Universiteit Leiden
The Netherlands

Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique

Verweij, J.P.; Verweij J.P.

Citation

Verweij, J. P. (2017, September 12). *Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique*. Retrieved from https://hdl.handle.net/1887/54689

Version:	Not Applicable (or Unknown)
License:	Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden
Downloaded from:	https://hdl.handle.net/1887/54689

Note: To cite this publication please use the final published version (if applicable).

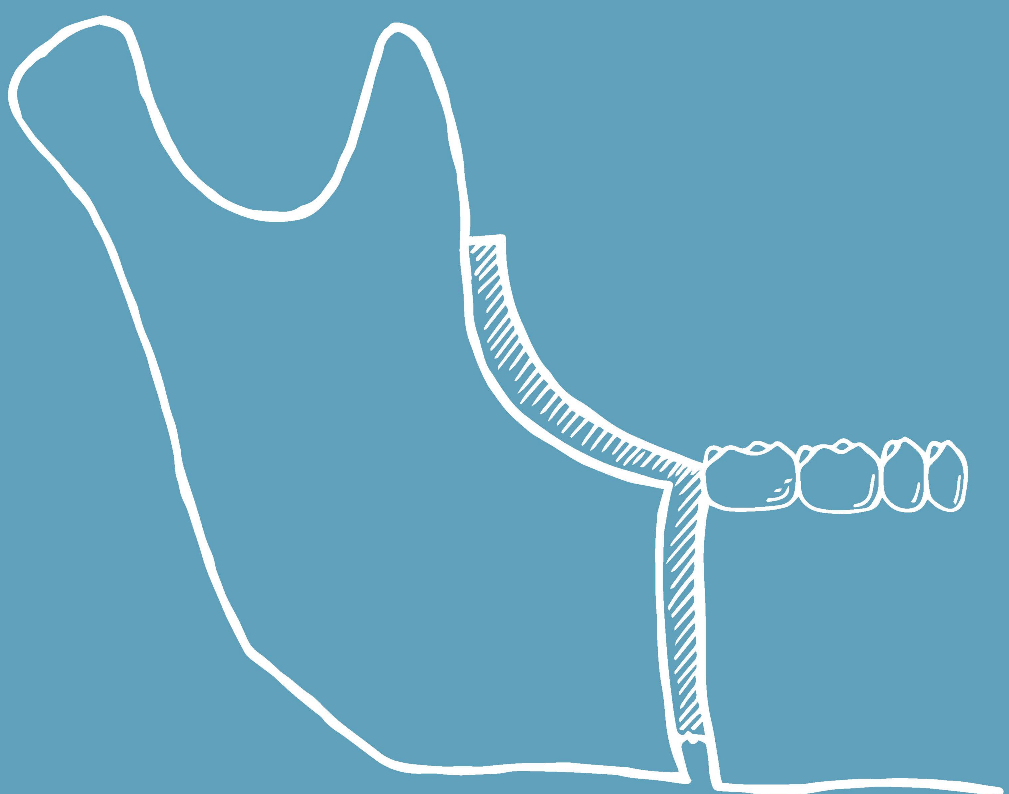
Cover Page

Universiteit Leiden

Leiden University Repository

The handle http://hdl.handle.net/1887/54689 holds various files of this Leiden University dissertation

Author: Verweij, Jop
Title: Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique
Date: 2017-09-12



CHAPTER 6

Are there risk factors for osseous mandibular inferior border defects after bilateral sagittal split osteotomy with splitter and separators?

This chapter is based on the manuscript:

Verweij JP, van Rijssel JG, Fiocco M, Mensink G, Gooris PJJ, van Merkesteyn JPR

Are there risk factors for osseous mandibular inferior border defects after bilateral sagittal split osteotomy with splitter and separators?

Journal of Cranio-Maxillofacial Surgery 2017; 45: 192-197.

ABSTRACT

Bone defects of the inferior mandibular border (osseous inferior border defects) can cause unaesthetic postoperative outcomes after bilateral sagittal split osteotomy (BSSO). The aim of this study was to estimate the frequency of osseous inferior border defects after BSSO and identify risk factors for this complication.

This retrospective study included consecutive patients who underwent BSSO for mandibular retrognathia. The primary outcome was the presence/absence of osseous inferior border defects. Predictors included the mandibular movement, rotation of the occlusal plane, postoperative proximal segment position, pattern of the lingual fracture, occurrence of bad split, and presence of third molars.

The study sample consisted of 200 patients (mean follow-up of 13 months). The mean mandibular advancement and rotation was respectively 5.8 millimeters and 5.4 degrees clockwise. Osseous inferior border defects were present in 7.0% of splits and 12.5% of patients. Significant risk factors for inferior border defects included increased advancement, increased clockwise rotation, cranial rotation of the proximal segment, and a split originating in the lingual cortex.

In conclusion, osseous inferior border defects occur significantly more often in cases with large mandibular advancement, increased clockwise rotation of the occlusal plane, malpositioning of the proximal segment, and a split originating in the lingual cortex.

INTRODUCTION

Bilateral sagittal split osteotomy (BSSO) is a widely used orthognathic surgical technique for the correction of mandibular deformities. The main purpose of this elective procedure is the establishment of a class I occlusion with good function. Surgeons should also aim to establish a harmonious maxillofacial profile with good facial esthetics.

BSSO is associated with some well-known postoperative complications, including damage to the inferior alveolar nerve, bad split, postoperative infection, and symptomatic removal of the osteosynthesis material.[1] A less common postoperative complication of BSSO advancement is the occurrence of osseous mandibular inferior border defects. These bone defects occur at the inferior border of the mandible, near the vertical osteotomy site of the sagittal split.[2, 3] They can cause visible and palpable dimples at the inferior border of the mandible and can result in an unaesthetic outcome of BSSO, leading to patient dissatisfaction.[2, 4, 5] Inferior border defects can sometimes even necessitate secondary reconstruction using bone products or allogeneic implants.[2, 4] These secondary procedures not only cause patient discomfort, but also pose a significant risk of iatrogenic damage.

Previously reported risk factors for the occurrence of osseous inferior border defects after BSSO include older age, increased extent of mandibular advancement, and inclusion of the full thickness of the mandibular inferior border in the split.[2] However, few studies have investigated this subject.

Surgeons should always attempt to avoid the occurrence of inferior border defects in order to increase patient satisfaction and minimize the risks associated with secondary procedures.

This study investigates the risk of osseous inferior border defects after BSSO according to the Hunsuck modification with sagittal splitter and separators. The investigators hypothesized that increased mandibular advancement, significant (clockwise) rotation of the occlusal plane, malpositioning of the proximal segment, the pattern of the lingual fracture, the occurrence of bad splits, and presence of third molars could play a role in the development of osseous inferior border defects. The specific aims of the study were to estimate the incidence of osseous inferior border defects and identify relevant risk factors associated with this complication.

MATERIAL AND METHODS

Study design/sample

To address the research purpose, the investigators designed and implemented a retrospective cohort study. The study population was composed of consecutive patients presenting for evaluation and management of retrognathia between July 2006 and March 2015 at the Department of Oral and Maxillofacial Surgery of the Leiden University Medical Center, the Netherlands. To be included in the study sample, patients had to have a class II malocclusion that was treated with BSSO according to the Hunsuck modification with sagittal splitter and separators. Single BSSO procedures as well as procedures combined with Le Fort I osteotomy and/or genioplasty were included in this study. Patients were excluded from this study if clinical follow-up was less than six months or radiographic evaluation was not available.

Surgical protocol

The BSSO procedures were performed by one of six consultant maxillofacial surgeons (specialists), usually closely supervising a resident operating on the contralateral side of the patient. All surgeons performed surgery according to the same surgical protocol, using the same osteotomy design and surgical technique, as reported in previous papers.[6, 7] Residents performed surgery only under close supervision of the surgeon.

BSSO was performed according to the Hunsuck[8] modification, using a sagittal splitter (Smith Ramus Separator 12 mm, Walter Lorentz Surgical, Jacksonville, FL, USA) and separators (Smith Sagittal Split Separators, curved, Walter Lorentz Surgical, Jacksonville, FL, USA). A short medial cut was placed just above the mandibular foramen. Subsequently, a sagittal cut was made over the anterior side of the ascending ramus towards the distal border of the second molar. The vertical osteotomy was always performed at the distal border of the second molar, perpendicular to the inferior border of the mandible. An inferior border cut was made completely passing through the inferior cortex and reaching the lingual cortex. The sagittal split was then performed using a splitter and separators without the use of chisels. The splitter was placed in the sagittal bone cut and the separator in the vertical bone cut, in order to guide the split. After successful splitting, the distal segment was fixed in its new position using an intermaxillary wafer. A small horizontal bone cut was performed in the medial side of the proximal segment, approximately at the midpoint of the vertical bone cut, and this mandibular segment was secured in its correct position using a Luniatschek ligature tucker. This technique was used to correctly secure the condyles in the glenoid fossa and, subsequently, position the proximal mandibular segment in line with the distal mandibular segment. The proximal segment was aligned with the distal segment by aligning the inferior mandibular border of both segments. Rigid fixation was then applied. Standard follow-up included clinical and radiographic evaluations at 1 week, 1 and 6 months, and 1 year after surgery.

Variables

The primary outcome variable in this study was the presence/absence of osseous inferior border defects. Osseous inferior border defects were defined as a bone defect in the inferior border of the mandible near the vertical osteotomy site. The occurrence of osseous inferior border defects was categorized on both sides of the patient as: 1) inferior mandibular border without relevant contour changes; 2) large contour changes of the inferior border equivalent to approximately one thickness of the inferior cortex; or 3) large contour changes of the inferior border corresponding to more than one cortical thickness. If a large contour change of the inferior border of more than one cortical thickness (category 3) was observed, an osseous inferior border defect was defined as 'present' during further analyses.

A set of predictor variables was used to investigate risk factors for osseous inferior border defects, including both operative and radiographic variables. Operative predictor variables included the presence/absence of third molars during surgery, and the presence/absence of bad splits. Radiographic predictor variables included the amount of mandibular movement (mm), the rotation of the occlusal plane (degrees), the postoperative position of the proximal segment, and the pattern of the lingual fracture. The position of the proximal segment was subcategorized as good anatomical position of the proximal segment, slight rotation of the proximal segment of less than one cortical thickness, or significant rotation of the proximal segment of more than one cortical thickness. If the proximal segment was aligned with the distal segment in a continuous line with the inferior mandibular border, this was defined as a good anatomical position of the proximal segment. The pattern of the lingual fracture was defined as either a type I or a type II split. A type I split (Figure 1) was defined when the inferior border had split on the lingual and buccal side with the cortical bone of the caudal cortex in both the proximal and distal segments. A type II split (Figure 2) was defined by a split originating in the lingual cortex (including the full thickness of the inferior border), leaving the complete bilateral caudal cortex attached to the proximal segment.

Patient and procedural characteristics were recorded. These characteristics included the age and sex of the patients, type of procedure (i.e., BSSO or bimaxillary procedure with or without genioplasty), and whether the procedure was performed by a specialist or by a resident under the close supervision of a specialist.

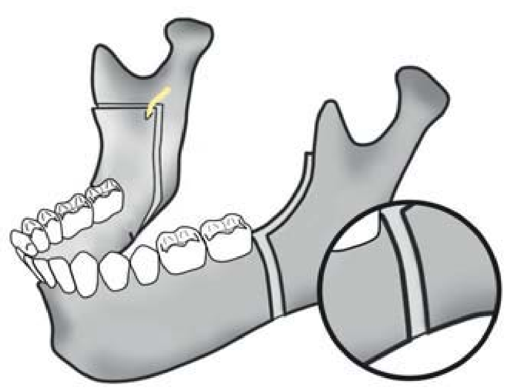


Figure 1: Type I split, with the lingual cortex attached to the distal mandibular segment.

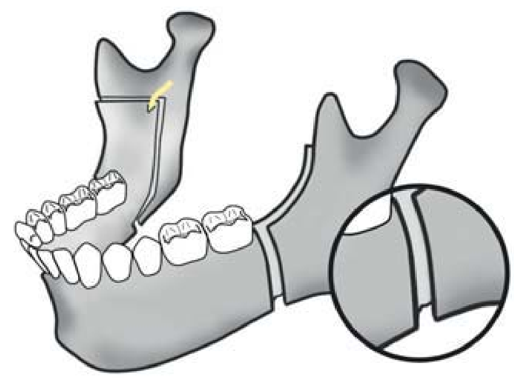


Figure 2: Type II split, with the full thickness inferior cortex completely attached to the proximal mandibular segment.

Data collection methods

The occurrence of osseous inferior border defects was analyzed using preoperative radiographs and postoperative radiographs (orthopantomographic images) acquired at the latest follow-up (minimally 6 months after BSSO) (Figure 3). In the most recent orthopantomogram, a tangential line to the inferior mandibular border was visualized to assess if a contour change was present near the vertical osteotomy site. This contour change of the inferior mandibular border was measured relative to the thickness of the inferior cortex (i.e. more/less than one cortical thickness).

The presence/absence of third molars and the occurrence of bad splits during surgery had been recorded in surgical reports. The extent of mandibular advancement and the rotation of the occlusal plane were calculated from the pre- and postoperative lateral cephalograms by cephalometric measurement. The amount of mandibular advancement was measured as the distance (mm) between reference point pogonion in the pre- and postoperative cephalogram. In case of a genioplasty, a reference point just above the chin-osteotomy was used. This distance between pogonion preoperatively and postoperatively was measured after precise superposition of the mandibular condyle and occlusal plane. The rotation of the occlusal plane was analyzed by superposing static reference points (mandibular condyle, sella, and nasion) and subsequently measuring the angle between the occlusal plane in the pre- and postoperative cephalogram. The assessment of the position of the proximal segment was performed through subjective evaluation by the surgeon, using orthopantomographic or cone-beam computed tomography (CBCT) images acquired one week after surgery. The type of split was analyzed using orthopantomographic images that were recorded one week after surgery.

The findings are reported according to the STROBE guidelines for reporting on observational studies.[9] The entire study was performed in accordance with the guidelines of our institution and followed the Declaration of Helsinki on medical protocol and ethics. Because of the retrospective nature of this study, it was granted an exemption by the Leiden University Medical Center institutional review board.

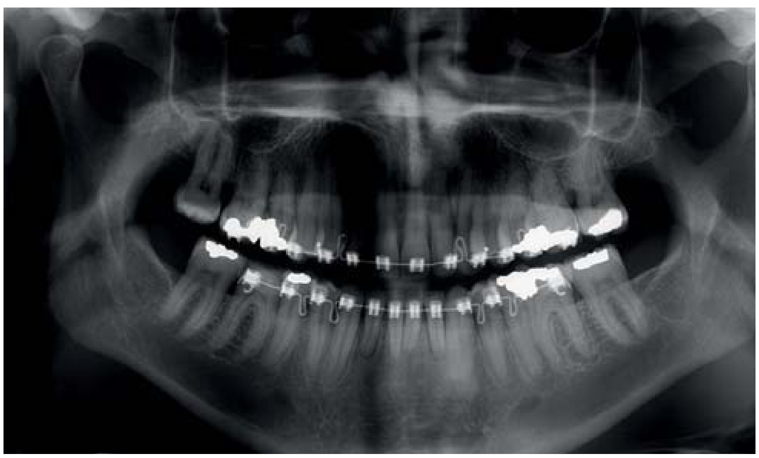


Figure 3a: Preoperative orthopantomographic image acquired a month before bilateral sagittal split osteotomy (BSSO).

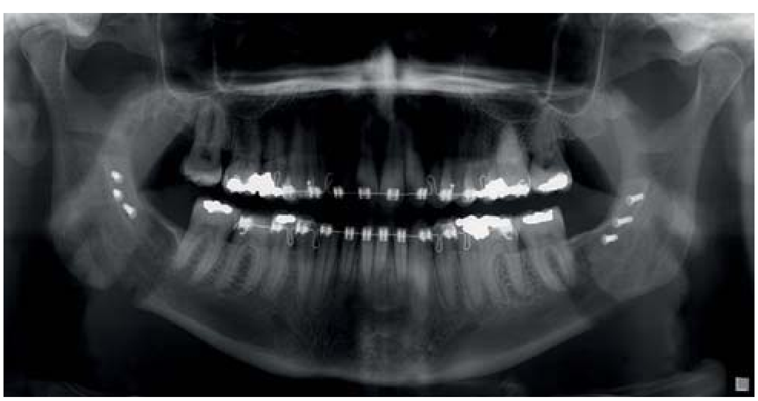


Figure 3b: Orthopantomographic image acquired 2 days after BSSO, showing a defect on the right side. Note that the full thickness of the inferior cortex is attached to the proximal segment on the right side (type II split) and the proximal segment is positioned downwards and backwards (in line with the distal segment). On the left side, a type I split was present, and a forward and upward (cranial) rotation of the proximal segment is observed.

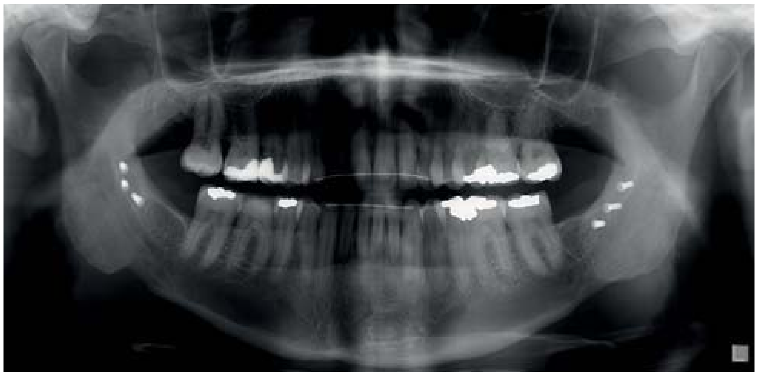


Figure 3c: Orthopantomographic image acquired a year after BSSO, showing an osseous inferior border defect on the right side.

Data analyses

Statistical analysis was performed with using the Statistical Package for Social Sciences (SPSS version 23.0 for Mac; IBM, Armonk, NY, USA). Descriptive analyses of the patient characteristics and specifics of the surgical procedures were performed first. The association between the risk factors and incidence of osseous inferior border defects was evaluated using generalized linear mixed models (GLMM) in order to account for the correlated nature of the data: repeated measures design involving the measurement of both the sagittal split osteotomy (SSO) on the right and left sides of each patient. Probabilities less than 0.05 were considered statistically significant.

RESULTS

The medical records of 219 patients were evaluated, leading to the inclusion of 200 patients in this study. The exclusion of 19 patients was necessary because of follow-up durations of less than 6 months (10 patients) or absence of postoperative radiographs (9 patients). The patient characteristics of the final study group are represented in Table 1. The mean follow-up duration was 13 months (standard deviation [SD], 5 months; range, 6–38 months).

Category	n (%)
Sex	
Male	78 (39.0%)
Female	122 (61.0%)
Mean age (years)	29.7
SD, range	12.0, 13.8–55.6
Procedures	
BSSO	141 (70.5)
BSSO + Le Fort I osteotomy	40 (20.0)
BSSO + genioplasty	5 (2.5)
BSSO + Le Fort I osteotomy + genioplasty	14 (7.0)
Operating surgeon (SSO)	
Specialist	220 (55%)
Resident	180 (45%)
Mean mandibular advancement (mm)	5.8
SD, range	1.8, 1–11
Clockwise rotation (degrees)	5.4
SD, range	2.5, 0–13

Table 1: Patient characteristics. Data are represented as the number of patients (%) unless otherwise specified; SD, standard deviation; BSSO, bilateral sagittal split osteotomy.

The incidence of osseous inferior border defects is represented in Table 2. Third molars were present during surgery at 163 SSO (40.8%) and absent at 237 SSO (59.3%). During surgery, bad splits occurred at 9 of 400 SSO (2.3% per SSO). Buccal plate fractures of the lateral cortex accounted for 5 of the 9 bad splits and lingual plate fractures of the medial cortex accounted for the remaining 4. No bilateral bad splits were recorded. Rigid fixation was performed using bicortical screws in 380 splits and monocortical miniplates in 16 splits; intermaxillary fixation was necessary because of a bad split in 2 patients.

	No. of SSO, n (%)
Inferior mandibular border without relevant contour changes	317 (79.3)
Large contour change of the inferior border	55 (13.8)
Inferior border defect	28 (7.0)

Table 2: Incidence of inferior border defects. Data are represented as the number of SSO (%).

6

Postoperative radiography findings revealed a good anatomical position of the proximal mandibular segment at 272 SSO (68.0%). Slight cranial rotation of the proximal mandibular segment (less than one cortical thickness) was observed at 114 SSO (28.5%) and significant cranial rotation of the proximal segment at 14 SSO (3.5%). The results of analysis of the origin of the split revealed type I splits in 344 SSO (86.0%), wherein the sagittal split originated in the caudal cortex, running through the inferior border with the buccal and lingual cortices attached to respectively the proximal and distal segment. The remaining 56 splits (14.0%) were classified as type II splits, indicating splits originating in the lingual cortex, leaving the complete bilateral caudal cortex attached to the proximal segment.

Using GLMM, no significant association was observed between the incidence of inferior border defects and the presence of third molars ($p = 0.14$) or bad splits ($p = 0.38$). Statistically significant associations were observed between the incidence of inferior border defects and increased extent of mandibular advancement ($p < 0.01$) as well as increased clockwise rotation ($p = 0.012$). Similarly, the occurrence of inferior border defects was found to be statistically significantly associated with the cranial rotation of the proximal segment ($p < 0.01$) as well as the presence of a type II split ($p < 0.01$).

DISCUSSION

The purpose of this study was to estimate the incidence of osseous inferior border defects after BSSO according to the Hunsuck modification with splitter and separators. Risk factors for this complication are furthermore assessed. In the current study group of 200 patients, the overall incidence of osseous inferior border defects was 12.5% per patient and 7.0% per SSO. Significant risk factors for osseous inferior border defects were larger mandibular advancements, increased clockwise rotation, cranial rotation (malposition) of the proximal segment, and a type II split originating in the lingual cortex (including the full thickness of the inferior cortex).

In a recent study, Agbaje et al.[2] reported a 36.5% incidence of inferior border defects per SSO after BSSO, which is significantly higher in comparison to the 7% incidence identified in our study. The discrepancy between the findings of these two studies could be related to the greater amount of mandibular advancement (10.7 mm vs. 5.8 mm) and higher percentage of type II splits (28% vs. 14%) in the study group of Agbaje, et al.[2] A smaller bone gap between the proximal and distal segment of the mandible could be less than the critical size defect, allowing healing of the bony gap, decreasing the evidence of inferior border defects. However, differences in the technique and the position of the vertical bone cut could also play a role in the different findings. Agbaje et al.[2] performed the vertical bone cut between the first and second molar as opposed to our technique, where the vertical bone cut was performed just distally of the second molar.

Advantages of placings the vertical bone cut distally of the second molar include a short (and therefore predictable) lingual fracture distance, and thus no need for an inferior border osteotomy.[10] With this technique, the masseter muscle could furthermore cover inferior border defects, preventing a visible unaesthetic inferior border defect.[5] Clinical studies show that BSSO according to this technique is associated with a low incidence of neurosensory disturbances.[6, 7, 11, 12] However, placing the vertical bone cut behind the second molar could also have several disadvantages like: a limited maximum amount of advancement, and no additional control of the vertical position of the proximal segment.[4, 5, 13]

Although the present study differed from the study by Agbaje et al.[2] with regard to the incidence of osseous inferior border defects, both studies identified a significant association between inferior border defects and large mandibular advancements or a type II split. This association between the extent of mandibular advancement and osseous inferior border defects could be explained by the basic principles of bone healing as well as the interference of the soft tissue during the healing process.[14] The higher risk for osseous inferior border defects following increased clockwise rotation of the occlusal plane is explained by the angle of the inferior border of the mandible created after the rotation. This angle is located near the vertical osteotomy site and, therefore, causes a contour change and sometimes even a slight dimple. Regular bone healing will not alter this angulation defect. Compromised bone healing in these cases would, however, rapidly lead to a noticeable inferior border defect.

Proximal segment positioning during BSSO remains an important part of surgery. In the present study, care was taken during surgery to secure the proximal segment correctly in the glenoid fossa and position the proximal segment in line with the distal mandibular segment. However, the results of our study indicated that, despite these precautions, 3.5% of the sagittal splits still showed significant cranial rotation of the proximal segment. Various authors have proposed different techniques to ensure correct positioning of the proximal segment before fixation of the mandibular segments after a successful split. Wolford[4] describes a stepwise sagittal cut, fixed with a Z-plate, to ensure correct positioning of the proximal segment. The use of additional positioning devices remains questionable.[15] The results of the present study indicate that the presence of malpositioned proximal segments is significantly associated with an increased risk of osseous inferior border defects, which is probably caused by the differences in the orientation of the cortex on both sides of the vertical osteotomy, thereby increasing the gap.

In this study, the presence of a type II split, wherein the full thickness of the inferior cortex is completely attached to the proximal mandibular segment, was found to be a significant risk factor for the occurrence of osseous inferior border defects. In a type I split, the lingual inferior cortex is attached to the distal mandibular segment, while the buccal inferior cortex is attached to the proximal segment, which results in the presence of a continuous cortical bone of the inferior border of the mandible after advancement. A bone defect will, therefore, only occur in the case of bone resorption. However, in a type II split, the complete inferior cortex is attached to the proximal segment, resulting in a gap in the inferior border of the mandible after advancement. A bone defect can, therefore, easily result in case of insufficient bone healing. This study found that the risk of inferior border defects after BSSO is reduced when the sagittal split originates in the inferior cortex (i.e. a type I split), which is in line with the results of previous studies by Wolford et al.[4, 16] and Agbaje et al.[2, 3]

Whether a type I or type II split is preferable nevertheless remains debatable.[4, 5, 13, 17] Some surgeons prefer a split that starts in the lingual cortex (i.e., type II split), so as to ensure safe splitting with a minimal chance of a bad split.[17] Performing an inferior border cut could contribute to the development of this kind of split. Other authors, however, prefer a split traversing the inferior cortex (i.e., type I split), so as to ensure maximal bony contact of the mandibular segments.[3, 4]

In a recent study, Agbaje et al.[3] described a surgical technique that develops the inferior part of the vertical bone cut towards the mandibular angle. This technique appears somewhat similar to the inferior border osteotomy described by Wolford et al.[16] However, in their technique, Agbaje et al.[3] only partially cut the inferior border using an ultrasonic Piezo device, unlike the much longer inferior border osteotomy with a reciprocating saw described by Wolford et al.[16] With their new technique, Agbaje et al.[3] reported occurrence of inferior border defects in 5% of the operated mandibular sites, which is in sharp contrast to their earlier findings.[2] The low incidence of osseous inferior border defects reported in their study coincides with that identified in the present study.

The findings of this study with regard to osseous inferior border defects help identify a scarcely described surgical complication of BSSO. Nevertheless, several disadvantages of the current study need to be mentioned. The retrospective nature of this study is evidently a disadvantage, especially since 19 patients had to be excluded because of insufficient data or loss to follow-up. Since there were no remarkable differences between the excluded patients and the patients included in the study group, we however believe the exclusion did not significantly affect the outcome of the study. BSSO was performed by one of six maxillofacial surgeons usually closely supervising a resident operating on the contralateral side of the mandible. All surgeons and residents performed BSSO according to the same surgical protocol, using the same technique and materials. However, small differences based on the surgeon/resident could be present because of the number of different physicians.

Further research is required for the investigation of the clinical consequences of the present findings and to assess the clinical importance of inferior border defects.

CONCLUSION

The overall incidence of osseous inferior border defects in the present study was found to be 12.5% per patient and 7.0% per SSO. Significant risk factors for osseous inferior border defects included large mandibular advancement, increased rotation of the occlusal plane, cranial rotation of the proximal segment, and a type II mandibular split. These findings could help surgeons increase the aesthetic outcome of BSSO and minimize the risks of secondary procedures.

REFERENCES

1. Verweij JP, Houppermans PNWJ, Gooris PJJ, Mensink G, Van Merkesteyn JPR. Risk factors for common complications associated with bilateral sagittal split osteotomy, a literature review and meta-analysis. J Craniomaxillofac Surg. 2016.

2. Agbaje JO, Sun Y, Vrielinck L, Schepers S, Lambrichts I, Politis C. Risk factors for the development of lower border defects after bilateral sagittal split osteotomy. J Oral Maxillofac Surg. 2013;71:588-96.

3. Agbaje JO, Gemels B, Salem AS, Anumendem D, Vrielinck L, Politis C. Modified Mandibular Inferior Border Sagittal Split Osteotomy Reduces Postoperative Risk for Developing Inferior Border Defects. J Oral Maxillofac Surg. 2016.

4. Wolford LM. Influence of Osteotomy Design on Bilateral Mandibular Ramus Sagittal Split Osteotomy. J Oral Maxillofac Surg. 2015;73:1994-2004.

5. Verweij JP, van Merkesteyn JP. Influence of Osteotomy Design on Bilateral Sagittal Split Osteotomy. J Oral Maxillofac Surg. 2015;73:1666.

6. van Merkesteyn JP, Zweers A, Corputty JE. Neurosensory disturbances one year after bilateral sagittal split mandibular ramus osteotomy performed with separators. J Craniomaxillofac Surg. 2007;35:222-6.

7. Mensink G, Zweers A, Wolterbeek R, Dicker GG, Groot RH, van Merkesteyn RJ. Neurosensory disturbances one year after bilateral sagittal split osteotomy of the mandibula performed with separators: a multi-centre prospective study. J Craniomaxillofac Surg. 2012;40:763-7.

8. Hunsuck EE. A modified intraoral sagittal splitting technic for correction of mandibular prognathism. J Oral Surg. 1968;26:250-3.

9. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61:344-9.

10. Marsell R, Einhorn TA. The biology of fracture healing. Injury. 2011;42:551-5.

11. Verweij JP, Mensink G, Fiocco M, van Merkesteyn JP. Presence of mandibular third molars during bilateral sagittal split osteotomy increases the possibility of bad split but not the risk of other post-operative complications. J Craniomaxillofac Surg. 2014;42:e359-63.

12. Verweij JP, Mensink G, Fiocco M, van Merkesteyn JP. Incidence and recovery of neurosensory disturbances after bilateral sagittal split osteotomy in different age groups: a retrospective study of 263 patients. Int J Oral Maxillofac Surg. 2016.

13. Cillo JE, Stella JP. Selection of sagittal split ramus osteotomy technique based on skeletal anatomy and planned distal segment movement: current therapy. J Oral Maxillofac Surg. 2005;63:109-14.

14. Ellis E, 3rd, Carlson DS, Billups J. Osseous healing of the sagittal ramus osteotomy: a histologic comparison of rigid and nonrigid fixation in Macaca mulatta. J Oral Maxillofac Surg. 1992;50:718-23.

15. Costa F, Robiony M, Toro C, Sembronio S, Polini F, Politi M. Condylar positioning devices for orthognathic surgery: a literature review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;106:179-90.

16. Wolford LM, Davis WM, Jr. The mandibular inferior border split: a modification in the sagittal split osteotomy. J Oral Maxillofac Surg. 1990;48:92-4.

17. Verweij JP, Mensink G, Houppermans PN, van Merkesteyn JP. Angled Osteotomy Design Aimed to Influence the Lingual Fracture Line in Bilateral Sagittal Split Osteotomy: A Human Cadaveric Study. J Oral Maxillofac Surg. 2015.