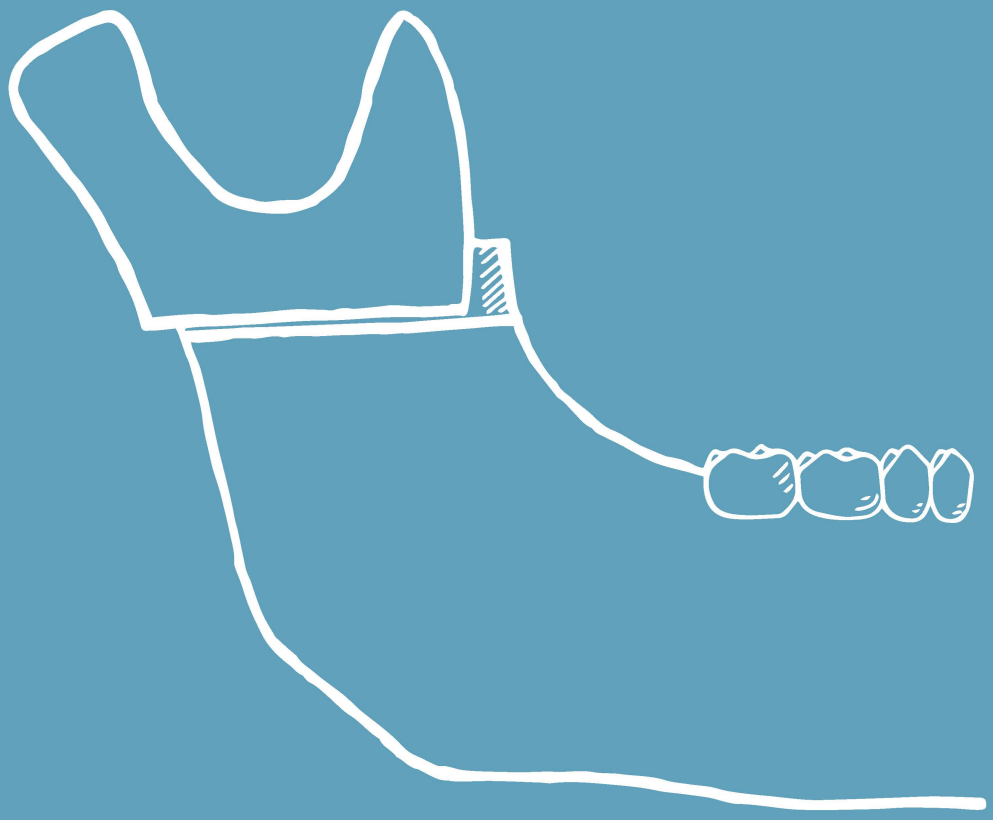
Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique

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



CHAPTER 1

Introduction and aim of the thesis

1

INTRODUCTION AND AIM OF THE THESIS

General introduction

Bilateral sagittal split osteotomy (BSSO) is a widely used orthognathic surgical technique. Since its development, it has become the cornerstone of modern maxillofacial surgery and an important part of the everyday practice of many maxillofacial surgeons.[1] Although alternative techniques are available to treat mandibular hyperplasia or hypoplasia, such as intra-oral vertical ramus osteotomy or distraction osteogenesis, BSSO is generally considered the golden standard to treat mandibular deformity.

The elective nature of orthognathic surgery makes it very important to minimize the risk of complications and adverse effects associated with BSSO. Increasing the predictability and safety of the surgical procedure is therefore an important topic and should be of major interest to the surgeon.

Development of the technique

The first surgical correction of malocclusion was performed in 1849 by Hullihen, an American general surgeon with dental training.[2] He performed an osteotomy of the mandibular body for correction of mandibular prognathism.[2]

The initiation of early orthognathic surgery, however, came to light in the beginning of the twentieth century in St. Louis, USA.[3] Plastic surgeon Vilray Blair and orthodontist Edward Angle were the first to describe an osteotomy of the horizontal ramus for the correction of mandibular prognathism.[4] They were furthermore the first to emphasize the importance of cooperation between orthodontists and surgeons. However, focus shifted towards the development of maxillofacial traumatology because of the First World War, and it would take a long time before orthognathic surgery would be rediscovered in the USA again.[3]

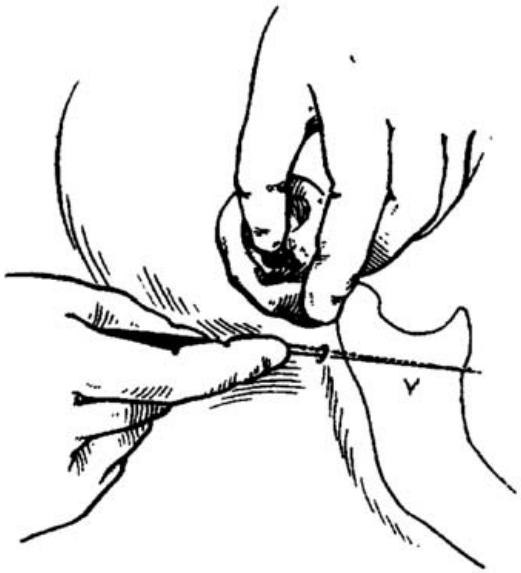


Figure 1: Osteotomy of the horizontal ramus as described by Blair.[4]

Later, in 1942, Schuchardt[5] was the first to describe a sagittal osteotomy of the mandibular ramus. This technique was carried out via an intra-oral approach and introduced the popularization of the BSSO. Trauner and Obwegeser[6] subsequently further developed and popularized this technique and are currently viewed as the founding fathers of the sagittal split osteotomy.

Initially, the BSSO technique consisted of two horizontal bone cuts, approximately 25mm apart in the lingual and buccal cortex of the mandibular ramus. These cuts were connected along the medial aspect of the lateral oblique ridge, separating a proximal and distal mandibular segment.

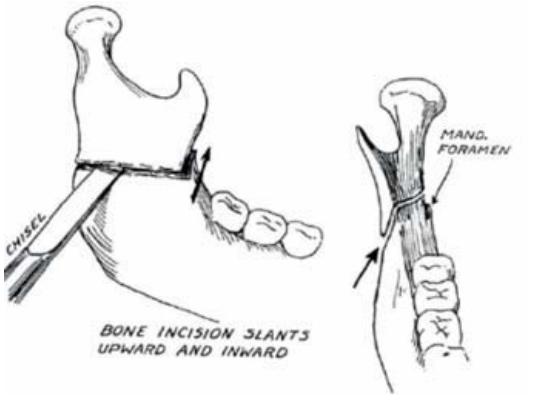


Figure 2: Sagittal horizontal split osteotomy, as described by Schuchardt.[5]

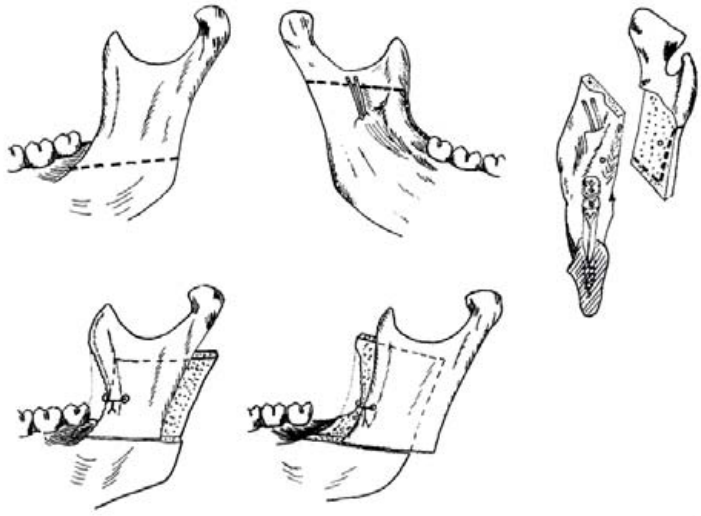


Figure 3: Sagittal split osteotomy, as described by Obwegeser.[6]

Soon after the introduction of the technique important modifications were suggested. In 1961, Dal Pont[7] advanced the lateral bone cut anteriorly towards the distal border of the second molar. Hunsuck[8] later shortened the medial bone cut, ending it just posterior of the lingula instead of carrying it through until the posterior border of the ramus. Hunsuck[8] furthermore suggested progressing the lateral bone cut through the inferior mandibular cortex, to establish an inferior border cut reaching into the lingual cortex. With these modifications, Hunsuck[8] was the first to complete the sagittal split with a fracture in the lingual cortex.

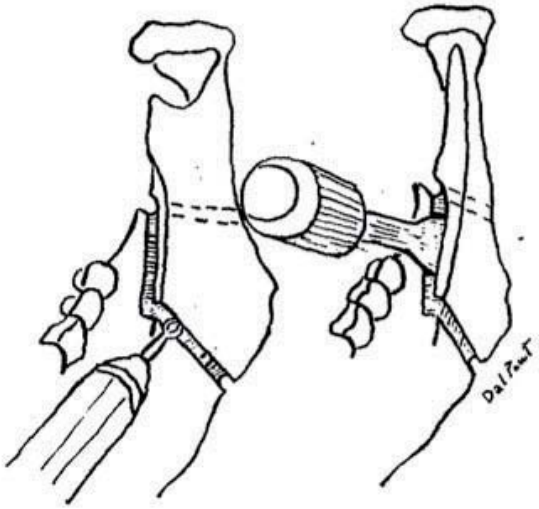


Figure 4: Sagittal split osteotomy, as described by Dal Pont.[7]

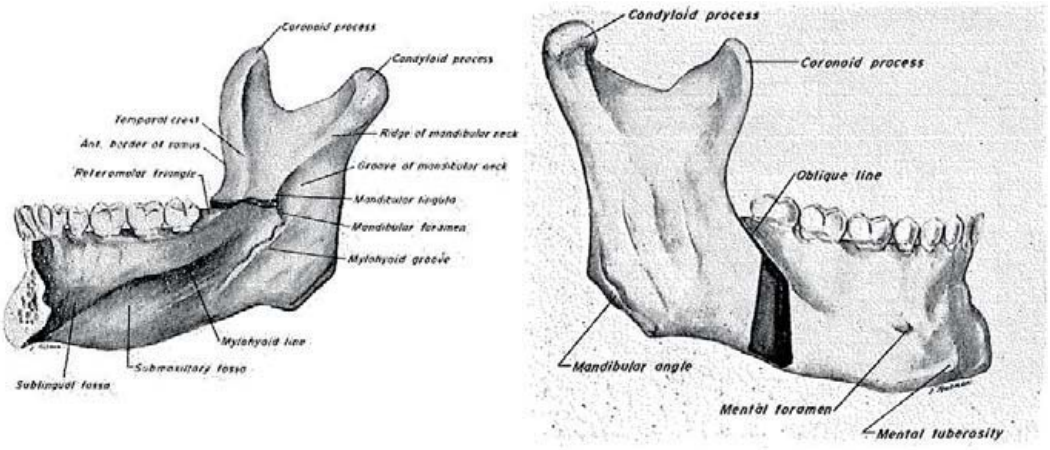


Figure 5: Sagittal split osteotomy with lingual fracture, as described by Hunsuck.[8]

Bell and Schendel[9] reported on the biological basis of BSSO in 1977. Epker[10] elaborated on these principles and suggested more biological modifications, such as limited mucoperiosteal stripping. He furthermore emphasized the importance of a complete osteotomy through the inferior mandibular cortex.

With these modifications, the major components of the contemporary BSSO technique were accomplished.[1] Many surgeons nowadays still perform BSSO according to these principles. Nevertheless, the surgical instruments with which the sagittal split is achieved vary.

The splitter-separator technique

Classic techniques used mallet and chisels to perform the split.[6] With this technique, the surgeon chiselled along the inner side of the buccal cortex until the chisel reached the inferior cortex of the mandible, effectively splitting the mandibular ramus in a proximal/buccal and distal/lingual segment.

More recently, the use of a sagittal splitter and separators has been suggested to split the mandibular segments using a prying and spreading technique. This splitter-separator technique prevents the use of sharp instruments near the inferior alveolar nerve.[11] BSSO with splitter and separators instead of chisels has shown to result in a low incidence of permanent neurosensory disturbances of the lower lip.[12] The use of a splitter and separators furthermore enables application of gradual force when performing the split and facilitates easy splitting of the mandible.

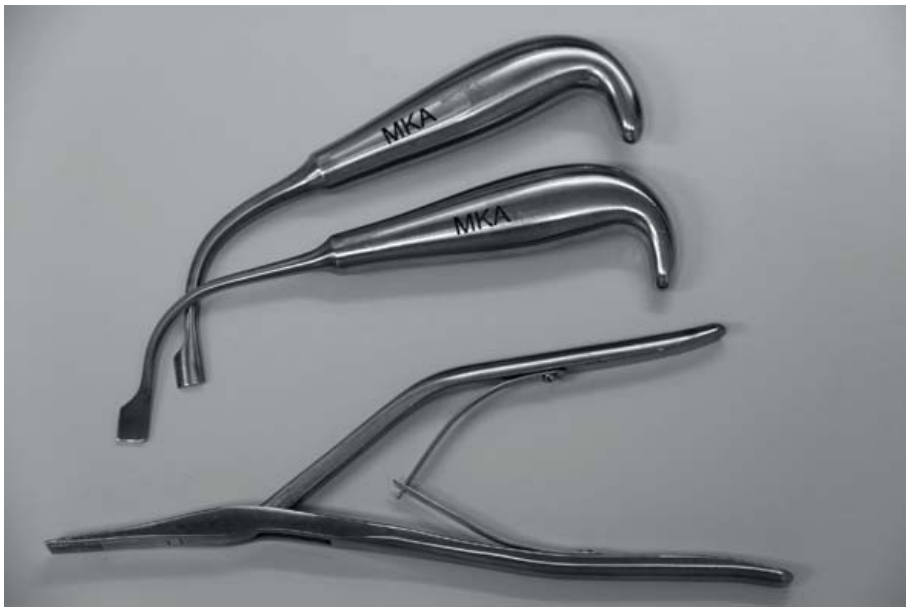


Figure 6: Sagittal splitter and separators (Walter Lorenz Surgical, Jacksonville, FL, USA).

Clinical complications associated with BSSO

Neurosensory disturbances

The inferior alveolar nerve (IAN) runs through the mandible and innervates the sensitivity of the lower lip and chin. It is regularly encountered during the sagittal splitting procedure.[13] Neurosensory disturbances (NSD) of the lower lip are frequent after BSSO and usually display as either increased sensation (hyperaesthesia), a tingling sensation (paraesthesia) or absence of sensitivity of the lower lip (hypoaesthesia).

Different aspects of the procedure present a risk of damaging the IAN. First of all, manipulation of the nerve should be minimized. Mucoperiosteal retraction to visualize the mandibular ramus can cause traction on the nerve near the mandibular foramen.[10] The risk of damaging the nerve is furthermore increased when the nerve is positioned near the buccal cortex or the nerve needs to be freed from the buccal segment after the split.[14] Splitting with chisels instead of splitters and separators could also increase the risk of NSD.[15, 16] After a successful split, damage to the nerve can be caused by stretching of the nerve in large advancements.[17] When fixating the mandibular segments, sharp bony interferences in between the mandibular segments should be removed and pressure on the nerve should be avoided to prevent crushing or puncturing the IAN.[18]

If altered sensation of the IAN is present for more than one year after BSSO, it is considered permanent.[12] Permanent neurosensory disturbances are one of the most important complications associated with BSSO. They have a significant influence on oral health related quality of life and

patient satisfaction after the procedure.[19] Sensory retraining exercises could help patients when the altered sensation causes burden in daily life.[20] Although most patients eventually learn to adjust to the altered sensation, it is very important to reduce and possibly even eliminate this complication after BSSO.

Bad split

The development of an unfavourable fracture pattern during the splitting of the mandible is called a bad split. This is a well-known intra-operative complication of BSSO. Different types of bad split can occur.

- A fracture in the lingual cortex resulting in a loose lingual plate. This is called a lingual plate fracture.
- A fracture in the buccal cortex usually starting in the vertical osteotomy of BSSO that can run until the semilunar incisure. This is called a buccal plate fracture.
- Relatively rare miscellaneous bad splits, such as a fracture of the coronoid process or condylar neck.

Some authors state that a bad split is particularly challenging to the surgeon, but not that damaging to the patient.[21] Patients eventually recover with good functional and aesthetic results.[22] Nevertheless, this complication leads to prolonged surgical time and the use of additional osteosynthesis material which sometimes has to be applied through a transbuccal approach. In some cases, postoperative intermaxillary fixation is even necessary to allow proper healing of the bone fragments.[23] In our opinion, it is therefore valuable for both the surgeon and the patient, to increase the predictability of the procedure by controlling the lingual fracture during BSSO.

Postoperative infection

Postoperative infection is a complication that can occur after any form of surgery. Infection of the surgical wound after BSSO is fairly common, due to the presence of oral flora in the mouth.[24] Different regiments of perioperative prophylactic antibiotics have been proposed, but the effect of prophylactic antibiotics on postoperative infection remains under debate. If postoperative infection does occur, it can usually be easily treated with additional antibiotics in the form of amoxicillin-clavulanate.[24]

Removal of the osteosynthesis material

The introduction of rigid fixation after BSSO has been a big leap forward in the development of the technique. Rigid fixation with either bicortical screws or monocortical miniplates eliminates the need for postoperative intermaxillary fixation.[25-27] This not only produces a more reliable end result, but also facilitates a more patient-friendly procedure.

If the patient does not experience any complaints related to the hardware, no removal is needed. In some cases, however, removal of the osteosynthesis material because of symptoms is necessary.[28, 29] This can be due to infection or other complaints, such as palpability of the hardware, subjective discomfort (for example related to cold weather), or breakage of the material.

When removal of osteosynthesis material after BSSO is necessary, it can usually be performed under local anaesthesia. After this additional postoperative procedure, the patient completely recovers without any remaining symptoms.

Inferior border defects

A mandibular inferior border defect is a postoperative complication that consists of an unaesthetic osseous defect of the inferior border of the mandible. This complication can occur due to insufficient bone healing at the caudal part of the vertical bone cut after BSSO, for example because of large mandibular advancements, clockwise rotation of the distal segment, or inclusion of the full thickness of the lower border in the split.[30] Persisting inferior border defects can also be associated with the surgical technique.[31] Unaesthetic inferior border defects can in rare cases even necessitate secondary procedures after BSSO and are a relevant complication of this type of surgery.[30, 32] In order to maximise the result of BSSO and minimise the risk of secondary procedures, the occurrence of inferior border defects should thus be minimised. Patients should furthermore be informed about the risk of this complication to ensure proper patient counselling and maximise patient satisfaction after BSSO.

Aim of this thesis

This thesis aims to investigate the risk of complications associated with bilateral sagittal split osteotomy (BSSO), performed with a splitter and separators. Specific risk factors for intra- and postoperative complications that occurred within the first year after surgery are investigated. Factors influencing the predictability of the technique are furthermore analysed in order to increase predictability of the split and therefore minimise sequelae.

This could facilitate individual counselling of patients before BSSO and help maxillofacial surgeons attempt to minimise the risk of complications associated with this procedure.

REFERENCES

1. Wyatt WM. Sagittal ramus split osteotomy: literature review and suggested modification of technique. Br J Oral Maxillofac Surg. 1997;35:137-41.

2. Hullihen SP. Case of elongation of the underjaw and distortion of the face and neck, caused by a burn, successfully treated. Am J Dent Sci. 1849;9:157.

3. Steinhauser EW. Historical development of orthognathic surgery. J Craniomaxillofac Surg. 1996;24:195-204.

4. Blair VP. Operations of the Jaw-bone and Face. Surg Gynecol Obstet. 1907;4:67-78.

5. Schuchardt G. Ein Beitrag zur chirurgischen Kieferorthopardie unter Berucksichtiging ihrer fur die Behandlung angeborener und erworbener Kiefer defomitaten bie Soldaten. Dtsch Zahn Mund Kieferheilkd. 1942;9:73-89.

6. Trauner R, Obwegeser H. Zur Operationstechnik bei der Progenia und anderen Unterkieferanomalien. Dtsch Zahn Mund Kieferhlkd. 1955;23:11-25.

7. Dal Pont G. Retromolar osteotomy for the correction of prognathism. J Oral Surg Anesth Hosp Dent Serv. 1961;19:42-7.

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

9. Bell WH, Schendel SA. Biologic basis for modification of the sagittal ramus split operation. J Oral Surg. 1977;35:362-9.

10. Epker BN. Modifications in the sagittal osteotomy of the mandible. J Oral Surg. 1977;35:157-9.

11. 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.

12. 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.

13. Westermark A, Bystedt H, von Konow L. Inferior alveolar nerve function after sagittal split osteotomy of the mandible: correlation with degree of intraoperative nerve encounter and other variables in 496 operations. Br J Oral Maxillofac Surg. 1998;36:429-33.

14. Politis C, Lambrichts I, Sun Y, Vrielinck L, Schepers S, Agbaje JO. Attachment rate of the inferior alveolar nerve to buccal plate during bilateral sagittal split osteotomy influences self-reported sensory impairment. J Craniofac Surg. 2014;25:2121-6.

15. Jaaskelainen SK, Teerijoki-Oksa T, Virtanen A, Tenovuo O, Forssell H. Sensory regeneration following intraoperatively verified trigeminal nerve injury. Neurology. 2004;62:1951-7.

16. Mensink G, Gooris PJ, Bergsma JE, van Hooft E, van Merkesteyn JP. Influence of BSSO surgical technique on postoperative inferior alveolar nerve hypoesthesia: a systematic review of the literature. J Craniomaxillofac Surg. 2014;42:976-82.

17. Van Sickels JE, Hatch J, Rugh J, Dolce C, Bays RA. Effects of age, amount of advancement and genioplasty on neurosensory distrubance following a BSSO. J Dent Res. 2002;81:A397-A.

18. Fujioka M, Hirano A, Fujii T. Comparative study of inferior alveolar disturbance restoration after sagittal split osteotomy by means of bicortical versus monocortical osteosynthesis. Plast Reconstr Surg. 1998;102:37-41.

19. Kuhlefelt M, Laine P, Suominen AL, Lindqvist C, Thoren H. Nerve manipulation during bilateral sagittal split osteotomy increases neurosensory disturbance and decreases patient satisfaction. J Oral Maxillofac Surg. 2014;72:2052 e1-5.

20. Phillips C, Kim SH, Tucker M, Turvey TA. Sensory retraining: burden in daily life related to altered sensation after orthognathic surgery, a randomized clinical trial. Orthod Craniofac Res. 2010;13:169-78.

21. Falter B, Schepers S, Vrielinck L, Lambrichts I, Thijs H, Politis C. Occurrence of bad splits during sagittal split osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;110:430-5.

22. Veras RB, Kriwalsky MS, Hoffmann S, Maurer P, Schubert J. Functional and radiographic long-term results after bad split in orthognathic surgery. Int J Oral Maxillofac Surg. 2008;37:606-11.

23. Chrcanovic BR, Freire-Maia B. Risk factors and prevention of bad splits during sagittal split osteotomy. Oral Maxillofac Surg. 2012;16:19-27.

24. Spaey YJ, Bettens RM, Mommaerts MY, Adriaens J, Van Landuyt HW, Abeloos JV, et al. A prospective study on infectious complications in orthognathic surgery. J Craniomaxillofac Surg. 2005;33:24-9.

25. Spiessl B. [Osteosynthesis in sagittal osteotomy using the Obwegeser-Dal Pont method]. Fortschr Kiefer Gesichtschir. 1974;18:145-8.

26. Lindorf HH. Sagittal ramus osteotomy with tandem screw fixation. Technique and results. J Maxillofac Surg. 1986;14:311-6.

27. Champy M, Lodde JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. J Maxillofac Surg. 1978;6:14-21.

28. Kuhlefelt M, Laine P, Suominen-Taipale L, Ingman T, Lindqvist C, Thoren H. Risk factors contributing to symptomatic miniplate removal: a retrospective study of 153 bilateral sagittal split osteotomy patients. Int J Oral Maxillofac Surg. 2010;39:430-5.

29. Becelli R, Fini G, Renzi G, Giovannetti F, Roefaro E. Complications of bicortical screw fixation observed in 482 mandibular sagittal osteotomies. J Craniofac Surg. 2004;15:64-8.

30. 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.

31. 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.

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