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Effect of the extent of posterior septectomy on surgical access during the endoscopic endonasal approach to the sella: A technical note

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ABSTRACT

Background: Using the bi-nostril 4-hand technique during the endoscopic endonasal approach (EEA) facilitates bimanual microsurgical techniques yet requires resection of the posterior nasal septum. The surgical exposure and degree of maneuverability gained proportionate to the extent of posterior septectomy in the sagittal plane was previously quantified.
Research question: We aim to describe our technique of posterior septectomy, and the effect of its extent in the axial plane on surgical access, and instrument maneuverability.
Material and methods: After fracturing the posterosuperior nasal septum, we disarticulate the vomer from the sphenoid rostrum and remove its upper part. The sphenoid rostrum is excised next exposing the clival recess where a suction tip without a side channel is anchored, allowing the assisting surgeon to use an additional instrument in their dominant hand. The vomer is removed down to the level of the floor of the sphenoid sinus.
Results: A wide exposure is achieved in the coronal plane bilaterally at the level of the sphenoid rostrum allowing unobstructed instrument manipulation in the craniocaudal and cross-court trajectories. Furthermore, the floor of the sella is reached through a straight rather than angled trajectory facilitating surgical access, manipulation, and instrument maneuverability. For lateral lesions requiring contralateral access, the assisting surgeon can assist in dissection from the contralateral nostril without changing the position of the endoscope.
Discussion and conclusion: Removing the upper vomer improves surgical access, and instrument maneuverability. Simultaneous dissection from both nostrils might be attempted. Caudally extending the posterior septectomy during the EEA allows better exposure and improves surgical access in all planes.

1. Introduction

Although the endoscopic endonasal approach (EEA) provides a panoramic view visualizating hidden areas using angled lenses, maneuvering the endoscope in conjunction with the surgical instruments through the nasal corridors to reach the target area without causing nasal trauma could be challenging. Ideally, necessary surgical access dictated by the morphoanatomical features of the pathological lesion would be gained with maximal preservation of nasal structures which in turn might aid in stabilizing the surgical instruments during the EEA thereby affording more precision within the narrow nasal corridors as well as shortening the postoperative recovery period (Jho et al., 1997; Spencer et al., 1999; Labidi et al., 2018; Thompson et al., 2014).

An approach through the ipsilateral nostril may be sufficient in some cases where the instruments are manipulated in the surgeon's dominant hand and the endoscope in their non-dominant hand, however, the surgical techniques employed would be unfamiliar to neurosurgeons trained in bimanual microsurgical techniques. Although, the use of an endoscopic holder might allow the application of bimanual microsurgical technique through a single nostril, it would limit the depth perception afforded through in- and outward motion of a freehand navigated endoscope and might impede the surgeon's hand movements (Jho et al., 1997; Cavallo et al., 2007).

The bi-nostril 4-hand technique performed by a team of two surgeons, where the assisting surgeon introduces the endoscope and suction tube through one nostril so that the operating surgeon introduces two instruments through the contralateral nostril, permits bimanual microsurgical techniques yet requires resection of the posterior nasal septum.

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Similarly, approaching laterally situated sellar lesions through the contralateral nostril would necessitate a posterior nasal septectomy to navigate the surgical instruments across both nostrils (Jho et al., 1997; Kassam et al., 2005).

The surgical exposure and degree of maneuverability gained proportionate to the extent of posterior septectomy in the sagittal plane was previously quantified (Garcia et al., 2016). However, to our knowledge the effect of the extent of posterior septectomy in the axial plane on the limits of the exposure, degree of surgical access, and instrument maneuverability during the EEA was not previously reported.

We describe our technique of posterior septectomy and the effects of its caudal extension on surgical access, and instrument maneuverability.

2. Methods

This study is a description of a surgical technique and did not enroll any human subject. Ethical review for this type of study is not required as per local institutional review board regulations.

2.1. Surgical anatomy

The cuboidal body of the sphenoid houses the sphenoid sinus in the center of the middle cranial base. The posterior bony nasal septum formed by the perpendicular plate of the ethmoid anterosuperiorly and the vomer posteroinferiorly articulates in the midline with the sphenoid crest of the anterior surface of the body of the sphenoid, and the sphenoid rostrum of its inferior surface, respectively. The superior border of the trapezoid vomer including its bilaterally projecting alae is the site of its articulation with the sphenoid rostrum (Rhoton, 2002; Standring and Standring, 2021a, 2021b) (Fig. 1).

The degree of projection and hence ease of identification of the sellar prominence during the EEA through the superior surface of the body of the sphenoid bounded anteriorly by the tuberculum sellae and posteriorly by the dorsum sellae which forms the sphenoid contribution to the clivus is determined by the degree of pneumatization of the sphenoid sinus. In the sellar type of the sphenoid sinus, pneumatization extends posterior to the tuberculum sellae in the sagittal plane and may further extend into the surrounding bony structures. The clival recess of the sphenoid sinus represents extension of pneumatization posterior to the posterior wall of the sella and can be viewed as a depression at a postero-caudal plane to the sellar prominence (Rhoton, 2002; Standring and Standring, 2021b; Abhinav et al., 2020; Wang et al., 2010; Hammer and Rådberg, 1961) (Fig. 2).

2.2. Surgical technique

The preoperative radiological assessment of the patient includes magnetic resonance imaging (MRI) of the sella for planning of the surgical approach and required trajectory; and computed tomography (CT) scans of the paranasal sinuses for assessment of the nasal anatomy, and the sphenoid sinus pneumatization.

The EEA had been described in detail elsewhere (Jho et al., 1997; Kassam et al., 2005; Bohnen et al., 2022). We perform a bi-nostril 4-hand technique. The endoscope is held in the non-dominant hand of the

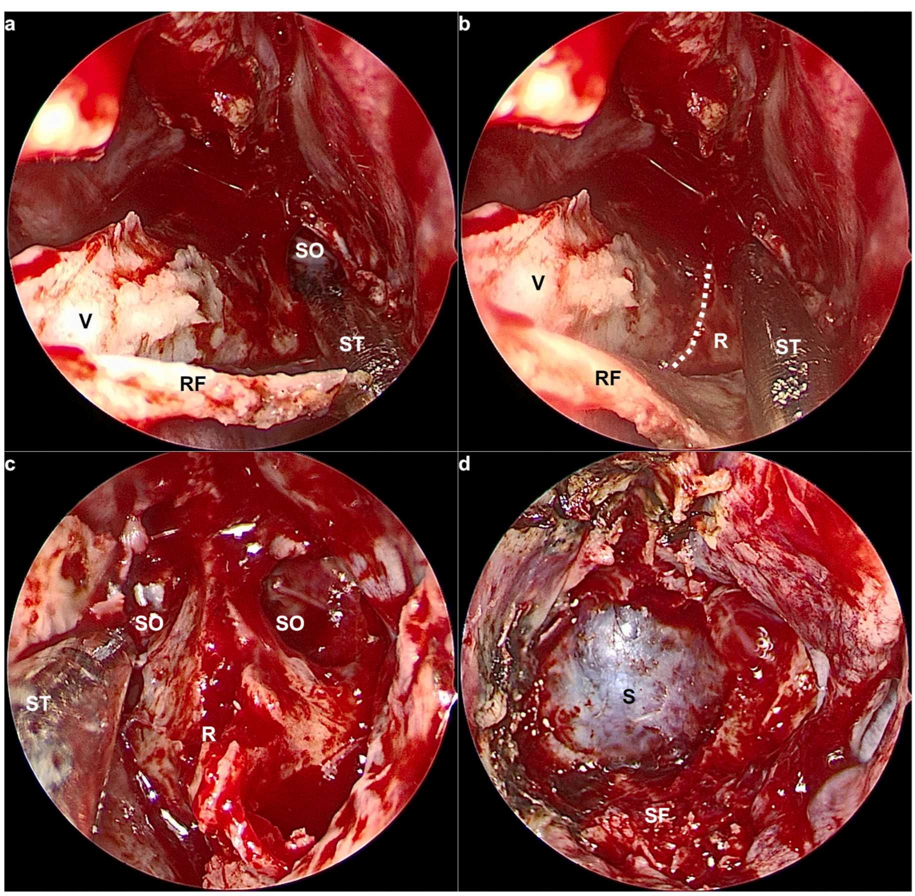

Fig. 1. Posterior septectomy during the EEA (a) endoscopic view of the articulation between the vomer and sphenoid rostrum viewed using a 0° angle scope from the left nostril after elevation of the recue flap, (b) The vomer has been disarticulated (dashed line) from the sphenoid rostrum and pushed to the right, (c) Removal of the disarticulated part of the vomer reveals the sphenoid rostrum and allows the bilateral sphenoid ostia to come into view, (d) final view after opening the sphenoid sinus and performing the septectomy down to the level of the sphenoid sinus floor. Part of the bony sellar floor has been opened revealing the sellar dura. R: rostrum; RF: rescue flap; S: sella; SF: sphenoid sinus floor; SO: sphenoid ostium; ST: suction tip; V: vomer.

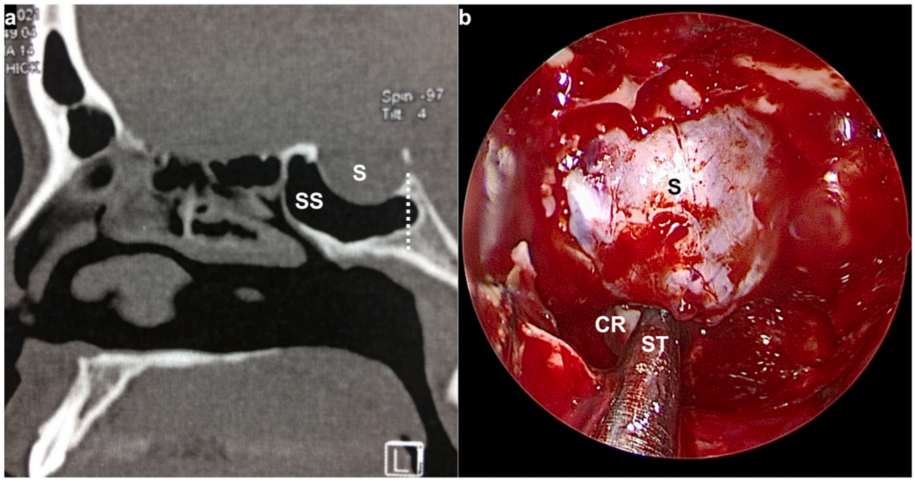

Fig. 2. The clival recess (a) Computed tomography scan of the paranasal sinuses sagittal view showing a sellar type of the sphenoid sinus, the clival recess is represented by the pneumatized sphenoid sinus posterior to the posterior border of the sella (dotted line), (b) endoscopic endonasal view inside the sphenoid sinus of the same patient in (a) using a 0° angle scope. The bony sellar floor has been opened. A suction tube without a side channel can be seen anchored within the clival recess and partially supported superiorly by posterior margin of the bony sellar floor. CR: clival recess; S: sella; SS: sphenoid sinus; ST: suction tip.

assisting surgeon to allow for a dynamic view with better three-dimensional appreciation. We use nasal packs soaked in diluted epinephrine 1:10,000 to decrease intraoperative mucosal bleeding. We do not perform a middle turbinectomy on either side unless an extended EEA is planned (Guthikonda et al., 2010). We elevate bilateral rescue flaps as a contingency (Rivera-Serrano et al., 2011). After fracturing the posterosuperior nasal septum thereby communicating both nasal cavities posteriorly, the superior border of the vomer is identified and disarticulated from the sphenoid rostrum. The vomer is then excised to the level of the floor of the sphenoid sinus in the axial plane and from its articulation with the face of the sphenoid to the anterior part of its articulation with the perpendicular plate of the ethmoid bone in the sagittal plane. We use the middle turbinate anteriorly as a landmark for the maximal extent of removal of the bony nasal septum in the sagittal plane. We attempt to remove the vomer in one piece in case needed for reconstruction of the sellar floor during closure. Next, the sphenoid rostrum is removed accessing the sphenoid sinus. The caudal part of the vomer marks the midline. In patients with a pneumatized clival recess, we anchor a suction tip without a side channel in the clival recess (Figs. 1–2). We open the bony sellar floor exposing the medial wall of the cavernous sinus bilaterally and the superior and inferior intercavernous sinuses craniocaudally. Removal of intrasellar pathology follows using bimanual techniques. At the conclusion of the intrasellar resection we swipe the resection bed using a piece of dry gauze to remove any remaining tumor that might be hidden within the arachnoid or redundant diaphragma sellae folds. We close the sella with a piece of gelatin sponge in the absence of a potential CSF leak. Other closure techniques are selected on a case-by-case basis. Video 1 illustrates important points of the described technique.

3. Results

A wide exposure is achieved at the level of the face of the sphenoid allowing unobstructed instrument manipulation in the coronal and craniocaudal planes from either nostril within the area bounded by both lateral opticocarotid recesses (LOCR). An unobstructed straight trajectory is achieved from either nostril to the contralateral LOCR with a wide range of freedom of motion in the craniocaudal direction at the lateral limit of the exposure. Increasing the range of the cross-court trajectory would be useful for laterally located lesions requiring more room for surgical manipulation from the contralateral side.

Additionally, for lateral lesions requiring contralateral access, anchoring the suction tip in the clival recess would enable the assisting surgeon to employ an instrument in their dominant hand from the contralateral nostril while maintaining continuous clearance of the field necessary for adequate endoscopic visualization by means of the anchored suction tip, and without changing the position of the endoscope, essentially using a bi-nostril, 4-hand, 5-instrument technique. Since dissection from the contralateral side is thereby made possible without changing the side of entry of the endoscope and suction tip, the trauma to the nasal passages from repeated entry and exit of the instruments would be minimized and the total surgical time would be optimized.

Furthermore, the removal of the vomer to the level of the floor of the sphenoid sinus facilitates instrument maneuverability craniocaudally in a straight trajectory from the level of the tuberculum sellae to the level of the upper clivus. This would enable access to the floor of the sella through a straight anteroinferior to posterosuperior trajectory from either nostril rather than the angled trajectory that would hinge around the superior border of the vomer forcing the surgeon to access the floor of the sella from a superolateral trajectory. This facilitates surgical access, manipulation, and instrument maneuverability in all planes while minimizing the need for angled instruments and allowing the surgeon to work more comfortably applying microsurgical dissection techniques (Fig. 3).

4. Discussion

4.1. Advantages of the 4-hand technique

An uni-narial approach would not require removal of the posterior nasal septum and would, therefore, be less invasive to the nasal anatomy while permitting a bimanual approach with the use of an endoscope holder, albeit at the expense of depth visualization. The uni-narial approach would also be inferior to the bi-nostril approach regarding the surgical space available for maneuvering the surgical instruments and for bringing the endoscope close to the surgical site for better visualization. Additionally, ipsilateral access to laterally located lesions would be limited by the preserved nasal septum (Cavallo et al., 2007; Kassam et al., 2005; Mamelak et al., 2013; de Divitiis et al., 2002).

To address the shortcomings of the uni-narial approach, using the "chopsticks technique" a single surgeon manipulates the endoscope together with a special malleable rotative suction tip with their non-dominant hand while using another instrument in their dominant hand through the same nostril. This modification utilizes the preserved nasal structures to stabilize the surgical instruments thereby presumably

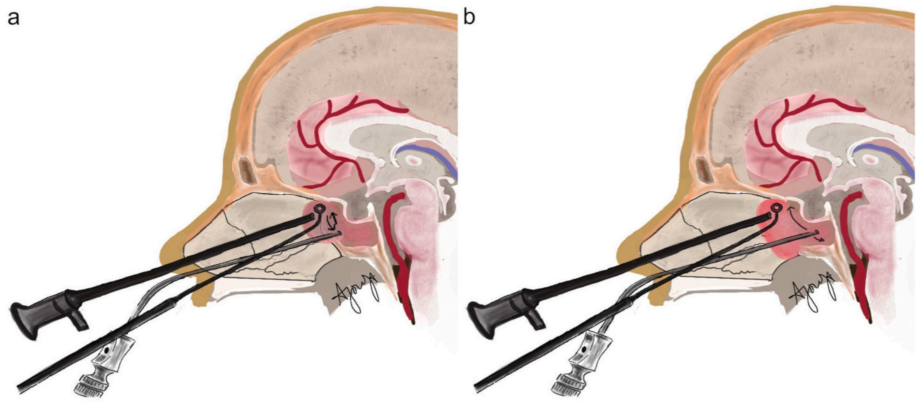

Fig. 3. A diagram illustrating the extent of exposure and instrument maneuverability gained after performing a posterior septectomy to the level of the floor of the sphenoid (a) A limited area of the sellar floor is accessible and a limited range of motion for the surgical instruments is possible before removing the vomer to the level of the sphenoid floor (arrows), access to the posteroinferior part of the sellar floor would be only possible in an indirect trajectory using angled instruments, (b) The entirety of the sellar floor is made accessible through a direct trajectory and the permissible range of motion of the surgical instruments is increased after carrying down the posterior septectomy to the level of the floor of the sphenoid.

lending more precision to the surgical movements, and with the use of angled scopes was reported to allow access to a wide range of surgical targerts (Labidi et al., 2018).

Despite the advantages of an uni-narial approach for preservation of nasal structures which was found to be associated with improved sino-nasal outcomes, the bi-nostril 4-hand technique was shown to result in similar surgical outcomes with fewer complications. Furthermore, the visual feedback provided by the dynamic movement of the endoscope in the bi-nostril, 4-hand technique was shown to facilitate EEA training (Thompson et al., 2014; Cavallo et al., 2007; Vaz-Guimaraes et al., 2015; Wen et al., 2016).

Even though the preservation of nasal anatomy might hasten the postoperative recovery, the removal of some nasal structures was shown to improve endoscopic endonasal accessibility to various surgical targets (Thompson et al., 2014; Guthikonda et al., 2010; de Divitiis et al., 2002). Therefore, performing the minimum required resection of nasal structures for adequate access to the target area furing the EEA would be important for facilitating the surgical procedure and thereby improving postoperative outcomes while minimizing the risk of increased sinonasal morbidity.

4.2. The effect of extended resection of the vomer in the axial plane

The increase in the extent of surgical exposure and access in the coronal plane was found to plateau beyond a 2 cm septectomy (Garcia et al., 2016). We seldom extend the posterior septectomy more than the plane of the middle turbinate (∼2 cm) sagitally as we have not observed more accessibility to most sellar targets with a more aggressive septectomy. However, to our knowledge there is no similar quantitative study evaluating the extent of posterior septectomy in the axial plane in relation to accessibility of sellar targets. In our experience, a straight trajectory to the sella would facilitate the resection of intrasellar pathology, minimize the need for angled instruments, and improve access in the coronal plane along the entirety of the craniocaudal axis of the sellar region. By excising the vomer to the level of the sphenoid sinus floor, the surgical instruments introduced from either nostril would have a straight trajectory to the sellar region without hinging on the upper edge of the vomer. This pivoting motion at the vomer would only enable access to most sellar lesions using angled instruments. Furthermore, access to the sellar floor along the long axis of the sella would be very challenging. Additionally, access to the most caudal portion of a laterally situated lesion from the contralateral side by the pivoting instrument would be limited by the lateral nasal wall on the side of instrument insertion. Therefore, taking the posterior septectomy to the level of the sphenoid sinus floor enables easier maneuverability in the craniocaudal as well as the coronal planes and provides better access to the sellar region in all planes.

Another advantage of extending the bony septectomy to the level of the floor of the sphenoid sinus is exposing the clival recess if present. In the absence of a continuous suction irrigation device, anchoring a suction tube without a side channel in the clival recess would keep a clear surgical field, by continuously removing fluid draining from the sella towards the clivus. The assisting surgeon would thus have the opportunity to use a fifth instrument in their dominant hand to assist with the resection without changing the position of the endoscope, simulating microsurgical procedures.

4.2.1. Limitations

The main limitation of this study is inherent to its design being a technical description unvalidated by reported patient outcomes and its effects on the postoperative patient quality of life have not been studied. However, our aim is to highlight the importance of this technical step during the EEA as a subject for further quantitative studies.

The utilization of a well pneumatized clival recess during the procedure is dependent on individual anatomy, however, even in cases with a poorly pneumatized clival recess, a bony shelf at the junction of the floor of the sella with the upper clivus could be fashioned during bone removal. Harmonizing the actions of both operating surgeons is usually a process that has a learning curve.

5. Conclusion

Removal of the vomer to the level of the floor of the sphenoid sinus increases surgical access in all planes during the EEA through straight trajectories which would facilitate surgical manipulation and instrument maneuverability. Anchoring a suction tip in the clival recess when present would allow surgical access from the bilateral nostrils simultaneously with the concurrent introduction of an additional instrument without changing the position of the endoscope thereby providing better access to laterally located lesions and minimizing trauma to the nasal passages.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bas.2024.102831.

References

Abhinav, K., Obikane, Y., Fernandez-Miranda, J.C., 2020. In: Brennan, P.A., Standring, S. M., Wiseman, S.M. (Eds.), Suprasellar and Paraclinoidal Regions, Gray's Surgical Anatomy. https://doi.org/10.1016/B978-0-7020-7386-1.00021-X, 145-151.e2.

Bohnen, A.M., Donaldson, A.M., Olomu, O.U., Quinones-Hinojosa, A., 2022. In: Quiñones-Hinojosa, A. (Ed.), Endoscopic Endonasal Approach to Sellar, Parasellar, and Suprasellar Surgery, Schmidek and Sweet: Operative Neurosurgical Techniques, pp. 131–139.e3. https://doi.org/10.1016/B978-0-323-41479-1.00012-6.

Cavallo, L.M., Dal Fabbro, M., Jalalod'din, H., et al., 2007. Endoscopic endonasal transsphenoidal surgery. Before scrubbing in: tips and tricks. Surg. Neurol. 67 (4), 342–347. https://doi.org/10.1016/j.surneu.2006.09.040.

de Divitiis, E., Cappabianca, P., Cavallo, L.M., 2002. Endoscopic transsphenoidal approach: adaptability of the procedure to different sellar lesions. Neurosurgery 51 (3), 699–707. https://doi.org/10.1227/00006123-200209000-00016.

Garcia, H.G., Otten, M., Pyfer, M., et al., 2016. Minimizing septectomy for endoscopic transsphenoidal approaches to the sellar and suprasellar regions: a cadaveric morphometric study. J Neurol Surg B Skull Base 77 (6), 479–484. https://doi.org/10.1055/s-0036-1584077.

Guthikonda, B., Nourbakhsh, A., Notarianni, C., Vannemreddy, P., Nanda, A., 2010. Middle turbinectomy for exposure in endoscopic endonasal transsphenoidal surgery: when is it necessary? Laryngoscope 120 (12), 2360–2366. https://doi.org/10.1002/lary.21153.

Hammer, G., Rådberg, C., 1961. The sphenoidal sinus: an anatomical and roentgenologic study with reference to transsphenoid hypophysectomy. Acta Radiol. os-56 (6), 401–422. https://doi.org/10.1177/028418516105600601.

Jho, H.D., Carrau, R.L., Ko, Y., Daly, M.A., 1997. Endoscopic pituitary surgery: an early experience. Surg. Neurol. 47 (3), 213–222. https://doi.org/10.1016/S0090-3019(96)00452-1.

Kassam, A., Snyderman, C.H., Mintz, A., Gardner, P., Carrau, R.L., 2005. Expanded endonasal approach: the rostrocaudal axis. Part I. Crista galli to the sella turcica. Neurosurg. Focus 19 (1), 1–12. https://doi.org/10.3171/foc.2005.19.1.4.

Labidi, M., Watanabe, K., Hanakita, S., et al., 2018. The chopsticks technique for endoscopic endonasal surgery-improving surgical efficiency and reducing the surgical footprint. World Neurosurg 117, 208–220. https://doi.org/10.1016/j.wneu.2018.05.229.

Mamelak, A.N., Carmichael, J., Bonert, V.H., Cooper, O., Melmed, S., 2013. Single-surgeon fully endoscopic endonasal transsphenoidal surgery: outcomes in three-hundred consecutive cases. Pituitary 16 (3), 393–401. https://doi.org/10.1007/s11102-012-0437-1.

Rhoton, AL Jr, 2002. The sellar region. Neurosurgery 51 (Suppl. l_4), S1–S335. https://doi.org/10.1097/00006123-200210001-00009.

Rivera-Serrano, C.M., Snyderman, C.H., Gardner, P., et al., 2011. Nasoseptal "Rescue" flap: a novel modification of the nasoseptal flap technique for pituitary surgery. Laryngoscope 121 (5), 990–993. https://doi.org/10.1002/lary.21419.

Spencer, W.R., Das, K., Nwagu, C., et al., 1999. Approaches to the sellar and parasellar region: anatomic comparison of the microscope versus endoscope. Laryngoscope 109 (5), 791–794. https://doi.org/10.1097/00005537-199905000-00020.

Standring, S., 2021a. In: Standring, S. (Ed.), Face and Scalp, Gray's Anatomy, pp. 607–635.e1. https://doi.org/10.1016/B978-0-7020-7705-0.00036-7.

Standring, S., 2021b. In: Standring, S. (Ed.), Infratemporal and Pterygopalatine Fossae and Temporomandibular Joint, Gray's Anatomy, pp. 664–685.e2. https://doi.org/10.1016/B978-0-7020-7705-0.00038-0.

Thompson, C.F., Suh, J.D., Liu, Y., Bergsneider, M., Wang, M.B., 2014. Modifications to the endoscopic approach for anterior skull base lesions improve postoperative sinonasal symptoms. J Neurol Surg B Skull Base 75 (1), 65–72. https://doi.org/10.1055/s-0033-1356492.

Vaz-Guimaraes, F., Rastelli, M.M., Fernandez-Miranda, J.C., Wang, E.W., Gardner, P.A., Snyderman, C.H., 2015. Impact of dynamic endoscopy and bimanual-binarial dissection in endoscopic endonasal surgery training: a laboratory investigation. J Neurol Surg B Skull Base 76 (5), 365–371. https://doi.org/10.1055/s-0034-1544124.

Wang, J., Bidari, S., Inoue, K., Yang, H., Rhoton Jr., A., 2010. Extensions of the sphenoid sinus: a new classification. Neurosurgery 66 (4), 797–816. https://doi.org/10.1227/01.NEU.0000367619.24800.B1.

Wen, G., Tang, C., Zhong, C., et al., 2016. Mononostril versus binostril endoscopic transsphenoidal approach for pituitary adenomas: a systematic review and meta-analysis. PLoS One 11 (4), e0153397. https://doi.org/10.1371/journal.pone.0153397.