Comparison of the Exposure Obtained by Endoscope and Microscope in the Extended Trans-Sphenoidal Approach

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ABSTRACT

Objective: Trans-sphenoidal surgery is often combined with other approaches for the treatment of middle cranial base tumors. By combining a maxillotomy with trans-sphenoidal approach, significantly wider exposure to these regions is gained. However, endoscope-assisted techniques have also been used for sellar and parasellar and upper clival regions. **Methods:** An extended trans-sphenoidal approach was performed on 10 cadaver heads using the operating microscope and was repeated with a 0-degree endoscope. The mean horizontal and vertical distances were measured and pictured for each technique, and both distances were compared using a parametric paired Student's *t*-test. **Results:** The mean horizontal distances in the 10 specimens were 19.5 ± 1.8 mm by microscope and 27.5 ± 2.2 mm by endoscope, and the mean vertical distances were 25.8 ± 1.9 mm by the microscope and 34.5 ± 3.5 mm by the endoscope. **Conclusion:** The aim of this study was to quantify the amount of exposure obtained with an extended trans-sphenoidal approach and to compare both endoscopic and microscopic techniques. Using the endoscope in conjunction with the operating microscope may provide additional exposure and better access in skull base surgery.

KEYWORDS: Extended trans-sphenoidal approach, microscope, endoscope, skull base surgery

Trans-sphenoidal surgery for pituitary tumors is a well-known surgical technique. This technique is often combined with other approaches in skull base surgery, especially to access middle cranial base lesions.¹⁻⁵ Combining a maxillotomy with a trans-sphenoidal approach significantly widens the exposure to skull base lesions. This additional maxillotomy not only provides a wider route but also allows a drill to be introduced through the opening for extensive bone removal when tumor has invaded the paranasal sinuses and clivus. Lesions extending from the superior sellar region and caudally to the foramen magnum may be attacked through this approach.⁶

Endoscope-assisted techniques also have been used to access the sellar, parasellar, and upper clival regions. The endoscope can be adopted as a primary surgical tool for visualization, or it can be used to supplement the operating microscope. Compared to the operating microscope, which allows only limited peripheral viewing of invaded areas, the endoscope has several advantages, among them the capability to provide close-up views.⁷⁻¹¹ In the present study, horizontal and vertical distances were measured through both the microscope and endoscope after an extended trans-sphenoidal approach and the exposures afforded by each were compared.

MATERIALS AND METHODS

An extended trans-sphenoidal approach, as described previously by Al-Mefty et al.,⁶ was performed on 10 cadavers. A 0-degree endoscope (Storz, Baltimore, MD, 4 mm) and operating microscope (Zeiss, Thornwood, NY, OPM 16) were used for all measurements. On each specimen, an extended trans-sphenoidal approach was performed on the left side using the microscope. First, the microscopic field was marked with orange dots, and the same exposure was marked with green dots by endoscope. Vertical and horizontal distances were measured with millimetric paper for each in-

strument. After both distances were measured, exposures were pictured by both microscope and endoscope. The mean horizontal and vertical distances were compared using a parametric paired Student's *t*-test.

Surgical Approach

After the upper lip was everted, a sublabial incision was made about 1 cm above the gingival mucosa using the standard technique employed in a trans-sphenoidal approach. The incision was extended about 4 cm further laterally on the left side. A subperiosteal dissection was extended up to the frontal process of the maxilla just below the inferior aspect of the orbit. The limiting factor in this dissection is the infraorbital nerve, which marks the most superior aspect of the exposure at the infraorbital foramen. The rostral-caudal extent of the dissection must be sufficient to accommodate the entire height of the self-retaining retractor blade. The dissection was carried laterally about 3 to 4 cm to provide the additional width needed (Fig. 1).

After the standard trans-sphenoidal exposure was achieved, in which the cartilaginous nasal septum was disarticulated from the hard palate and vomer, the nasal septum was swung contralaterally

Figure 1 Bony specimen showing the osseous landmarks of the extended trans-sphenoidal approach. The left maxillary has been osteotomized to open the maxillary sinus. Note the infraorbital nerve (arrow).

to the side of the maxillotomy. A B5 bit on the Midas Rex drill (Midas Rex, Fort Worth, TX) was used to create the maxillotomy on the anterior wall of the maxilla. Any bone left along the medial wall of the maxilla was removed with a rongeur. When the self-retaining retractor system was opened maximally, it pushed mucosa into the opening in the maxilla created by the maxillotomy. This maneuver provided additional width to the exposure. Along the inferior aspect of the vomer, the mucosa was elevated inferiorly along the clivus to gain maximal exposure.

Once the anterior wall of the sphenoid sinus was opened and the sinus mucosa was exenterated, the sphenoid septa were removed. The sellar floor was removed using a high-speed drill. Resection of the sellar floor was continued until the color of the underlying dura changed because of the presence of the lateral cavernous sinuses and intercavernous sinuses. The dura was opened and both cavernous portions of the internal carotid artery were exposed. The clivus was also drilled, and the petrous portion of the internal carotid artery was exposed on the left side. After the exposure was completed, its horizontal and vertical distances were measured and pictured using both microscope and endoscope (Figs. 2, 3).

Figure 2 Photographic view through the operating microscope showing the cavernous portion of the ICA (double white arrows), the dura after drilling of the clivus (white arrow), and the pituitary (thick arrow).

Figure 3 Photographic view through the endoscope showing the cavernous portion of the ICA (single white arrow), the petrous portion of the ICA (double white arrows), the dura after drilling of the clivus (asterisk), and the pituitary (thick arrow).

RESULTS

The mean horizontal distances in the 10 specimens were 19.5 ± 1.8 mm by microscope and 27.5 ± 2.2 mm by endoscope. The mean vertical distances were 25.8 ± 1.9 mm by microscope and 34.5 ± 3.5 mm by endoscope. The differences between both distances were statistically significant using the paired Student's *t*-test ($P < 0.001$, Fig. 4).

DISCUSSION

Advances in skull base surgery have dictated the need for a multidisciplinary approach in the treatment of complex lesions. In recent decades, the development of microsurgical techniques and several alternative combined approaches have reduced the rates of surgical morbidity.¹² Wider access and minimal morbidity rates can be achieved by combining a small osteotomy with traditional approaches. In

Figure 4 Mean differences in the extent of exposure visualized with both microscope and endoscope.

1992 Rabadan et al. described a transmaxillary-transnasal approach to the clival region.¹³ An extended trans-sphenoidal approach also has been described for the sellar, parasellar, and upper clival regions.⁶ Harrison and Al-Mefty primarily used this approach for chordomas,⁶ but the exposure is well suited for any midline lesion. This approach is ideal for lesions that have broken into the paranasal sinuses and invaded and extended down the clivus. This maxillotomy also allows drilling of the clivus and petrous bone. Fraioli et al.¹⁴ also used a transmaxillophenoidal approach to remove sellar tumors invading the cavernous sinus. In contrast to Al-Mefty's group, however, they used this approach for ipsilateral cavernous sinus lesions.

Although anterior approaches to the skull base offer various degrees of exposure to midline lesions of the pituitary and clivus, the limited lateral access and difficulty in attaining proximal control of the internal carotid artery (ICA) restrict their usefulness. A safe and minimally invasive route for reaching the parasellar and upper clival regions can be obtained with an extended trans-sphenoidal approach. The surgical exposure gained allows adequate access to the contralateral cavernous sinus, the cavernous portion of the ICA, the ventral surface of the upper third of the clivus, the medial

portion of the petrous bone, to a portion of the ICA and the infrasellar region.⁶

Recently, Sabit et al.¹⁵ presented a modification of the transmaxillary approach to the sellar region and cavernous sinus, which expanded surgical access without the need for a wide transfacial dissection. They suggested that this approach offered excellent visualization of the ipsilateral carotid artery with proximal and distal control, as well as visualization of cranial nerves III, IV, VI, and V2; the hypophyseal region; and the medial aspect of the cavernous sinus.¹⁵ These approaches minimize the need for the invasive transfacial approaches of the midfacial degloving operations.

Although various combined approaches can be used for skull base surgery, visibility at the corners remains problematic. To address this issue, other tools have been used during surgery. Advances in optics, microscopic miniaturization, and endoscopic instrumentation have revolutionized almost every surgical specialty. Visualization of areas outside the direct line of vision is highly desirable in neurosurgical procedures.¹⁶ In this regard, Apuzzo et al.¹⁶ described the Hopkins telescope technique and the advantages of using it. In 1975 Sugita et al.¹⁷ suggested using a pharyngeal mirror to solve the problem of obscure angles of visibility.

In neurosurgery, endoscopy has been limited largely to intraventricular applications. Bushe and Halves¹⁸ first suggested use of the endoscope in pituitary surgery. Gamea et al.⁷ found that the endoscope enabled better differentiation between tumor and normal pituitary tissue than the operating microscope. Spencer et al.¹⁹ believed that endoscopic surgery of the sellar region could be performed safely and effectively, while providing the surgeon with a view superior to that afforded by the operating microscope. In 1997 Jho and Carrau²⁰ developed an endonasal endoscopic trans-sphenoidal technique that avoided the need for a nasal speculum or trans-sphenoidal retractor. Initially, they used an endoscope in conjunction with an operating microscope while executing the standard sublabial-trans-septal approach. Then, having gained confidence in using the endoscope as a visualizing tool, they began to use the endoscopic approach.

Overall, provision of close-up views and its viewing capability are some advantages of the endoscope compared to the operating microscope, which allows only limited peripheral viewing. The endoscope can be used as a supplemental tool to the operating microscope, and it provides visibility into anatomical corners.^{9,21}

Spencer et al.¹⁹ also used a 0-degree endoscope to compare the amount of exposure provided by the endoscope and the microscope that was associated with three different anterior approaches to the sellar region. Their results also demonstrated that the view afforded by the sinus endoscope is greater than that of the microscope in transethmoidal and trans-sphenoidal approaches.

In this present study, the endoscope was used as a tool to supplement the microscope. Because the microscope is limited to direct viewing only, a 0-degree endoscope was used for this anatomical study. After the exposure was completed, the horizontal and vertical extents of the opening were measured using both microscope and endoscope. A larger exposure was provided by the endoscope than by the operating microscope. Hence,

use of the endoscope in conjunction with the operating microscope may provide additional exposure and better access in skull base surgery.

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