscopy", "pituitary surgery", "microscopic transsphenoidal approach", "binostril endoscopy", "mononostril endoscopy", "one and a half nostril endoscopy", "transcranial approach to pituitary adenoma", we retrieved all the relevant articles from Google Scholar, PubMed, and Medline. Then, we reviewed them and critically analyzed them.

3. Results

The endoscopic approach can be classified as three approaches: mononostril, binostril, and one and a half nostril. From the technical viewpoint, the mononostril approach is a two-hand technique, and the binostril and one and a half nostril approach can be a three-hand or four-hand technique. Endoscopes create a good and extensive visualization of the surgical field [6, 7]. We compared these three approaches and techniques and consider the short-term and long-term outcomes, benefits, and complications of these three approaches for pituitary adenoma surgery.

4. Discussion

Tumor resection rate

Post-operative MRI can detect tumor resection rate based on the amount of tumor remnant. Based on the tumor resection rate, there is no prominent dissimilarity between META, OETA, and BETA (77.8% in META, 80.3% in BETA, and 79% in OETA) [7-11]. However, in invasive pituitary macroadenomas (such as tumors with parasellar and suprasellar extension and tumors requiring extended approaches), the preferred approach is the binostril approach because of its better surgical field visualization, maneuverability, and resection rate [12-17].

Post-operative hormonal recovery rate

For hormone remission rate, there is no prominent dissimilarity between three EETAs (72.9% in META, 77.8% in OETA, and 76% in BETA) [7-11, 18, 19] and also between the type of hormone-secreting adenoma [7-11]. The factors against biochemical remission are invasive tumors and previous operations (for microadenomas).

Post-operative visual recovery

There is no prominent dissimilarity in the META and BETA groups but with a lower rate of improvement in the OETA group without any reasonable and sensible explanation (91.1% in META, 88% in BETA, and 73% in OETA) [7-11]. For more desirable surgical results and improvement of visual function, it is better to do an operation in the early stage of visual impairment before the occurrence of optic atrophy [20].

Post-operative admission days

There is a prominent dissimilarity between the three EETAs (1.6-6.5 days) [11].

Complications

Neurologic Complications [7-11].

CSF leakage

No noticeable difference was seen between the three EETAs (2.9% in META, 3.1% in BETA, and 3.5% in OETA).

Diabetes insipidus

The rate of temporary diabetes insipidus is lower in BETA (5.3% in META, 2.9% in BETA, and 5.3% in OETA). But for the permanent diabetes insipidus rate, there is no noticeable difference between META and BETA (1.0% META and 0.9% in BETA) without any information about OETA.

Anterior pituitary dysfunction

The rate of anterior pituitary dysfunction is lower in BETA (6.4% in META, 2.3% in BETA, and 5.3% in OETA).

Meningitis

There is no significant difference between META and BETA (0.8% in META and 0.8% in BETA) without any data in OETA.

Nasal complications

Sinusitis

There is no prominent dissimilarity between META and BETA (0.3% in META and 0.9% in BETA).

Nose bleeding

The rate of nose bleeding is higher in the BETA group than META and OETA (0.4% in META, 1.5% in BETA, and 0% in OETA).

The choice between META, OETA, and BETA

The three most commonly used endoscopic approaches for pituitary adenomas are the META, OETA, and BETA. To evaluate the efficiency of these three approaches, we must consider post-operative results, free and easy movement of surgical instruments, post-operative morbidity, and post-operative quality of life. For general pituitary adenomas, based on the literature review, there are similar results for tumor resection rate, hormonal recovery rate, post-operative visual recovery rate, CSF leak, and occurrence of diabetes insipidus. In invasive pituitary macroadenomas like tumors with parasellar and suprasellar extension and tumors requiring extended approaches, binostril is a better choice. However, the worst outcome of the binostril approach is the damage to the nasal cavity with sinonasal complication, low sinonasal quality of life, and changes in smell sensation. The rate of damage to the nasal cavity is less in META and OETA than in BETA [13, 19, 21].

The above items occur for the followings reasons: 1) limitations of meta-analysis, 2) the highly developed endoscopes create a clear extensive view of the operative field and a higher chance of total tumor resection rate so that surgeons can recognize anatomic structures, even in a restricted surgical field, with the usage of different angled endoscopes for the operation of parasellar and suprasellar regions, 3) in the mononostril approach, many surgeons for creation of wide and clear surgical field, separate and move the nasal septum to the contralateral side and some surgeons use a speculum to narrow the surgical passage, and 4) other factors, such as the shared operation with an ENT, the use of intraoperative navigation system or MRI, and the consistency of pituitary adenomas (the majority is soft).

All the above-mentioned items can increase the good results of the mononostril approach and can cope with most pituitary adenomas. However, we believe that the META limitations are resolved with changes in the lens of the endoscope and some maneuver in creating a visual field in the nasal cavity and transsphenoidal route. In other words, the advantage of the binostril approach is unclear within general pituitary adenomas. In the binostril approach, passing through the middle turbinate can increase the surgical space and clear visualization of anatomic structures in the surgical field, with resultant decrease injury to normal pituitary gland as lower anterior pituitary insufficiency and temporary diabetes insipidus in binostril approach [8-10, 22-26].

Comparing traditional microsurgery (microscopic transsphenoidal) with endoscopic endonasal transsphenoidal pituitary surgery and transcranial pituitary surgery

The fundamental reason for pituitary surgery is selecting a surgical approach and technique with maximal safe resection of adenoma and minimal injury to patients. The demerits and merits regarding these three surgical approaches have become a hot topic of discussion. Traditional microsurgery (microscopic transsphenoidal surgery) is similar to endoscopic surgery with two differences. First, it needs Hardy's speculum, and second, it needs a microscope instead of an endoscope. However, endoscopic endonasal pituitary surgery has a more spacious surgical view, clearer and brighter surgical field anatomy, significantly higher cure rate, less intraoperative and post-operative problems, decreased operative time, less bleeding, elimination of intraoral and transseptal dissection, and decreased admission days [18, 27, 28]. In a retrospective study, all patients underwent microscopic transsphenoidal surgery because of the restriction of endoscopy in the pediatric group and the prevention of extensive anatomical damage. They used submucosal transnasal approach, and most of the tumors were macroadenoma; they could resect the tumor in 90% of patients [29]. In 1% to 4% of pituitary tumors, the transcranial approach is the preferred approach at the following conditions:

1) for removal of an isolated macroadenoma because of a narrow waist at the diaphragma sellae;

2) extension to the cavernous sinus lateral to the carotid artery;

3) anterior extension onto the planum sphenoidale;

4) lateral extension into the middle fossa;

5) fibrous hard pituitary macroadenoma.

For fibrous, hard pituitary macroadenoma, it is better to use the transcranial approach, and tumors with soft consistency are easily resected by suction through the transsphenoidal approach. It is better to do a preoperative assessment of the pituitary macroadenoma tumor consistency and, based on this, detect a suitable type of operative approach, whether transsphenoidal or transcranial approach. The Diffusion-Weighted MR Imaging (DWI) can help predict the detection of the tumor consistency of pituitary macroadenomas. Based on DWI, we can detect an appropriate approach and decreasing the risk of incomplete excision and the chance of recurrence [30-32]. However, for a more reliable conclusion, further studies are needed [33].

Comparing OETA with BETA

The injury to the nasal cavity is lower in OETA than BETA. The rate of nose bleeding and loss of smell is lower in OETA than BETA for the following reasons. In OETA, on the left side, 2 cm of nasal septal mucosa is excised, and at the right side, a "rescue" flap is created with the preservation of vascular pedicles and olfactory strip. If there is no CSF leakage intraoperatively, the preserved unilateral "rescue" flap is placed back to the normal anatomic position. In BETA, there is a possibility of damage to vascular pedicles and olfactory strips because of bilateral manipulation of posterior septal mucosa. In OETA, recovery of smell post-operatively occurs about three months in 96% of the patients, and sinonasal complications are recovered about six months. The outcome of permanent loss of smell and nose bleeding is better in OETA than in BETA [7].

Comparing OETA with META

Based on the literature review, there is a higher surgical outcome in OETA in comparison to endoscope-based series, and this is because of the broad bright view of the endoscope. In the OETA, we can employ both nasal cavities for using surgical instruments. We have a wide spacious surgical field in comparison to META. So the senior surgeon can freely use surgical instruments for hemostasis, tumor resection, and sellar floor repair and assistant surgeon holding the endoscope. In the META, because of using one side of the nasal cavity, the surgical field is more restricted and limited, and there is a struggle between the endoscope and surgical instruments as in macroadenoma with parasellar extension, and it is better to approach from contralateral nostril about the surgical target area. In OETA, moving the endoscope to the contralateral nostril concerning the surgical target area creates a tremendous surgical field view, spacious wide surgical field, and sufficient space for the free movement of instruments [8, 20, 34-37].

Comparing BETA with META

In the META, the operation length is shorter than BETA. In META, the maneuverability of surgical instruments like suction cannula, curettes, and endoscope are limited because of restricted passage through a speculum. Speculum prevents injury to the nasal cavity by surgical instruments, but it can cause injury to the nasal mucosa with intranasal bleeding that is more common in META. In BETA, there is no restriction of maneuverability of surgical instruments because of the pliability of nasal structures, and you can dislodge nostrils, turbinates, and the nasal septum by the shaft of rigid instruments, but there is the chance of injury to nasal mucosa or structures. Because of this possibility in BETA, we must do extensive hemostasis and create a broad spacious surgical field with a broader opening of the sphenoid sinus. Briefly, both META and BETA are safe techniques, but in META, because of limited passage, resection of large tumors is difficult. Based on these findings, If there are very large adenomas with extension to parasellar areas or involvement of the cavernous sinus, it is better to use the binostril technique without a speculum. There is no difference between META and BETA in a residual tumor, CSF fistulas, rhinological aspects, and endocrinological or ophthalmological recovery [21].

Usage of the speculum in endoscopic transnasal and microsurgical approach to the sella

Neurosurgeons can use speculum for endoscopic transnasal and microsurgical approach to the sella. A speculum is typically used in META, not in BETA and OETA. In META, the speculum creates a broader surgical passage, and neurosurgeons can easily reach the sphenoid sinus. In META, in comparison to the microsurgical approach, we can pass an endoscope into the sphenoid sinus and sellar space to differentiate tumor tissue from normal hypophysis because of the bright excellent visualization of the surgical field. The speculum limits lighting and lateral visualization and microsurgical approaches; however, this is less relevant in endoscopic approaches. The speculum restricts the bimanual handling of instruments [7, 15, 38-40].

The advantage of the unilateral "rescue" nasoseptal flap

For rescue flap, a small incision is made at the level of the ostium of the sphenoid sinus and extended anteriorly onto the superior nasal septum. The mucosa is elevated inferiorly from the sphenoid ostium, protecting the posterior septal branch of the sphenopalatine artery for blood supply of rescue flap. Some neurosurgeons create unilateral rescue flap and others bilateral rescue flap. In patients with intraoperative CSF leak reconstruction of the sellar cavity is done using unilateral rescue flap with a successful decrease in the rate of post-operative CSF leak [8, 15, 20, 34, 36, 41]. In the bilateral rescue nasoseptal flap, the chance of injury to nasoseptal mucosa is increased. Based on the literature review, the unilateral rescue flap is efficient in the reconstruction of sellar space, and because of the unilaterality of the flap, the chance of injury to nasal mucosa is decreased with preservation of the contralateral side [18, 42, 43].

5. Conclusion

The demerits and merits regarding the transcranial approach and microscopic transsphenoidal approach and EETA and also between three widely-used EETAs (META, OETA, BETA) have become a hot topic of discussion. Based on the results of this study, the transcranial approach is effective when resection of a pituitary macroadenoma cannot be done with the transsphenoidal route. Microscopic transsphenoidal surgery due to limitation of the endoscopic approach is suitable in pediatric patients and avoided wide anatomical deficit, and for selecting suitable EETA as META, BETA, or OETA, the size and consistency of tumor, general versus invasive pituitary adenoma, and the extent of parasellar and suprasellar extension is essential, but for more reliable conclusion further studies are needed.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Conception and design: Shahrokh Yousefzadeh-Chabok, Ali Kazeminezhad; Data analysis and interpretation, drafting the article, critically revising the article, reviewing submitted version of manuscript, approving the final version of the manuscript: All authors.

Conflict of interest

The authors declared no conflict of interest.

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