Intraoperative Transillumination to Determine the Extent of Frontal Sinus in Subcranial Approach to Anterior Skull Base

Rajeev Sharan, M.B.B.S., M.S., M.Ch.,¹
Krishnakumar Thankappan, M.B.B.S., M.S., M.Ch.,²
Subramania Iyer, M.Ch., F.R.C.S.,² Dilip Panicker, M.Ch.,²
and Moni Abraham Kuriakose, M.D., F.R.C.S.³

ABSTRACT

We sought to determine the extent of the frontal sinus by intraoperative transillumination through the superomedial orbital wall in a subcranial approach to the anterior skull base. After raising a bicoronal flap, the frontal sinus was transilluminated through the superomedial orbital wall with a fiber-optic light source, delineating the extent of the frontal sinus. The frontal sinus boundary was marked with a marker pen. A frontal sinus anterior wall osteotomy was performed with a sagittal saw, staying within the confines of the frontal sinus marking. A bone flap was removed, and the posterior wall was drilled out. The remaining procedure was performed in a standard fashion. At the end of the procedure, the bone flap was fixed with a titanium plate. A total of 58 patients had undergone craniofacial resection from January 2004 to December 2007. In 13 patients, a subcranial approach was employed using the transillumination technique. Transillumination was successful in delineating the frontal sinus periphery in all 13 patients. Intraoperative transillumination of the frontal sinus through the superomedial orbital wall is a simple and effective method to delineate the frontal sinus periphery in a subcranial approach to the anterior skull base.

KEYWORDS: Transillumination of frontal sinus, subcranial approach, frontal craniotomy, osteoplastic flap, anterior skull base

The subcranial approach described by Raveh and colleagues is a well-established technique to access the anterior skull base.^{1–5} This involves temporary removal of the anterior wall of the frontal sinus and nasal bone, after making a frontal bone osteotomy within the limits of the frontal sinus. This mandates accurate determina-

tion of the frontal sinus periphery, which has considerable interpersonal variations. Current methods of identification of the extent of the frontal sinus include obtaining 1:1 posteroanterior Caldwell view taken at 6 feet and creation of a template or by computed tomography (CT)-generated frontal sinus template

¹Dharamshila Cancer Hospital and Research Centre, Vasundhara Enclave, Delhi, India, ²Amrita Institute of Medical Sciences, Elamakkara, Cochin, Kerala, India, ³Department of Surgical Oncology, Mazumdar Shaw Cancer Centre, Narayana Hrudayalaya, Bommasandra, Bengaluru, Karnataka, India.

Address for correspondence and reprint requests: Moni Abraham Kuriakose, M.D., F.D.S.R.C.S., F.F.D.R.C.S., F.R.C.S.Ed., F.R.C.S., Professor and Chairman, Surgical Oncology Services, Mazumdar-Shaw Cancer Institute, Narayana Hrudayalaya 258/A,

Bommasandra Industrial Area, Anekal Taluk, Bangalore, 560 099 (e-mail: mak12@nyu.edu; makuriakose@gmail.com).

Skull Base 2011;21:71–74. Copyright © 2011 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1 (212) 584-4662.

Received: November 20, 2009. Accepted after revision: April 30, 2010. Published online: July 7, 2010.

DOI: <http://dx.doi.org/10.1055/s-0030-1261267>.

ISSN 1531-5010.

based on the CT scan imaging findings.⁶⁻⁸ The former technique is cumbersome, and with the latter technique, to avoid injury to the dura, limited osteotomy is made erring on the frontal sinus, which limits the size of the bone flap and then exposure. However, maximum bone removal improves skull base exposure. We report a simple and effective method to determine the extent of the frontal sinus wall by a transillumination technique.

METHODS

Surgical Techniques

A bicoronal flap was raised in a subperiosteal plane, extending laterally to the preauricular areas. The flap was then elevated anteriorly beyond the supraorbital ridges and glabella, taking care to preserve the supraorbital and supratrochlear nerves. The supraorbital and supratrochlear nerves and vessels were identified and carefully dissected from the supraorbital and supratrochlear notches. If they were in foramina, then the inferior rim of bone was removed with a fine osteotome or a Kerrison punch. Bilateral medial canthal ligaments were identified and tagged with a suture. Both orbits were then entered in a subperiosteal plane, by exposing the roofs and the medial walls. The ethmoidal arteries were identified and cauterized in the process. The periosteum overlying the nasal bones was elevated to the bone-cartilage junction. The bicoronal flap was then retracted in a forward position with fish hooks (Fig. 1). The frontal sinus was transilluminated using a fiber-optic light source through the thin bone of the superomedial orbital wall (Fig. 2). The operation room light could be dimmed to improve visualization. The boundaries of the frontal sinus were marked with a sterile pencil or ink (Fig. 3). The procedure was repeated on the opposite side. Using a sagittal saw, osteotomy was performed,

Figure 1 Raising of scalp flap with galea-pericranium and exposing frontal and nasal bone. Supratrochlear and supraorbital neurovascular bundles have been carefully dissected and included in the flap.

Figure 2 Transillumination of left frontal sinus through thin superomedial orbital wall by a fiber-optic light source and marking of frontal sinus boundary, staying 5 mm inside.

staying within the confines of the frontal sinus marking (Fig. 4). The osteotomy was extended toward the superior orbital wall and inferiorly through the nasal bones. This enabled total displacement of the anterior wall of the frontal sinus and the nasal bone (Fig. 5). Further surgery was completed in the standard fashion discussed well in the literature (Fig. 6). After completion of the tumor resection, the bone flap was repositioned using a titanium plate. The medial canthus also needed to be reattached.

Records of all the patients who had undergone subcranial approaches from January 2004 to December 2007 were reviewed to determine the efficacy of the technique as well as perioperative complications.

RESULTS

A total of 58 patients had undergone craniofacial resection during the study period. In 13 patients, subcranial approach was employed. The transillumination

Figure 3 Complete marking of the frontal sinus boundaries for bifrontal craniotomy.

Figure 4 Bone flap being detached from septum after osteotomy with sagittal saw.

technique was employed in all 13 patients. Transillumination was successful in delineating the frontal sinus periphery in all 13 patients. The frontal sinus periphery marked by transillumination accurately corresponded to the actual extent of the frontal sinus. None of the 13 patients had inadvertent dural injury.

DISCUSSION

The subcranial approach offers a broad operative exposure of the anterior skull base region. This approach can be combined with transfacial approaches depending upon the location and extent of the tumor. After the first description of the technique by Raveh et al,¹ the benefits of a subcranial approach have been confirmed by different authors.^{9–11} These advantages are based on the broad surgical exposure, direct visualization of the anterior skull base, avoidance of frontal lobe retraction, en bloc resection of intra- and extradural tumors, and watertight dural reconstruction at the end of the procedure.

The most important advantage of the transillumination technique is the avoidance of inadvertent dural

Figure 5 Bone flap.

Figure 6 Drilling of posterior wall of frontal sinus.

injury during frontal craniotomy. In this series, with transillumination of the frontal sinus, we were able to avoid direct entry into the cranial cavity and thus avoid dural injury in all the patients. Also, marking of the boundaries by transillumination is a simple technique, which can be performed using instrumentation readily available in the craniofacial surgery operating rooms.

Transillumination of the frontal sinus has been previously described to delineate the extent of the frontal sinus for osteoplastic flaps for inflammatory diseases of the frontal sinus.^{12,13} For this, a cutting burr is used to make a 4-mm trephine into the frontal sinus, lateral to midline and low in the sinus. A rigid 4-mm telescope connected to a powerful light source is then inserted through the burr hole to transilluminate the frontal sinus. Using transillumination, the limits of the frontal sinus are visualized and can be outlined using electrocautery or drill. In this study, we did not use trephine of the frontal sinus. Instead, the thin superomedial orbital wall was used for transillumination of the frontal sinus.

It is important to appreciate that at the periphery of the frontal sinus, the anterior and posterior walls of the frontal sinuses are in close approximation. Therefore, to prevent accidental penetration through the posterior sinus wall, the osteotomy needs to be made ~5 mm within the transillumination marking. This has been shown to be a reliable method in a previous study by Melroy et al.¹⁴ The saw or drill used to make the osteotomy needs to be beveled anteriorly to prevent dural injury. Out of 13 patients in this study, in none of the patients did the saw inadvertently enter the cranial cavity or cause dural tear during craniotomy. Performing the craniotomy with the sagittal saw minimizes bone loss. As there is no need to make burr holes, the occasional dimpling of skin seen with a burr hole may be avoided by the technique described.

Another method of making an osteoplastic flap is by using a template from a Caldwell radiograph taken from 6 feet, to delineate the frontal sinus margins.^{6,7}

This technique can be subject to error through inaccurate template production or placement, in turn causing possibility of intracranial entry and dural injury. Also, it takes time and requires special effort for making the template preoperatively and for autoclaving to be used during surgery. In comparison, the transillumination method does not require any preoperative preparation. Various other image guidance methods have been used for delineation of the frontal sinus, but all require preoperative preparation and additional instrumentation.

CONCLUSION

Transillumination of frontal sinus through the superomedial orbital wall is a simple and effective method to delineate the frontal sinus periphery to assist in the subcranial approach to the anterior skull base.

REFERENCES

1. Raveh J, Vuillemin T. The surgical one-stage management of combined cranio-maxillo-facial and frontobasal fractures. Advantages of the subcranial approach in 374 cases. *J Craniomaxillofac Surg* 1988;16:160–172
2. Raveh J, Vuillemin T, Sutter F. Subcranial management of 395 combined frontobasal-midface fractures. *Arch Otolaryngol Head Neck Surg* 1988;114:1115–1122
3. Raveh J, Vuillemin T. Advantages of an additional subcranial approach in the correction of craniofacial deformities. *J Craniomaxillofac Surg* 1988;16:350–358
4. Raveh J, Vuillemin T. Subcranial-supraorbital and temporal approach for tumor resection. *J Craniofac Surg* 1990;1:53–59
5. Raveh J, Laedrach K, Speiser M, et al. The subcranial approach for fronto-orbital and anteroposterior skull-base tumors. *Arch Otolaryngol Head Neck Surg* 1993;119:385–393
6. Tato JM, Sibbald DW, Bergaglio OE. Surgical treatment of the frontal sinus by the external route. *Laryngoscope* 1954;64:504–521
7. Fung MK. Template for frontal osteoplastic flap. *Laryngoscope* 1986;96:578–579
8. Fewins JL, Otto PM, Otto RA. Computed tomography-generated templates: a new approach to frontal sinus osteoplastic flap surgery. *Am J Rhinol* 2004;18:285–289; discussion 289–290
9. Sekhar LN, Janecka IP, Jones NF. Subtemporal-infratemporal and basal subfrontal approach to extensive cranial base tumours. *Acta Neurochir (Wien)* 1988;92:83–92
10. Spetzler RF, Herman JM, Beals S, Joganic E, Milligan J. Preservation of olfaction in anterior craniofacial approaches. *J Neurosurg* 1993;79:48–52
11. Delfini R, Iannetti G, Belli E, Santoro A, Ciappetta P, Cantore G. Cranio-facial approaches for tumours involving the anterior half of the skull base. *Acta Neurochir (Wien)* 1993;124:53–60
12. Friedman M, Landsberg R, Tanyeri H. Intraoperative and postoperative assessment of frontal sinus patency by transillumination. *Laryngoscope* 2000;110:683–684
13. Yoskovitch A, Wright ED, Sobol SE, Desrosiers M. Frontal sinus transillumination approach to the osteoplastic flap. *J Otolaryngol* 2002;31:118–119
14. Melroy CT, Dubin MG, Hardy SM, Senior BA. Analysis of methods to assess frontal sinus extent in osteoplastic flap surgery: transillumination versus 6-ft Caldwell versus image guidance. *Am J Rhinol* 2006;20:77–83