Bilateral Sagittal Split Osteotomy

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Abstract

The bilateral sagittal split osteotomy is an indispensable tool in the correction of dentofacial abnormalities. The technique has been in practice since the late 1800s, but did not reach widespread acceptance and use until several modifications were described in the 1960s and 1970s. Those modifications came from a desire to make the procedure safer, more reliable, and more predictable with less relapse. Those goals continue to stimulate innovation in the field today and have helped the procedure evolve to be a very dependable, consistent method of correction of many types of malocclusion. The operative surgeon should be well versed in the history, anatomy, technical aspects, and complications of the bilateral sagittal split osteotomy to fully understand the procedure and to counsel the patient.

Keywords

- bilateral sagittal split osteotomy
- mandible
- orthognathic

Background

Orthognathic surgery involves the surgical correction of the components of the facial skeleton to restore the proper anatomical and functional relationship in patients with dentofacial skeletal abnormalities. An important component of orthognathic surgery is the bilateral sagittal split osteotomy (BSSO), which is the most commonly performed jaw surgery, either with or without upper jaw surgery. Indications for a bilateral sagittal split include horizontal mandibular excess, deficiency, and/or asymmetry. It is the most commonly performed procedure for mandibular advancement and can also be utilized for a mandibular setback of small to moderate magnitude. More than 7 to 8 mm of posterior repositioning of the mandible with a BSSO can be difficult, and consideration should be given to an inverted "L" osteotomy or intraoral vertical ramus osteotomy (IVRO).¹ Asymmetry cases require careful workup and planning, but can be easily addressed with a BSSO. Cases requiring large advancements, patients with poor soft tissue envelopes, and skeletally immature mandibles are better addressed with mandibular distraction osteogenesis.² The bilateral sagittal split osteotomy is an indispensable surgical procedure for the correction of mandibular deformities. Undertaking the correction of these deformities requires a thorough knowledge of the indications, technique, and complications of the sagittal split osteotomy.

History

The history of orthognathic surgery of the mandible started with Hüllihen in 1846, who performed an osteotomy of the mandibular body for the correction of prognathism.³ There was little further innovation until that of Blair in the early 1900s, who performed a horizontal osteotomy of the ramus.⁴ The 1920s and 1930s saw further modifications by Limberg, Wassmund, and Kazanjian of external approaches to ramal osteotomies.⁵ All of these had difficulties with relapse. The earliest description of what would become the modern BSSO and the first intraoral approach to a ramal osteotomy was described in the German literature by Schuchardt in 1942.⁵ In 1954, Caldwell and Letterman described a vertical ramus osteotomy technique, which was shown to preserve the inferior alveolar neurovascular bundle.⁶ The focus of innovation in mandibular surgery then migrated to Europe where Trauner and Obwegeser in 1957 described what would become today's BSSO.⁷

The next several decades would see improvements and modifications to the procedure with the focus on decreasing relapse, improving healing, and decreasing complications. The main contributors to these improvements included Dal Pont (1961), Hunsuck (1968), and Epker (1977). In 1961, Dal Pont modified the lower horizontal cut to a vertical osteotomy on the buccal cortex between the first and the second molars, which allowed for greater contact surfaces and

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required minimal muscular displacement.⁸ In 1968, Hunsuck modified the technique, advocating a shorter horizontal medial cut just past the lingual to minimize the soft tissue dissection. His anterior vertical cut was similar to Dal Pont's.⁹ In 1977, Epker proposed several refinements.¹⁰ These included less stripping of the masseter muscle as well as limited medial dissection, all of which led to decreased postoperative swelling, hemorrhage, and manipulation of the neurovascular bundle. The decreased stripping of the masticatory muscles increased the vascular pedicle to the proximal segment, which diminished bone resorption and loss of the gonial angle. Rigid internal fixation was introduced in 1976 by Spiessel to promote healing, restore early function, and decrease relapse.¹¹ The introduction of an internal rigid fixation method, instead of 5- to 6-week intermaxillary fixation, had the added benefit of improved patient convenience. This new method was an applied concept from orthopedic trauma surgery.

Workup

Standardized photos are required not only for documentation and photometric analysis, but for evaluation of outcomes as well. Photographs with the patient's face in repose and while smiling should be obtained with the amount of incisal display noted with each. Skeletal evaluation typically includes radiographic evaluation with ortho-Panorex and cephalometric X-rays. Ortho-Panorex X-rays provide an overview of the stage of dental development, the mandibular anatomy, and gross pathology. Cephalometric X-rays provide for standardized skull and/or facial views that allow for comparison over time to assess growth in an individual and for comparison of that individual against standardized population norms. Obtain quantitative measurements based on key anatomic landmarks (cephalometric analysis). Numerous cephalometric analyses exist, each emphasizing particular skeletal and dental elements. Common analyses include Steiner, Ricketts, and Delaire; however, these are beyond the scope of this overview. For the surgeon, the analysis must be clinically workable, simple to use, and directly relatable to the skeletal elements that can be repositioned. Although the analysis is invaluable, it is inappropriate to focus the treatment plan solely on correcting cephalometric abnormalities. Surgical movements of the maxilla and mandible inherently alter the maxillary-mandibular dental occlusion, and as such, careful analysis of the dental models with the orthodontist is essential. The maxillary dental and mandibular dental casts can be studied individually and hand manipulated with each other to assess how the arches are coordinated. Establish the diagnosis from a working problem list generated from the clinical and photographic evaluation, cephalometric analysis, and dental models.

Treatment

There are several determinants of the optimal modification for BSSO in an individual patient, including the position of the mandibular foramen (lingual), course of the inferior alveolar nerve in the mandible, presence of the mandibular third molars, and planned direction and magnitude of distal

segment movement. Although it has been shown that increasing bone-to-bone contact, as in the Dal Pont lateral osteotomy location, should theoretically increase biomechanical stability, in general, however, the location of the lateral osteotomy cut for BSSO varies according to the surgeon's preference and training, and no consensus has been reached regarding the ideal location from the perspective of biomechanics.¹² Although biomechanics is only one of the factors determining the osteotomy technique to be used, it is important for the surgeon to consider the presence of jaw deformities, and their subsequent abnormal forces, while planning the treatment strategy.

The patient is placed in supine position on the operating table with general nasotracheal intubation and is prepared and draped for an intraoral procedure, with the entire face and neck within the field. Bilateral inferior alveolar nerve blocks with a short-acting local anesthetic and vasoconstrictor are given, which can be supplemented by a long-acting anesthetic at the end of the procedure. These blocks are infiltrated into the submucosa anteriorly in the buccal vestibule and along the ascending ramus. Intraoral landmarks are identified for the intraoral incision, including the anterior border of the ramus and the external oblique ridge. A bite block is placed on the contralateral side, and a Minnesota retractor is placed lateral to the external oblique ridge, to expose the mucosa overlying the anterior border of the ramus. A point is identified at just above halfway up the anterior border of the ramus, and the mucosa is incised with electrocautery continuing inferiorly, lateral to the external oblique ridge, to the second molar, where the incision continues more laterally into the vestibule down to the distal first molar. A cuff of tissue should be preserved medial to the incision to facilitate closure. The incision is continued through submucosa, muscle, and periosteum with electrocautery. With a periosteal elevator, the periosteum is elevated, exposing the external oblique ridge up to the coronoid notch. A periosteal elevator is used to dissect all of the tissue along the buccal surface of the ramus and the proximal mandibular body. Dissection is carried down to the inferior border of the mandibular body and the posterior border of the ramus. A J-stripper is then inserted along the inferior border of the mandible and all attachments are released. A V-shaper retractor is then placed along the external oblique ridge and all attachments to the anterior ramus are released as superior onto the coronoid as possible. A Kocher clamp with a chain is then placed on the coronoid process and secured to the surgical drape. Subperiosteal dissection continues along the internal oblique ridge inferior to the level of the occlusal plane to allow visualization of the medial aspect of the ramus. Starting superiorly a blunt elevator is passed posteriorly and inferiorly until just superior and posterior to the lingula.

Once all of the soft tissue dissection has been completed, attention can be turned to the osteotomies. A small elevator is placed along the medial aspect of the ramus and is utilized to retract and protect the pedicle. The lingula is typically located 1 cm above the occlusal plane and between one-half to two-thirds the distance from anterior to posterior on the ramus. Once the pedicle is adequately protected, a channel retractor

is inserted to provide lateral retraction, a Kocher is placed to provide superior retraction, and a reciprocating saw is placed medial to the ascending ramus, superior to the lingula and parallel to the occlusal plane. The cut is made through the cortical bone and into the cancellous bone, and then the saw is turned and the cut continued anteriorly down the external oblique ridge to the level of the second molar. Depending on each surgeon's training and preference, this cut can be made with the reciprocating saw or with a fissure bur. The final cut is then made vertically along the buccal cortex at the level of the second molar down to the inferior border of the mandible. It is important that this cut is made completely through the cortical bone along the inferior border. All of the cuts are then checked to ensure that they are complete through the cortex and down to cancellous bone. The osteotomy is then finished with small curved osteotomes, taking care to direct the curve buccally and to protect the soft tissues with a channel retractor. The osteotomes progress from anterior to posterior completing the cut. It is important to make sure that each one is complete down to the channel retractor below and that no twisting forces are utilized to prevent a bad split. As the split is opening, check the position of the inferior alveolar nerve, if it is hung up either on the lateral or proximal segment, use a blunt elevator to gently release it. Once the osteotomy is complete, check that each segment is free of the other and that the condylar head is still attached to the proximal segment.

Now the mandible is placed in its desired position with the aid of the prefabricated splint and any intervening bone is removed if performing a mandibular setback. The two segments are then fixated according to the surgeon's preference with either three bicortical screws on either side or with a miniplate with three holes on either side of the osteotomy. Care is taken during the placement of fixation to ensure that the condyle remains within the fossa and that the inferior border is well aligned. Once the segments are fixated, check the occlusion to ensure that it is satisfactory. If the desired occlusion has been reached, the incisions are closed with absorbable suture following copious irrigation and hemostasis. Guiding elastics can be placed intraoperatively or postoperatively following extubation.

Complications

Complications related to BSSO include bleeding from injury to the inferior alveolar artery or masseteric artery, unanticipated fractures and unfavorable splits, avascular necrosis, condylar resorption, malposition of the proximal segment, and worsening of temporomandibular joint (TMJ) symptoms.

The risk of injury to the inferior alveolar nerve is a significant consideration when performing a BSSO. The incidence of transection is reported between 2 to 3.5% and the incidence of some form of long-term neurologic deficit is reported in 10 to 30% of patients, whether symptomatic or not.¹³ When the sagittal split osteotomy is performed with an osseous genioplasty, nearly 70% of patients have some degree of neurosensory deficit at 1 year.¹⁴ Fixation of the segments without proper seating of the condyles can result in condylar malposition, which can lead to rotation of the

proximal segment and ultimate relapse, malocclusion, worsening of TMJ symptoms, and remodeling of the condylar head. Malocclusion in the form of an open bite is often the result of inadequate original fixation or hardware failure. When noted intraoperatively, the fixation should be revised; when noted in the postoperative course films should be obtained to assess for hardware function. Small postoperative posterior open bites can often be managed orthodontically. All orthognathic patients should be seen on a weekly basis following surgery if any signs of malocclusion develop and elastics adjusted appropriately to ensure healing in the proper occlusion.

Proximal segment fractures occur most often as a result of failure to completely cut the inferior border; this results in a fracture line that propagates along the buccal side of the inferior border. As the two fragments are split and this is noted, the inferior border should be recut.

Impacted third molars are another cause of unfavorable fractures and should ideally be removed 6 months to 1 year prior to mandibular surgery. When an impacted third molar must be removed at the time of surgery, care should be taken to not use excessive force. Cutting the tooth into smaller fragments will facilitate this.

Since the modern era of screw fixation, the incidence of lingual nerve injury has declined and become an uncommon complication following a BSSO. However, several cases have been reported in the literature. In most instances, lingual nerve paresthesia spontaneously resolves, but Peppersack and Chausse reported a 3% neurosensory deficit at 5 years.¹⁵ Most cases were due to wire or bicortical screw placement near the superior border of the mandible in the region of the third molar.

Temporomandibular dysfunction (TMD) is a common finding in the general population, with a reported incidence between 20% and 25%.¹⁶ The incidence of preoperative TMD in the orthognathic population is reported to be between 16 and 50%.¹ The most frequent symptoms identified were pain and clicking of the TMJ. Although the literature has a wide variation in the rates of symptom improvement, most studies have shown that the majority of patients has improvement in their symptoms with only a small percentage experiencing worsening of symptoms.¹

Decreased mobility after a BSSO is not an uncommon postoperative problem. It is most frequently attributable to prolonged immobility that results in fibrosis and atrophy of the muscle and connective tissue of the masticatory system. The incidence of hypomobility after a BSSO has declined with the use of rigid fixation, as prolonged periods of maxillomandibular fixation are not necessary. With the institution of a program of active rehabilitation, most patients return to preoperative interincisal opening within 3 months.

Intraoperative serious hemorrhage is a rare complication during a BSSO. Maintaining the surgical dissection subperiosteally and adequate retraction of soft tissue prevent minor intraoperative oozing and most cases of major hemorrhage. Minor hemorrhage from tearing of the periosteum can be controlled with electrocautery, pressure, or additional vasoconstrictive agents.

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