The Bilateral Sagittal Split Mandibular Ramus Osteotomy

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Introduction

The correction of dentofacial deformities demands accurate treatment planning for the orthodontic preparation and subsequent surgery. It is also mandatory that the surgical correction be performed accurately to ensure predictable and successful outcomes. This article describes the technique for the sagittal split mandibular ramus osteotomy in a step-by-step fashion with tips and traps with each step.

In 1970, J M Ferrer in said: “it must be recognized that at every operation the surgeon inevitably injures the patient; this injury can and must be minimized by the use of careful, gentle, and accurate surgical technique.”

Sound technical craft, science, and operating experience all come together to make most surgical procedures occur smoothly and successfully. No 2 surgeons’ surgical techniques are identical; however, there are certain basic principles that have to be adhered to when performing orthognathic surgery. This will not only ensure good surgical outcome but also limit complications. Moreover, important details of diagnosis and management of operative complications are difficult to master, since no 2 complications are ever identical.

Although the anatomy and shape of the human mandible lends itself to splitting in a sagittal plane, the surgical osteotomy of the mandible remains a challenging procedure. Over the last 30 years, the ingenuity of modifications 1,2 to the original technique as described by Obwegeser and Trauner in 1955,3 development of special instruments,4 and improvement of surgical skills have made it possible to achieve surgical goals relatively quickly andatraumatically. The surgical repositioning of the mandible has developed from a life-threatening procedure to outpatient surgery (in some parts of the world).5

Each surgeon should develop a routine that will enable the surgical team to anticipate each step, thus increasing efficiency and decreasing operating time and eventually limit postoperative morbidity.6

The surgical technique of the sagittal split mandibular ramus osteotomy can be performed in 32 steps. Each step will have certain tips and traps.

Step 1—infiltrate the soft tissue with vasoconstrictor

The lips should be kept lubricated with steroid ointment throughout the surgical procedure.

The area of dissection is infiltrated with a local anesthetic containing a vasoconstrictor (epinephrine in a concentration of 1:100,000) 10 minutes before surgery.

Step 2—the soft tissue incision

An incision is made through the mucosa, muscle, and periosseum from just lingual to the external oblique ridge, halfway up the mandibular ramus superiorly to mesial of the second molar inferiorly.
At least 5 mm of nonkeratinized mucosa should be left buccally at the lower end of the incision for ease of suturing later.

**Step 3—buccal subperiosteal dissection**

Strip the periosteum from the body and anterior aspect of the mandibular ramus to allow for adequate visualization.

Dissection must remain subperiosteal, decisive, clean, and neat.

It is not necessary to strip the entire masseter muscle attachment off the mandibular angle. Total stripping of the muscle will result in dead space and encourage swelling and hematoma formation.

**Step 4—superior subperiosteal dissection**

Strip the lower fibers of the temporalis muscle off the anterior border of the ramus.

Dissect the periosteum from the internal oblique ridge down to the medial aspect of the retromolar area.

Place a swallowtail (forked or notched) retractor over the anterior border and pull upwards for good visualization.

**Step 5—exposure of the lingula**

Start the medial dissection from above and then dissect inferiorly (Fig. 1).

Stay subperiosteal at all times.

Carefully identify the lingula and ensure visualization.

Perforation of the periosteum in this area may cause brisk hemorrhage (usually from the medial pterygoid muscle); however it often subsides spontaneously.

**Step 6—medial ramus osteotomy**

Use a Lindeman or 701 fissure bur, aim at the notch of the lingula and angle the osteotomy parallel to the occlusal plane (Fig. 2).

The convexity of the internal oblique ridge may obscure the lingula. If visualization is difficult, the ridge should be reduced with a large trimming burr (Fig. 3).

Terminate the osteotomy just posterior to the lingula into the fossa (see Fig. 2).

If the osteotomy is terminated short of the fossa, the bone will tend to split anterior to the foramen, leaving the inferior alveolar nerve and canal attached to the proximal segment.

When a mandibular setback procedure or a clockwise rotation of the maxillomandibular complex will be performed, a small segment of bone should be removed superior to the osteotomy. This will prevent bony interferences in this area following setback of the mandible or superior rotation of the distal segment (clockwise rotation).

**Step 7—sagittal osteotomy**

Use a saw or 701-fissure bur; start at the medial horizontal osteotomy superiorly, and stay just inside the buccal cortex of the mandibular ramus and body (Fig. 4).

Ensure the osteotomy is made through the cortex (approximately 5 mm).

The presence of an impacted third molar tooth may interfere (ideally impacted third molars should be removed at least 9 months before surgery). However the tooth should be treated as bone, and the osteotomy performed through the tooth.

![Fig. 1](image1.png) The subperiosteal dissection on the medial aspect of the mandibular ramus is started superiorly (arrow) and carefully carried downwards to identify the lingula.

![Fig. 2](image2.png) The medial osteotomy is angled parallel to the occlusal plane and carried past the lingula into the fossa (arrow).
Step 8—buccal osteotomy of the mandibular body

Remove the swallowtail (forked or notched) retractor and place a channel retractor at the lower border of the body. Start the buccal osteotomy at the lower border, and join it superiorly with the vertical osteotomy (see Fig. 4).

Ensure that the cortex of the lower border is included in the osteotomy (Fig. 5). The actual start of the split should be at the lower border and include the lingual cortex.

Cut toward the mandible and feel the bur perforate the cortex; however, be careful not to damage the inferior alveolar nerve. The inferior border cut should be preferably slightly angled posterior—medially, not at a right angle to the buccal cortex, so the initiation of the split begins in the proper direction and osteotomes may be inserted easily.

Step 9—drill holes for a holding wire

Positioning the condyle in the glenoid fossa is the most important step of the procedure and should be performed as a separate step prior to placement if rigid fixation. The use of a holding wire is optional; however, it allows the surgeon to position and maintain the condyle in the fossa while applying rigid fixation.

The holes of the positioning wires should be drilled in such a way that the proximal segment is directed distally. The ideal distance between the holes after repositioning the segments should be 4 mm.

For a patient requiring an advancement of 6 mm, the holes should be drilled 10 mm apart. After advancement of 6 mm, the holes will be 4 mm apart with the hole in the distal segment anterior and the hole in the proximal posterior (Fig. 6A).

For setback procedures (ie, 6 mm), the holes should be drilled 2 mm apart (anterior in the distal segment and posterior in the proximal segment). Once the mandible is set back, the holes will be 4 mm apart (see Fig. 6B).

Alternative techniques

Some surgeons make use of a bone clamp to hold the segments in position. However, there is a danger that the segments will be compressed, which may lead to peripheral condylar sag.

Step 10—drill a hole for the condylar positioner

The hole is drilled in the buccal cortex of the distal segment and angled posteriorly. The hole serves as a purchase point for the condylar positioning instrument during condylar positioning (Fig. 7).
Step 11—place reference marks

Reference marks are placed on either side of the vertical buccal osteotomy. Alignment of these marks will ensure accurate positioning of the proximal segment and alignment of the lower borders during condylar positioning (see Fig. 7).

Step 12—lavage

Wash the surgical area thoroughly with saline solution and gently place a small sponge in it. Once the osteotomy cuts have been completed on one side, it is recommended that the other side to be completed before proceeding to split the mandible.

Step 13—define the osteotomy

Use a 10 mm wide osteotome to tap along the vertical osteotomy line from the medial osteotomy downward to the buccal osteotomy below (see Fig. 7).

It is important to support the mandible when splitting the contralateral side to prevent hard and soft tissue damage on the side already split.

The osteotomy cuts are only defined at this stage; make no attempt to split to completely separate the segments.

Vigorous indiscriminate tapping may fracture the buccal cortical plate or even cause trauma to the temporomandibular joint (hemarthrosis or disc displacement).

Step 14—splitting the mandible

The actual splitting of the mandible can be divided into 2 stages.

First stage

The mandible should be supported at all times by the channel retractor and digital pressure to protect the temporomandibular joint.

Place a large 10 mm osteotome superiorly into the sagittal osteotomy and a small Reyneke splitter into the buccal osteotomy to engage the lower border of the mandible (Fig. 8).

Rotate the 2 instruments gently but firmly.
Visualize and ensure that:

1. The lower border of the mandible splits toward the proximal segment.
2. The neurovascular bundle is intact and separates from the proximal segment.

Second stage

Rotate the instruments further.

The lower border should continue to split toward the proximal segment, and the neurovascular bundle should detach from the proximal segment.

The inferior alveolar foramen and proximal part of the nerve canal should detach from the proximal segment.

The osteotome is now replaced by a larger Obwegeser osteotome and the small Reyneke splitter by the larger splitter; the split can now be completed.

The neurovascular bundle often remains attached to the proximal segment, especially in cases where the mandible is antero-posteriorly excessive or asymmetric (excessive side), in the presence of an unerupted third molar tooth, and when there is unilateral condylar hyperplasia (excessive side).

As soon as the surgeon realizes that the neurovascular bundle is still attached, the split should be stopped and the bundle carefully detached from the segment using a blunt (Howarth) dissector.

Fig. 8 A Reyneke splitter is placed into the buccal osteotomy on the lower border of the mandible (1). The splitter and an osteotome, placed into the superior aspect of the vertical osteotomy, are gently rotated (1 & 2). The lower border should separate from the distal segment including the lower border of the mandible (3).
When the inferior alveolar canal splits toward the proximal side, the surgeon should stop the procedure and carefully dissect the medial wall of the canal from the proximal segment using a small osteotome. Use a small nontoothed forceps to remove the bony canal from the bundle.

The bad split

An unfavorable split can be prevented by meticulously following the surgical steps. However, in case the split does not proceed favorably, stop the procedure and identify the problem under good vision. It is much easier to salvage the procedure if a potential problem is recognized early.

The following section describes the features if an unfavorable or bad split.

Fracture of the buccal cortex of the mandibular body

Early diagnosis
The buccal cortex start splitting; however, the lower border remains attached, and a small fracture is detected in the segment.
Redefine the buccal osteotomy, especially around the lower border.
Place the small Reyneke splitter low down in the buccal osteotomy and recapture the lower border to fracture it with the cortex of the proximal segment.
Place bicortical screws in the nonfractured part of the segment as well as through the small fractured segment. Alternatively use plate fixation.

Late diagnosis
If diagnosed late, the buccal cortex will be totally separated from the mandible. Remove the bone segment and place it in a saline soaked sponge. Redefine the remaining part of the osteotomy, especially the lower border (Fig. 9). Pay special attention not to damage the inferior alveolar neurovascular bundle. Use a small straight osteotome placed at the superior aspect of the vertical ramus osteotomy and a Reyneke splitter low down in the buccal osteotomy and complete the split. Replace the separated bony segment and fixate it with a lag screw while the nonfractured segments can be fixated by either bicortical or plate fixation.

Fracture of the buccal cortex involving the body and ramus of the mandible

Early diagnosis
A small fracture line occurs on the buccal aspect of the body, about halfway down the buccal osteotomy, and runs superiorly toward the coronoid notch. The lower border remains attached to the distal segment (see Fig. 11).
The buccal osteotomy should be redefined at the lower border. Correct the problem as a buccal plate fracture.

Late diagnosis
The buccal cortex including the coronoid process detaches from the mandible. The segment remains attached to the temporal muscle and should not be removed.
The proximal and distal segments are still attached, and every effort should be made to salvage the small part of the proximal segment still attached at the lower border.
Redefine the buccal osteotomy at the lower border. Carefully start the split along the fracture line of the cortex and complete the split.
There will now be little bone contact between the 2 segments, and plate fixation should be used. Secure the fractured segment with bicortical screws.

The split occurs anterior to the inferior alveolar foramen

Early diagnosis
This complication usually occurs if the horizontal osteotomy is left short of the lingula (Step 6) (Fig. 10). To prevent inferior alveolar nerve damage and long-term neurosensory problems, early diagnosis is imperative (Step 14).
Carefully redefine and extend the horizontal osteotomy beyond the lingula into the fossa posterior to the lingula. Complete the split under good vision and ensure that the split occurs beyond the lingula, and the neurovascular bundle detaches from the proximal segment.

Late diagnosis
The split is completed and segments are separated. Care should be taken not to manipulate the segments excessively. Extend the horizontal osteotomy past the lingula. Dissect the bony canal from the proximal segment. Carefully remove the bony canal from the neurovascular bundle.

Fracture of the retromolar aspect of the distal segment

The retromolar aspect of the distal segment is often fragile, especially when a third molar tooth is still present (Fig. 11). Care should be taken not to lever against this part of the jaw during the splitting maneuver (Step 14).
Early diagnosis
Carefully remove the impacted third molar tooth. Use plate fixation.

Late diagnosis
Remove the impacted third molar tooth. Take care not to damage the inferior alveolar nerve. Use plate fixation.

Step 15—stripping the pterygomasseteric sling
Place a curved periosteal elevator (J-stripper) between the segments and strip the muscle attachments from the distal segment.
This step will also ensure that no greenstick bony attachments remain between the 2 segments. Protect the neuromuscular bundle at all times. Insufficient stripping and any remaining bony attachments will lead to difficulty in repositioning of the distal segment and inaccurate condylar positioning.

Step 16—stripping the medial pterygoid muscle and stylomandibular ligament
Failure to strip these structures will interfere with positioning the distal segment and may lead to unfavorable rotation of the proximal segment (Fig. 12).

Step 17
The author is in favor of the removal of impacted third molars 9 months before surgery. Due to circumstances it is often necessary to remove third molars during the sagittal split osteotomy procedure.

Fig. 10 The split has been completed; however, the neurovascular bundle, lingula, and superior aspect of the inferior alveolar canal remains attached to the proximal segment (arrow).

Fig. 11 The 4 typical fracture lines of bad splits are demonstrated: buccal plate fracture (1), buccal plate fracture including the coronoid process (2), a fracture short of the lingula (3), and a retromolar fracture (4).

Fig. 12 The pterygoid muscle and stylomandibular ligament is stripped off the medial aspect of the mandibular angle (arrow).
The presence of impacted third molars during the SSO will often prevent ideal bone contact and may also weaken the retromolar aspect of the distal segment. Remove the third molars and take care not to damage the inferior alveolar nerve or fracture the retromolar bone. The presence of a third molar (or tooth socket) will jeopardize the placement of rigid fixation.

Step 18—smooth the contact areas of the segments

Use a large pear shaped reduction bur to smooth contact areas. Take care not to damage the inferior alveolar nerve.

Step 19—place the holding wire

Feed a 0.018-inch wire (25 gauge) through the holes (see Step 9).

Step 20

Note the position of the inferior alveolar neurovascular bundle and the socket of the third molar (if a tooth was present and removed).

Step 21—mobilize the bone segments

Remove the sponge placed following splitting the first side (Step 12). Support the proximal segment with the index finger and pull the distal segment gently but firmly anteriorly. Adequate mobilization will ensure that the soft tissue drape will allow free positioning of the distal segment.

Step 22—place the teeth into the planned occlusion

In 2-jaw cases, when the mandibular surgery is performed first, an intermediate surgical splint is used. In 2-jaw cases when the mandibular surgery is performed second or for single-jaw mandibular surgery cases, the use of a final splint is optional. Fixate the teeth into occlusion using 0.014-inch or 28 gauge wires.

Step 23—remove bone from the proximal segment in class III mandibular setback cases

With the teeth wired into occlusion, the proximal should now be gently pushed posteriorly. There will now be an overlap between the 2 bone segments, which should coincide with the planned amount of setback.

Remove enough bone to allow free repositioning of the proximal segment.

Refrain from forcing the proximal segment posteriorly to achieve a good fit at the vertical buccal osteotomy. This will force the condyle distally in the glenoid fossa resulting in condylar malpositioning.

Step 24—positioning the condyle

This is a challenging maneuver and certainly the most important step of the procedure. The surgeon may perform superb surgery; however, if the condyle is not positioned accurately into the glenoid fossa, the procedure will fail. The method of condylar positioning described here has been developed during the performance of more than 5200 bilateral sagittal split osteotomies over a period of 36 years.

Place the condylar positioner into the hole drilled in Step 10. Support the angle of the mandible by extraoral digital pressure.

Apply light posterior pressure on the positioner and at the same time digital superior and slightly anterior pressure on the mandibular angle. Note the vectors of force in Fig. 13. This will give the surgeon control of the proximal segment and an awareness of the anatomic relationship between the condyle and the fossa.

Use the reference lines, marked in Step 11, to align the lower borders of the segments and prevent unfavorable rotation of the proximal segment (Fig. 14).

Step 25—tightening the holding wires

The teeth are still secured in the planned occlusion by intermaxillary fixation. The surgeon should hold the proximal segment in its desired position (as described in Step 24), while the assistant gently tightens the holding wire.

View the segment while the wire is tightened to ensure that the segments are not forced together.

The wire should hold the segments passively together. Excessive force or overtightening of the wire will displace the condyle in the fossa and lead to peripheral (medio–lateral) condylar malpositioning.

The author does not recommend the use of a bone clamp at this stage because of concerns of generating condylar torque. Clamps such as the Sullivan BSSO clamp (Biomet Microfixation, Biomet Micro Fixation, Farmers Branch, Texas) may be used to hold the bones together with minimal torque. The holding wire is then secured (Fig. 14).

Fig. 13  Positioning of the condyle. Posterior pressure on the positioning instrument (1) and extraoral digital pressure on the angle of the mandible pushing superiorly and slightly anteriorly (2) will give the surgeon control of the proximal segment (3). Once the surgeon is confident that the condyle is positioned correctly in the fossa, the assistant can tighten the positioning wire (4).
Jacksonville, FL, USA) are designed to preclude this if judiciously utilized.

Step 26—placement of the trocar

Ridged fixation may be placed through an intra- or extraoral approach.

An extraoral stab incision is made through the skin just below the lower border of the mandible.

The trocar is now placed through the stab, and the periosteum is perforated intraorally. Angle the trocar superiorly to avoid damage to the neurovascular bundle or displace the bone segments.

By using the Reyneke intraoral trocar, the ridged fixation may be placed through an intraoral approach. The use of this approach is influenced by the presence of a third molar, bone thickness, position of the inferior alveolar nerve, and adequate access to appropriately orient the screws through the segments.

Step 27—drill the holes and for the place of rigid fixation

The proximal and distal segments can be fixated by means of bicortical screws or plate fixation.

Bicortical screw fixation

During placement of ridged fixation several factors should be considered:

- The position of the inferior alveolar neurovascular bundle (see Step 18)
- The distal root of the lower second molar
- Thickness of the bone to estimate the length of the screws (a depth gauge may be used)
- Ensure that the drill perforate both bone cortices
- Configure the position of the holes to ensure stable fixation (ie, in a triangular fashion or in a straight line at the upper border)
- Place enough screws for adequate fixation (3–4 screws are usually sufficient)

Use a sharp drill and apply light pressure with the trocar when drilling the holes. Undue pressure may displace the bone segments, the condyle or the occlusion.

Use copious water cooling. If the shaft of the drill is forced against the trocar, it will generate heat and burn the skin and subcutaneous tissue in contact with the tube of the trocar.

Angle the holes lightly backward to support the repositioned condyle.

Once a hole is drilled the assistant should load the screw with an appropriate length on the screwdriver, (a motorized screwdriver is a handy instrument at this time).

View the bone segments carefully when applying the screw to ensure the screw engages the lingual cortex without displacing the position of the segments.

Keep in mind that bicortical screws are self-tapping and need only to be turned to engage. No excessive force is required.

Make sure that the segments are not compressed or any intersegmental gaps should not be closed by tightening the screws. This will displace the condyle and result in peripheral sag.

The small bone defects should be grafted.

Plate fixation

The principles also apply when plates are used as a fixation method.

An appropriate plate is selected to allow for at least 2 screws to be placed on each side of the osteotomy. One or 2 plates may be used; however, most surgeons use only one 2.0 mm plate.

Bend the plate to fit accurately to the bone and position the plate to allow for placement of the posterior screws first. Two bicortical (or unicortical) screws are placed through the posterior holes.

The unicortical screws engaging the distal segment are then placed while the proximal segment is held in place by either the holding wire or a positioning instrument.

Step 28—remove the intermaxillary fixation and check the occlusion

To ensure that the condyles will settle and have been positioned correctly, the occlusion should not be checked...
immediately following removal of the intermaxillary fixation. Wait a few minutes. Gently open and close the mouth and translate the mandible from side to side. With light finger pressure, the mouth is closed and the occlusion checked. The occlusion should be exactly as planned or fit perfectly into the surgical splint. The author is not in favor of a final splint, as it may hide small discrepancies at this stage.

**Step 29—Intraoperative diagnosis of a malocclusion**

An incorrect occlusion at this stage may be caused by:

- Incorrect condylar position (condylar sag)
- Failure of fixation
- Displacement of the occlusion during placement of the ridged fixation
- Inaccurate surgical splint
- Intracapsular edema or hemarthrosis and condylar disc displacement—these problems may only become apparent postoperatively.

It is imperative that an incorrect occlusion not be accepted. There is no better time to address the problem than at this stage. The intraoperative differential diagnosis of an incorrect occlusion is important for the correction of the problem.7

**Step 30—Place intra and extraoral sutures**

Resorbable sutures are used intraorally and non-resorbable sutures extraorally. The extraoral sutures are removed 2 days postoperatively.

**Step 31—Place intermaxillary elastics**

One 4-oz. 0.25-inch elastic is placed on each side. The elastics are placed in a triangular fashion usually in the canine region.

The direction of the elastics should reinforce the surgical movement (ie, Class II elastics for mandibular advancement and a Class III pattern for mandibular setback procedures). Keep in mind that the purpose of the elastics is to override the proprioception and not to correct an incorrect occlusion or condylar sag.

The final position of the bone segments is demonstrated in Fig. 14.

**Step 32—Apply a pressure bandage**

The pressure bandage is removed 1 day following surgery, at which time the postoperative physiotherapy is commenced. Over the past three decades our knowledge and understanding of all aspects of orthognathic surgery has increased greatly. Not only has there been an evolution in the sophistication of diagnostic skills and treatment planning, but through experience, surgical techniques have attained a level enabling surgeons to treat the most complex jaw deformities with confidence.

There is a magnitude of instruments available to facilitate the surgeon’s technique. It is preferable, however, that the surgeon develops a familiarity with a small selected group of instruments that will ultimately achieve the same goal.

No matter how accurate and meticulous the surgeon, complications may and will occur during and after orthognathic surgery. The surgeon should therefore have a routine and an understanding of the step-by-step sequence of the procedure. For each step, there are relevant tips to improve the outcome. The surgeon should also be aware of specific traps that may lead to consequences or complications. This will enable him or her to recognize and manage a complication before it occurs.

**References**
