Historically, the transoral exposures have provided access to ventral entities at the craniovertebral junction (CVJ). In a small subset of patients who undergo such approaches, the lack of mandibular mobility at the temporal mandibular joint and other associated craniofacial, intraoral anomalies can make it difficult or impossible to perform the transoral approach. Adjuncts to the transoral approach have been devised to facilitate exposure of the CVJ in such patients, including the midline “stair-step” mandibulotomy. This approach requires that extraoral incisions of the lip as well as median glossotomy or a lateral mucosal incision. The purpose of this study was to show that bilateral sagittal split mandibular osteotomies (BSSMOs), which are used in orthognathic surgery, represent a safer and more effective alternative to the stair-step split mandibulotomy when performed as an adjunct to the transoral approach because all incisions are intraoral and the plane of retraction is rostrocaudal instead of lateral.

Hospital records and radiographic files of four patients who underwent BSSMO/transoral approach for odontoidectomy between 1994 and 1997 were reviewed retrospectively. There were three women and one boy (mean age 37.8 years, range 11–68 years). Predisposing conditions included rheumatoid arthritis (two patients), Klippel–Feil syndrome (one patient), and congenital occipitocervical instability (one patient). Jaw mobility was limited in all patients. In addition, one patient had macroglossia, another micrognathia, and another retrognathia.

The BSSMO provided excellent exposure for resection of the odontoid process, as verified on follow-up magnetic resonance imaging or computerized tomography studies obtained in all patients. All mandibles were rigidly fixed by placing anterior mandibular border titanium plates and unicortical screws, and there was no incidence of nonunion or of lingual or inferior alveolar nerve injuries. The mean follow-up period was 26 months.

The BSSMO is an excellent, less invasive adjunct to the transoral approach in patients with limited jaw mobility.

KEY WORDS • sagittal mandibular osteotomy • adjunct transoral approach

Patients and Methods

Patient Population

Hospital records and radiographs obtained in four patients who underwent bilateral sagittal split mandibular osteotomies (BSSMOs)/transoral approaches between 1994 and 1997 were reviewed retrospectively (Table 1). There were three women and one boy (mean age at surgery 37.8 years, range 11–68 years). Three patients became symptomatic with spastic quadriparesis and one patient with episodic quadriplegia that was associated with apnea. Two patients suffered from rheumatoid arthritis, one patient from a Klippel–Feil syndrome anomaly, and the fourth had a history of occipitocervical instability. Ultimately, in all patients odontogenic neural compression caused by basilar...
invagination (three patients) or instability (one patient) had been demonstrated. Three of the patients had undergone an occipitocervical fusion procedure before the BSSMO/transoral odontopectomy. The last patient underwent occipitocervical fusion after the odontopectomy was performed via the BSSMO/transoral approach.

Radiological Evaluation

Preoperative radiographs, including a cervical spine series (anteroposterior, lateral, odontoid views) as well as magnetic resonance imaging and computerized tomography studies of the CVJ, were obtained in all patients. When indicated, dynamic radiographs (cervical spine flexion-extension views) were also obtained. All patients were evaluated by both a neurological surgeon and a craniomaxillary surgeon.

Surgical Procedure

Although optional, a tracheotomy that is performed during the same setting but before the BSSMO/transoral surgery can protect the airway and the approach incision sites while the wounds heal. If a tracheotomy is not performed after intubation, a reinforced orotracheal tube is secured to the lower dentition with 26-gauge stainless steel wire. The lower buccal sulcus is then infiltrated with an adrenalin solution in preparation for the BSSMO procedure. All our patients underwent tracheotomies before the actual surgery.

The patient is placed supine on the operating table, with the head in the neutral position. After routine sterile preparation, the lower buccal sulcus is incised on the right. The lateral ramus and posterior mandibular body are exposed and retractors are placed. Medially, the lingula is identified as the site at which the mandibular neurovascular bundle enters the hemimandible. The site of the sagittal split, which is the most convenient for plate application, is marked next. The split courses through the cortex medially above the lingula (avoiding the mandibular neurovascular bundle), along the anterior border of the ramus lateral to the second and third molars, and through the lateral cortex (Fig. 1 upper and center). The selected plate is passively adapted across the lateral osteotomy site at its superior border. A drill hole is made on each side and screws are placed. The remaining holes are drilled, and the plate is removed and set aside.

The osteotomy is then performed using a reciprocating saw and completed using thin osteotomes. After the contralateral osteotomy is performed, the mandibular arch is freed and displaced inferiorly (Fig. 1 lower) as the oral retractor is positioned. If needed, additional exposure can be obtained by retracting the soft palate into the nasopharynx or by dividing it.

When the transoral surgery is completed, the soft palate is repaired. Next, the oral retractors are removed, and the mandible is repositioned in its anatomical position with the posterior fragment. The prepared plates are applied with unicortical screws. If an orotracheal tube is used instead of a tracheotomy, the mandible typically cannot be placed in the intermaxillary fixation position, as would be desired. If there is space posterior to the dental arch, however, placing the tube in this position allows intermaxillary fixation. If intermaxillary fixation is an absolute requirement to restore the mandible to its normal position, the respiratory tube can be placed nasotracheally at the outset. Next, the oral mucosa is closed using a No. 4-0 absorbable suture.

At the end of the procedure, a feeding tube is placed, with the aid of direct visualization, and retained until both the transoral and mucosal incisions for the BSSMO have begun to heal. Once the incisions are stable, the feeding tube is removed. The patient is fed a liquid diet for approximately 4 weeks, advanced to a soft diet for 4 weeks, and then gradually returned to a regular diet.

Results

The BSSMO provided excellent exposure of the anterior CVJ in all patients. During surgery, exposure was ample. Retraction was possible down to the inferior aspect of C-2 and the C2–3 disc space anteriorly. In some cases, the majority of the C-3 body was also visible.

Postoperatively, imaging studies revealed excellent resection had been obtained of compressive entities. Two patients developed superficial mucosal infections along a small portion of the buccal incision but dehiscence did not occur. Both infections responded to oral antibiotic therapy. There were no cerebrospinal fluid leaks. All patients had their tracheotomy tubes removed within 4 weeks of surgery. All patients began liquid oral feedings within 7 days and returned to a regular diet within 2 months.

At long-term follow-up examination (mean 26 months, range 14–52), there was no evidence of other infections, osteomyelitis, or malocclusion. Furthermore, there was no incidence of inferior alveolar or lingual nerve injuries.

### TABLE 1

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Presentation</th>
<th>Primary Disease</th>
<th>Facial/Mandibular Anomalies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11, M</td>
<td>episodic quadriplegia/apnea</td>
<td>occip instability/basilar invagination</td>
<td>mandibular excursion &amp; macroglossia</td>
<td></td>
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<tr>
<td>2</td>
<td>49, F</td>
<td>quadriparesis</td>
<td>RA/basilar invagination</td>
<td>mandibular excursion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20, F</td>
<td>spastic quadripariesis</td>
<td>Klippel–Feil anomaly</td>
<td>mandibular excursion</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>68, F</td>
<td>spastic quadripariesis</td>
<td>RA/basilar invagination</td>
<td>mandibular excursion &amp; retrognathia</td>
<td></td>
</tr>
</tbody>
</table>

* occip = occipitocervical; RA = rheumatoid arthritis.
Discussion

The transoral approach to the CVJ provides neurosurgeons with an excellent method to resect compressive entities from an anterior perspective.\textsuperscript{2–4,7–9} In a subset of patients retractor systems and instrumentation may be impossible to place because of limited mandibular excursion, macroglossia, or other intraoral anomalies. Previously, in such patients the “stairstep” mandibulotomy, with or without midline glossotomy, was performed to provide ample exposure. The

Fig. 1. Anatomical illustrations depicting oblique (A and B) and superior views (C and D) of the mandible before and after planned (dashed lines) osteotomies. Transoral exposure obtained before (E) and after (F) the BSSMO procedures were performed.
cost, however, was high. This approach requires an extraoral incision, and the lip must be split externally. Furthermore, the tongue may need to be split in the midline, or a lateral retroglossal incision may be needed.

Other techniques that have been used to gain additional retraction in the transoral approach include mandibular coronoidectomy and unilateral or bilateral displacement of the mandibular head(s) from the temporomandibular joint(s). In fact, bilateral mandibular coronoidectomies offer little additional rostral-caudal retraction. The “mandibular swing” can be performed to approach the upper cervical spine, but the technique is quite invasive.

The BSSMO is performed in orthognathic surgery to repair a variety of facial and jaw deformities. When a malocclusion is caused by retrognathia, for example, the inferior mandible unit can be mobilized anteriorly and fused after BSSMO. The use of this technique in skull base surgery requires the expertise of a craniofacial/plastic surgeon or a maxillofacial surgeon. This is quite a valuable adjunct to the transoral approach in providing neurosurgeons with access to the CVJ. Space for the placement of retractors and instrumentation is ample, and additional exposure can be obtained for the resection of the pathological entities. Because all the incisions made in this approach are intraoral, they are not associated with the cosmetic deformities that may be encountered in patients who have undergone the midline split mandibulotomy.

The BSSMO can potentially lead to injury of the inferior alveolar or lingual nerves. Both can occur as the result of excessive traction or injury during the osteotomy procedure. We had no such injuries in our patients. Otherwise, BSSMO appears to be associated only with minor complications inherent to transoral approaches. Two of our patients experienced superficial mucosal infections along a small portion of the suture line; neither of which was associated with dehiscence, osteomyelitis, or meningitis. The infections probably reflect the prolonged duration of surgery conducted through a contaminated field. In both patients, the contaminating oral flora were easily eradicated by oral antibiotic therapy on an outpatient basis. In addition to prophylactic preoperative antibiotic therapy, a short course of postoperative antibiotic therapy may also be prudent in such cases and especially when oral feedings are reintroduced.

Conclusions

The BSSMO is an excellent adjunct to the transoral approach for access to the anterior CVJ in patients with intraoral anomalies or poor mandibular excursion. Potentially, this adjunct is less disfiguring and more practical than other traditional adjuncts to the transoral approach such as the “stairstep” mandibulotomy.

References


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