Access to the Central Skull Base Via a Modified Le Fort I Maxillotomy: The Palatal Hinge Flap

Abstract—We describe a modification of the standard Le Fort I maxillotomy in favor of a unilateral palatal hinge flap. Used in combination with a partial medial maxillectomy, submucous resection of the nasal septum, and contralateral inferior turbinectomy, this approach provides direct access to the entire nasal cavity, ipsilateral maxillary antrum, pterygopalatine fossa, nasopharynx, clivus, and first two cervical vertebrae. Use of the palatal hinge serves both to maintain palatal vascularity and eliminates the need for intermaxillary fixation. Facial incisions are avoided through a midfacial degloving approach. A variety of other surgical techniques used to access the central skull base are critically reviewed and compared with this new technique. (*Skull Base Surgery*, 3(2):60–68, 1993)

Surgical access to the central skull base can be achieved via transoral, transpalatal, transnasal, transmaxillary, and transmandibular approaches. No single approach provides wide exposure with an acceptable level of morbidity. Therefore, a combination of these standard surgical approaches is often employed, with each adjunctive procedure being used to compensate for the limitations of the other.

Transnasal approaches, either via an anterior facial degloving,¹ alotomy, or lateral rhinotomy, provide limited exposure of the nasopharynx. Exposure can be minimally improved by performing a submucous resection of the nasal septum (Fig. 1). These procedures are usually reserved for lesions limited to the nasal cavity or as adjuncts to one of the following procedures.

The transpalatal approach provides direct access to the sphenoid rostrum and proximal clivus. Exposure is most limited superiorly despite extension of the patient's head (Fig. 2). Because of the removal of palatal bone, this procedure requires temporary insertion of a prefabricated

palatal stent to prevent postoperative palatal displacement and dehiscence. Division of the soft palate greatly improves exposure to the lower clivus, but is associated with a high incidence of soft palate fistulization or nasopharyngeal insufficiency or both. This is especially true in diabetics, patients on chronic steroid therapy, and those who have received previous oropharyngeal irradiation. In order to achieve the same exposure and not violate the soft palate, a combination of approaches is usually required.

The transoral route usually provides direct access to the lower clivus and upper cervical spine, especially when coupled with retraction or division of the soft palate and depression of the tongue (Fig. 3). The minimum vertical interdental distance required for this approach is 25 mm. Even mild trismus limits exposure significantly. The nasopharynx is usually inaccessible via this route unless the soft palate is divided. Prolonged retraction or depression of the tongue results in postoperative lingual edema, which may require continued intubation or tracheostomy for airway management.

Figure 1. Transnasal approach with alotomy allows visualization from line B (sphenoid rostrum) to C (hard palate). A lateral rhinotomy extends vertical exposure to line A (floor of anterior cranial fossa).

Figure 3. Transoral approach allows visualization from lower clivus (line A) to C₂ (line B). To achieve this exposure, soft palate must be divided and tongue significantly retracted inferiorly.

The transmandibular or mandibular swing approach^{2,3} to the nasopharynx requires a median mandibulotomy. It provides wide exposure to the clivus and upper cervical spine (Fig. 4). Extension of the intraoral incision medial to the maxillary tuberosity will improve access to the lower

nasopharynx. It is the only procedure described herein that allows lateral exposure and protection of the internal carotid artery. This procedure is associated with possible injury to the lingual and hypoglossal nerves. A tracheostomy is mandatory. Postoperative oral intake is delayed

Figure 2. Transpalatal approach exposes central skull base between line A (sphenoid rostrum) and line B (C₁-first cervical vertebrae). Extension to line B requires division of a soft palate.

Figure 4. Transmandibular approach provides excellent exposure from C₃ (line B) to lower clivus (line A). Clival exposure requires division of palate.

for at least a week due to oropharyngeal edema and an extensive intraoral suture line. Malunion or nonunion of the mandible can occur secondary to intraoral contamination and infection.

Transmaxillary access to the nasopharynx can be achieved via a transantral approach, a bilateral Le Fort I osteotomy, or one of several maxillotomy procedures. The transantral approach is usually combined with either a transnasal or transpalatal approach because exposure is limited in the vertical direction and across the midline. Crumley and Gutin⁴ report a variation of this technique by removing the entire posterior wall and portions of the lateral and medial walls of the antrum in order to improve exposure to the pterygomaxillary space, lateral clivus, and sphenoid sinus. However, exposure of the cervical spine and superior nasopharynx is still limited.

The open door approach⁵ to the central skull base also employs a facial degloving technique. Vertical exposure is excellent; however, it requires complete division of the soft palate and lateral retraction of each half of the maxilla. The latter is limited by the soft tissues of the face. Thus, exposure is dependent on retractors in both the vertical and horizontal planes. Palatal vascularity is preserved bilaterally, and intermaxillary fixation is not required since miniplates reflex the facial skeleton. As in the bilateral Le Fort I maxillotomy, the risk of postoperative malocclusion is increased because of the need for multiple bilateral maxillary osteotomies.

The standard Le Fort I osteotomy⁶⁻⁸ provides excellent visualization of the upper half of the clivus, lower sphenoid, and pterygopalatine fossa, bilaterally. However, the inferior turbinates, nasal septum, and medial walls of the maxilla limit superior exposure (Fig. 5). Because the

hard palate is hinged posteriorly, it is difficult to obtain enough caudal displacement of the palate to visualize the lower clivus and cervical spine. The oral endotracheal tube may further hinder inferior palatal displacement. In addition, both maxillary sinuses are violated, thus increasing the risk of postoperative malocclusion due to altered positioning of the maxillary dentition.

In an effort to provide wide exposure to both the nasopharynx and upper oropharynx, a modification of the standard Le Fort I osteotomy was developed using a palatal hinge flap. A description of the surgical technique follows representative case reports.

CASE REPORT

An 85-year-old woman with a history of severe rheumatoid arthritis for which she was treated with chronic steroid therapy presented to her internist in October 1990 with a new onset of bilateral lower extremity weakness, gait instability, and mild neck pain. Examination confirmed the bilateral lower extremity weakness and diminished reflexes. There were no signs of cerebellar dysfunction. A lateral neck radiograph revealed a possible fracture of the first and second cervical vertebrae. Within 36 hours, the patient developed a rapidly progressive quadriplegia and was admitted to our institution.

Computed tomography and magnetic resonance scans of the cervical spine revealed marked brainstem and proximal spinal cord compression and displacement from a posteriorly subluxed first cervical vertebrae (Fig. 6A, B). The clivus was rotated to a more horizontal position and the cervical spine was foreshortened.

The patient was placed in a halo and dexamethasone 10 mg was administered intravenously every 6 hours. Due to instability of the cervical spine, surgery had to be performed with the head in a neutral position. Access to the entire clivus and first two cervical vertebrae was achieved via the palatal hinge flap. A 4 by 3 cm laterally based pharyngeal mucosal flap was elevated to allow removal of the subluxed vertebral body and primary grafting with iliac bone. At the completion of transfacial approach, the patient was placed prone. The craniovertebral junction was then stabilized with rigid fixation through a posterior midline neck incision.

Postoperatively, motor strengths returned to 4/5 in the upper extremities and 2/5 in the lower extremities. However, on postoperative day 5, the patient developed a deep vein thrombosis of the leg requiring heparinization. Thereafter, lower extremity strength deteriorated to 1/5. It is now 1 year since surgery was performed. The patient is decannulated and tolerating a regular diet. There is no vestibular stenosis nor nasal deformity from the facial degloving. The hard palate has healed primarily and is able to support the patient's upper denture. She is wheelchair bound with good upper extremity mobility function. Her cervical spine is stable.

Figure 5. Standard Le Fort I maxillotomy provides access from sphenoid rostrum (line A) to C₁ (line B).

Figure 6. A: Preoperative axial computed tomography scan showing subluxed dens (black arrow) retrodisplaced against spinal cord (white arrow). B: Preoperative sagittal magnetic resonance imaging showing spinal cord compression (black arrow) from dens. Note position of hard palate (white arrow/solid) and soft palate (open arrow) with respect to area of subluxation.

PROCEDURE

The patient is placed supine on the operating table. Neurosurgical head pins may enhance head stabilization during the procedure. An oral endotracheal tube provides access and protection for the airway and is easily secured at the contralateral aspect of the oral cavity so as not to interfere with surgical exposure. The head of the operating table is flexed 30°. Eye protection is achieved through bilateral tarsorrhaphy sutures. A midfacial degloving is performed to expose the anterior wall of both maxillas, the pyriform apertures, and the caudal septum. The infraorbital nerves are identified. Screw holes for miniplate fixation should be made prior to the vertical and transverse osteotomies. An ipsilateral transverse osteotomy is made in the lateral wall of the maxilla just above the level of the canine tooth root (Fig. 7). A unilateral Caldwell-Luc is performed preserving the infraorbital nerve. The medial wall of the ipsilateral maxilla is then removed up to and including the attachment of the inferior turbinate (Fig. 8).

If additional superior or contralateral exposure is required, a submucous resection of the bony nasal septum is performed. The cartilaginous and bony septum are partially resected to facilitate their dislocation to the contralateral nasal wall. The upper lateral cartilages may be

separated from the nasal septum, and a contralateral inferior turbinatectomy may be required to maximize septal displacement. A palatal osteotomy is then made parallel to the nasal spine on the side opposite the Caldwell-Luc (Fig. 8). The osteotomy is extended the full length of the hard palate. Care is taken not to disrupt the palatal mucosa. Starting anteriorly at the palatal osteotomy site, an incision is made in the palatal mucosa along the inner margin of the contralateral alveolus (Fig. 9). This incision can be extended posteriorly just lateral to the greater palatine foramen. The ipsilateral palate is then mobilized caudally (Figs. 10, 11). This is facilitated by blunt dissection of the palatal mucosa to the contralateral gingival incision. Both greater palatine vascular pedicles are preserved. A Dingman-style mouth gag may be used to support the upper lip and soft tissues of the face superiorly while at the same time maintaining caudal displacement of the hard palate. If necessary, the operating microscope may now be positioned.

In those cases in which primary soft tissue healing may be compromised, a variation of this procedure may be employed that does not require a gingival mucosal incision. Instead, the palatal mucosa may be bluntly dissected off of the contralateral hard palate to the inner margin of the alveolus. This will limit hard palate displacement approximately to 1.5 cm instead of the 2.0 to 3.0 cm that

Figure 7. Facial degloving exposes anterior face of maxilla. Infra-orbital neurovascular bundle identified bilaterally (arrow). Transverse osteotomy (line A) and vertical osteotomy (line B). Maxilla and palate between lines A and B constitutes palatal hinge flap.

is routinely achieved when using the gingival incision. A Dingman-style mouth gag is required to maintain the caudal displacement of the hard and soft palates. It is perhaps prudent that the surgeon begin each case with this approach, reserving the incision in the palatal mucosa for those cases in which additional exposure is needed.

At the completion of the procedure, the hard palate is

repositioned and secured using a 4-hole miniplate, oriented transversely across the premaxilla. A second L-shaped miniplate is placed vertically across the lateral maxillotomy site (Fig. 12). A single 24 gauge wire is used to fix the posterior aspect of the palatal osteotomy. The palatal mucosa is sutured along the alveolar margin using interrupted 3-0 silk sutures. The nasal septum is reposi-

Figure 8. Caldwell-Luc completed ipsilaterally. Medial wall of maxilla (open arrow) has been removed. Septum (A) displaced contralaterally. Osteotomy in palatal floor outlined (solid arrow).

Figure 9. Palatal view showing mucosal incision (line B) and hard palate osteotomy (line A). Hard palate under "A" will be displaced inferiorly. Greater palatine vessels at points C.

Figure 10. Oblique view showing inferiorly displaced palatal hinge flap (B). Note contralateral palate (A). Intact palatal mucosa (arrow) is dissected off contralateral hard palate (A) to increase palatal drop.

tioned and splintered with 2 mm thick Silastic sheeting. Nasal packing is placed bilaterally. The nasal incisions are closed with interrupted 4-0 chromic sutures and the sublabial incisions are closed with running, interlocking 3-0 chromic sutures. The nasal dorsum is taped transversely in two layers. Ice is applied intermittently to the face for the first 48 hours.

The nasal packing is removed in 2 days. Oral alimentation is begun on the first postoperative day, with the diet progressing from full liquids to a soft diet by the sixth day after surgery.

DISCUSSION

Our new modification of the Le Fort I maxillotomy provides excellent access to the entire nasal cavity, nasopharynx, sphenoid sinus, ipsilateral pterygopalatine fossa, clivus, and upper cervical spine (Figs. 13, 14). As demonstrated by a case presented herein, it can be a useful approach to decompress the anterior brainstem following atlas subluxation. This is especially true when the cervical spine is unstable and the patient's head must be held in a neutral position. However, it can also be used to remove nasopharyngeal cysts, select clival chordomas, angiofibromas, nasopharyngeal carcinomas, and other small to medium-sized lesions of the nasopharynx, maxilla, pterygopalatine fossa, clivus, and upper cervical spine (Fig. 15).

Vestibular stenosis is the most common problem associated with facial degloving and can be avoided by meticulous closure of the intranasal incisions. Perforation of the nasal septum can occur secondary to extensive mucosal dissection and mobilization. Silastic sheeting, placed parallel to the septum, helps to decrease postoperative synechia. The Silastic sheeting is removed 7 to 10 days after surgery. Nasal crusting occurs invariably and is secondary to the partial maxillectomy and inferior turbinectomies. This may require long-term care and is the major disadvantage of this procedure. Saline nose drops, administered several times a day, help to alleviate the problem.

Palatal blood supply via the greater palatine vessels is uninterrupted, minimizing the untoward effects of chronic steroid therapy, radiation therapy, or small vessel disease. As previously mentioned, the surgeon may choose not to violate the palatal mucosa along the alveolar margin in order to minimize the risk of oroantral fistulization that may occur if palatal blood supply is interrupted, or the palatal fixation is not rigid⁹ (Fig. 16). Miniplates are preferred to interosseous wiring because they provide more rigid fixation, promote primary bone healing, and permit early resumption of oral intake. Thus, intermaxillary fixation is not required. Placement of screw holes for miniplate fixation prior to the vertical and transverse osteotomies is critical for avoiding postoperative malocclusion secondary to malalignment of the hard palate.

Figure 11. Intraoperative photograph demonstrates placement of endotracheal tube under stationary left maxilla. Note caudal displacement of right hemipalate without aid of retractors. Upper lid retracted superiorly. Tumor clearly seen in depth of wound.

In light of the recent popularity of skull base surgery, numerous new techniques have been introduced to access the cranial base. The indications and limitations of each procedure must be kept in proper perspective. This new addition to the armamentarium of skull base procedures is not recommended for lesions with extensive intradural spread, those that involve the cavernous sinus or carotid artery, or for the repair of vertebral artery aneurysms or cervical arteriovenous malformations. The limitations of this procedure are directly related to the depth of the

Figure 12. Rigid fixation is applied to the maxillofacial skeleton. An L-shaped miniplate is positioned laterally and a straight plate is affixed anteriorly. The nasal septum is splinted midline.

Figure 13. Vertical exposure achieved with the palatal hinge flap extended from the cribriform plate (line A) to C2 (line B).

surgical field which challenges the surgeon's ability to obtain a watertight dural closure, and the unreliable nature of local nasopharyngeal and oropharyngeal tissues to prevent cerebrospinal fluid contamination. Nevertheless, the palatal hinge flap allows the surgeon to access the central skull base directly and is presented as an alternative to techniques previously described. The decision regarding which approach to use must be based, in part, on the exposure provided by, and the morbidity associated with, a particular technique.

Figure 14. Horizontal exposure achieved with this procedure extends from the contralateral nasal wall (line A) to the pterygoid plates (line B). If the posterior wall of the antrum is removed, access to the pterygoid fossa (C) can be achieved.

Figure 15. Preoperative coronal computed tomography scan of hemangiopericytoma of right nasal cavity excised via this approach. Intraoperative view shown in Figure 11.

CONCLUSION

A modification of the Le Fort I maxillotomy that provides direct access to the entire nasopharynx, ipsilateral maxilla and pterygopalatine fossa, and inferior clivus and proximal vertebrae is described. In addition, this approach can provide wide, safe exposure of the central skull base when the cervical spine is unstable. Vascularity to the hard and soft palate is maintained via the greater palatine vessels. Dental occlusion is easily restored using miniplate fixation, and facial incisions are avoided using a midfacial degloving approach.

Figure 16. Intraoral view showing primary healing of palate. Photograph taken during third postoperative week.

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REVIEWER'S COMMENTS

This article provides a review of some of the older approaches to the nasopharynx, clivus, and the upper cervical spine. The modifications of the palatal osteotomies are not new and have been used by oral maxillofacial surgeons. The application to skull base surgery is illustrated in their case report. Judging from the clinical photograph (Fig. 11), the actual working space intraorally and intranasally within the overall degloving approach appears rather limited and probably does not measure more than several centimeters. The authors do not list the reasons why a standard transoral approach, possibly with a soft palate split, would not have sufficed to approach the craniovertebral junction in this patient. There appears to be several disadvantages to their procedure: the drawings indicate that the soft palate is kept intact to assure additional vascularity to the displaced maxillary segment. This, by itself, makes the approach to the cervical spine somehow cumbersome by having a horizontal structure albeit somehow displaceable in the middle of the surgical field. Also, as with any other modification of a maxillary split and displacement intraorally, these segments are displaceable but do remain within the oral cavity and thus occupy precious surgical space. Also, as with other transoral procedures, if vascularized tissue is needed for reconstruction, it is difficult to provide regional tissue. For complex lesions of the central and paracentral skull base, we have used a combination of facial translocation and midfacial split.¹

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AUTHOR'S RESPONSE

It is most important that the reader understand the applications and indications of a given surgical technique. The utility of this procedure and its limitations are fully detailed in the discussion section of this article. When appropriately selected, this technique provides excellent exposure of the anatomic areas described. For large lesions, or those requiring corresponding intracranial access, we prefer the osteoplastic maxillotomy. Our reasons for avoiding a midline soft palate split are described in the introduction. To summarize, division of the soft palate is most hazardous in patients on chronic steroid therapy (i.e., case report), diabetics, or those who have received head and neck irradiation. Therefore, maintaining the vascularity of the displaced hard palate and the integrity of the soft palate is a critical advantage of this technique, especially in these high-risk subgroups.

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