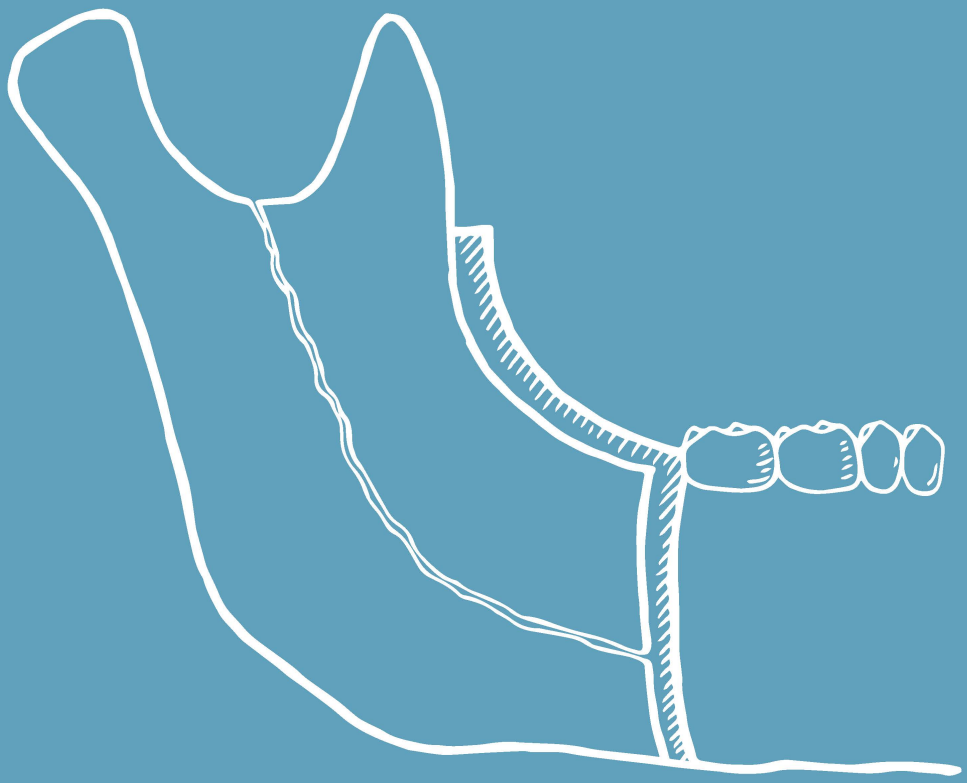
Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique

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



CHAPTER 4

Bad split during bilateral sagittal split osteotomy of the mandible performed with separators: retrospective study of 427 patients

This chapter is based on the manuscript:

Mensink G, Verweij JP, Frank MD, Bergsma JE, van Merkesteyn JPR

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ABSTRACT

An unfavourable fracture, known as a bad split, is a common intra-operative complication in bilateral sagittal split ramus osteotomy (BSSO). The reported incidence of this complication ranges from 0.5 to 5.5% per site. Since 1994 BSSO has been performed in our clinic with sagittal splitters and separators, instead of chisels, in an attempt to prevent post-operative hypoesthesia. Theoretically, a higher percentage of bad splits could be expected with this technique. This retrospective study aimed to determine the incidence of bad splits associated with BSSO performed with splitters and separators. Furthermore, we assessed different risk factors for bad splits.

The study group consisted of 427 consecutive patients. The incidence of bad splits in this group was 2.0% per site. This is well within the range reported in the literature. The only predicting factor for a bad split was the removal of third molars concomitant with BSSO. There was no significant association between bad splits and age, sex, occlusion class, or the experience of the surgeon.

We believe that BSSO, performed with splitters and separators instead of chisels, does not increase the risk of a bad split and is therefore a safe technique with predictable results.

INTRODUCTION

Bilateral sagittal split osteotomy (BSSO) is one of the most frequently used operative techniques for correcting mandibular deformities.[1] Efforts to reduce complications associated with the procedure have led to several modifications, since it was first described by Trauner and Obwegeser.[2] However, the procedure still presents a certain degree of technical difficulty and is associated with several potential complications.

One such intra-operative complication associated with BSSO is an irregular osteotomy pattern or unfavourable fracture, known as a bad split.3 The reported incidence of bad split at a sagittal split osteotomy (SSO) site ranges from 0.5 to 5.5%.[4-20] This unwanted fracture is normally located in either the distal (lingual plate fracture) or proximal cortical plate (buccal plate fracture) of the mandible and more rarely affects the coronoid process or the condylar neck. When a bad split is adequately treated, the chances of functional success are good, though some limitations can occur.[21] Therefore, the number of bad splits should be minimised.

Our clinic abandoned the use of chisels to minimise post-operative hypoesthesia.[22] Instead, sagittal splitters and separators (i.e. elevators) are used.[8] Theoretically, this technique could result in a higher percentage of bad splits. The purpose of this study is to retrospectively review bad splits of the mandible associated with BSSO using sagittal split separators, in a single centre over 17 years.

MATERIAL AND METHODS

We retrospectively analysed the clinical records and radiographs of 427 consecutive patients who underwent BSSO at our institution between July 1994 and December 2011. In 1994, we started to perform BSSO with sagittal splitters and separators instead of chisels. All planned BSSOs, single procedures, and those associated with other procedures were included (Table 1).

Procedure(s)	Patients	%
BSSO	229	53.6
BSSO + Le Fort I	124	29.0
BSSO + genioplasty	31	7.3
BSSO + Le Fort I + genioplasty	43	10.1

Table 1: Distribution of concomitant procedures in 427 patients. Data are presented as number (%) of operations.

The patients' medical files and orthopantomographs were screened for the patient's sex, age at surgery, pre-operative diagnosis, BSSO procedure (unilateral or bilateral), concomitant procedures, and presence of third molars. The status of third molars was classified as follows: absent at first consultation; removed prior to BSSO; removed concomitant with BSSO; or present after surgery. If third molars were left in situ, they were in occlusion with maxillary antagonists. Furthermore, we noted whether the BSSO was performed by a specialist or a resident, the occurrence of a bad split during surgery and type of bad split, the incidental use of chisels, and the method of postoperative fixation.

The patient sample consisted of 150 males and 277 females. The age at surgery ranged from 13.8 to 55.6 years (mean age, 27.3 [SD, 9.8 years]). In 363 cases, the mandible was moved ventrally to correct a class II malocclusion. A class III malocclusion was present in 59 patients, resulting in posterior movement of the mandible. Indications for BSSO are summarised in Table 2. Indications other than class II/III malocclusion (e.g. condylar hyperplasia or cleft lip and palate) were present in 5 cases.

Category	Patients	%
Class II malocclusion	363	85.0
Class III malocclusion	59	13.8
Other	5	1.2

Table 2: Indications for BSSO in our patients. Data are presented as number (%) of patients

BSSO was performed without the use of chisels, as first described by van Merkesteyn et al.[8,22] Splitting forceps (Smith Ramus Separator 12 mm, Walter Lorentz Surgical, Jacksonville, FL, USA) and elevators were used. The procedures were performed while patients were under general anaesthesia. To reduce bleeding, the surgical area was infiltrated with epinephrine 1:160 000 (Ultracaine D-S, Aventis Pharma, Hoevelaken, The Netherlands). The mandibular ramus was exposed and the mandibular foramen was located. A periosteal elevator was placed subperiosteally just above the mandibular foramen, and the horizontal bone was cut with a Lindemann burr (2.3 × 22 mm) approximately 5 mm above the mandibular foramen. Subsequently, the sagittal and vertical cuts were made with a short Lindemann burr (1.4 × 5 mm). The inferior border was cut perpendicularly through the inferior cortex, just reaching the medial side. Splitting was done with an elevator positioned in the vertical bone cut and the splitting forceps in the sagittal bone cut. Once the superior aspect of the mandible started to split, the elevator was repositioned at the inferior end of the vertical cut, and splitting was completed. Care was taken to be certain that the inferior alveolar nerve was in the distal segment when the split was completed. A chisel was only used when a small bridge of cortical bone between the buccal and lingual segments remained at the inferior

border of the mandible, well below the level of the mandibular canal.

After mobilisation, the mandible was placed into the new intermaxillary relationship using a wafer, and intermaxillary wire fixation was applied. When possible, 3 bicortical screws (Martin GmbH, Tuttlingen, Germany; 9, 11, or 13 mm in length; 2.0 mm in diameter) were placed in the upper border of the mandible on both sides. Other fixation methods, such as Champy plates or upper wire fixation, were used if screw fixation was not optimal because of fragile bone, after removal of third molars or after a bad split. The temporary intermaxillary fixation was then removed, and the occlusion was checked. No elastic bands were used. Permanent intermaxillary fixation with upper border wiring was only used after a bad split or intra-oral vertical ramus osteotomy (IVRO).

All patients were discharged from the hospital within a week after the operation and were scheduled to return for evaluation approximately 1, 6, and 12 months after the discharge.

Statistical methods

All statistical analyses were performed with SPSS 16.0 for Windows (SPSS, Inc.; Chicago, IL, USA). Crosstabs, Pearson's chi-square test, and logistic regression were used to assess associations between parameters. All statistical associations are reported with odds ratios (ORs) and 95% confidence intervals (CIs). A p-value smaller than 0.05 was considered statistically significant.

RESULTS

Out of 851 sagittal splits (427 patients), 17 bad splits occurred (2.0%). All the bad splits were unilateral, localised as 11 buccal plate fractures (64.7%), 5 lingual plate fractures (29.4%) and 1 condylar neck fracture (5.9%) (Figure 1 and 2). Although BSSO was planned in all cases, unilateral sagittal split osteotomy (USSO) was performed in 3 (0.7%) patients. One patient eventually underwent IVRO on both sides, after a large buccal plate fracture occurred during the first initial sagittal split. In 1 patient, a sagittal split was performed on one side and IVRO on the contralateral side, because of a very high mandibular foramen. In the third case, the operation was terminated after the first sagittal split, and fixation was completed without translocation of the mandible because of a large buccal plate fracture. The buccal plate was fixated and both lower third molars were removed. A successful BSSO was performed 6 months after the initial procedure.

The bad splits occurred in 6 males and 11 females (mean age, 29.3 years; range, 14.83–53.89 years). Sex (p = 0.988, OR 1.01, 95% CI 0.363–2.711) and older age (p = 0.399, OR 0.980, 95% CI 0.935–1.027) had no statistically significant association with bad splits during BSSO; however, bad splits occurred more in females than in males. Preoperative occlusion class was not a statistically significant factor either; bad splits occurred in 14 patients having a class II malocclusion and 2 patients having a class III malocclusion (p = 0.862, OR 1.143).

We analysed the duration between preoperative removal of third molars and bad splits. The preoperative status of third molars is summarised in Table 3. In 180 patients (328 sites), one or both third molars were absent at first consultation, making it impossible to determine the time of removal. Third molars were removed preoperatively in 177 patients (301 sites), with time of removal ranging from 1 month to 15 years prior to surgery (mean 10.4 months). Third molars were removed during BSSO in 120 patients (219 sites) and remained present after surgery in 4 patients (6 sites). The duration between removal of third molars and bad split had no statistically significant association with bad split (p = 0.149, OR 0.998, 95% CI 0.998–1.001). However, the removal of third molars concomitant with BSSO was positively associated with bad split (p = 0.041, OR 2.637). In 8 of the 17 bad splits, a third molar was present at the site of the split.

Category	Left side	%	Right side	%
Absent at first consultation	169	39.6	159	37.2
Removed prior to BSSO	148	34.7	153	35.8
Removed concomitant with BSSO	107	25.1	112	26.2
Present after surgery	3	0.7	3	0.7

Table 3: Status of lower third molars in our patients. Data are presented as number (%) of patients.

All patients were operated on by either experienced senior staff or a resident assisted by a senior staff member. In 165 (38.6%) patients, the sagittal splits on both sides were performed by senior staff; in 252 (59.1%) patients, senior staff performed the sagittal split on one side and a resident on the other side; and in 10 (2.3%) patients, a resident, supervised by senior staff, operated on both sides. The occurrence of bad splits was not associated with the residents' experience level (p = 0.472, OR 1.514, 95% CI 0.489–4.687).

Out of the 17 patients with a bad split, 2 patients (11.7% of the patients) experienced persistent neurosensory disturbances after at least 1 year.

In 403 (94.4%) patients, BSSO was performed with only spreaders and separators. A chisel was necessary in only 24 (5.6%) patients, because of a small bridge of cortical bone remaining at the inferior border of the mandible.

Bilateral screw fixation was used for postoperative mandibular fixation in 414 (97.4%) patients. In this group, 4 (0.9%) cases involved combined fixation with mini-plates, and 2 (0.4%) patients underwent screw fixation in combination with intermaxillary fixation (IMF). In 5 (1.2%) patients, unilateral plate fixation on 1 side was combined with screw fixation on the contralateral side, and bilateral plate fixation was used in 1 patient (0.2%). Plate fixation was used because of a bad split in 4 (0.9%) patients and fragile cortical bone in the other 6 (1.4%). Intermaxillary fixation was used on 9 (2.1%) patients (7 times after a bad split and twice after the IVRO).

All patients eventually recovered with good functional and aesthetic results.

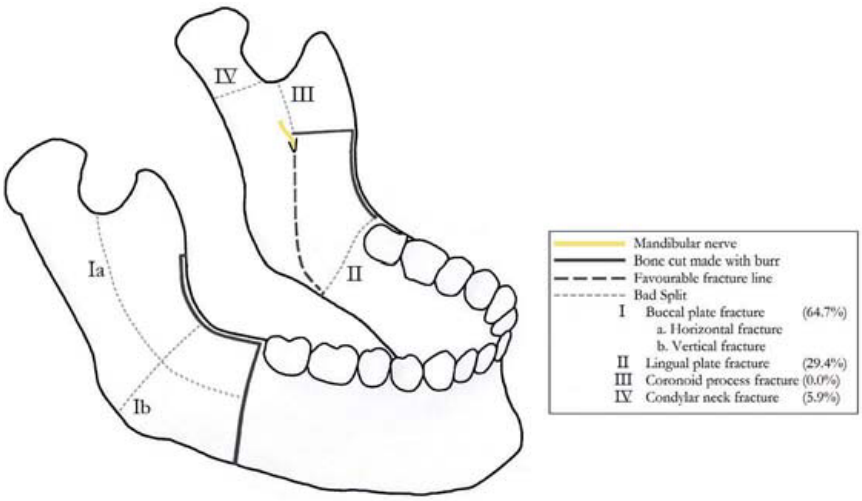

Figure 1: The fracture lines and cuts of a BSSO including the most common unfavourable fractures. The incidence of the different types of bad splits in this study are mentioned in percentages.

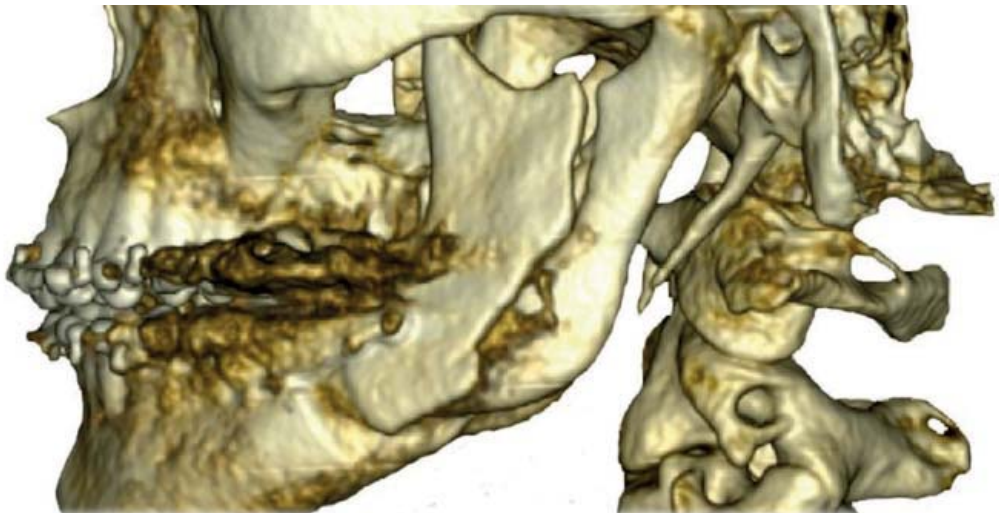

Figure 2: Cone Beam Computed Tomography (CB-CT) scan of a horizontal buccal plate fracture of the left side of the mandible during a BSSO, reaching the incisura semilunaris (figure 1; type Ia). The proximal and distal segment of the mandibula were eventually fixated with two bicortical screws on the lower border of the mandible (in this CB-CT hidden behind the buccal segment), combined with plate fixation to attach the buccal segment.

DISCUSSION

The exact combination of factors resulting in bad split is unknown. Reported predictors for bad split are the presence of third molars and age at surgery. Advanced age has been reported to increase the risk of bad split.[6] In our patients, age was not considered a complicating factor; we found no relationship between age and bad split.

No association between bad split and patient sex or surgeon experience has been reported, and our findings are consistent with the literature in this regard.[10,11,12]

The removal of third molars before BSSO is controversial. Some suggest that if third molar removal is required, it should be done at least 6 months prior to orthognathic surgery.[11,13,23] Other authors advise removal of third molars concomitant with surgery and describe fewer postoperative complications, like hypoesthesia, associated with this method.[4,15,24] In our patients, there were significantly more bad splits during BSSO among those who had concomitant removal of the third molars.

Although one could expect that more healing time would reduce the risk of a bad split, our retrospective study did not allow us to infer an optimal timing for removing third molars prior to BSSO. In our clinic, most third molars that were present during the last five years before surgery were removed at the time of BSSO. This is because separate third molar removal is estimated to increase the risk of inferior alveolar nerve damage, and separate surgery was also more inconvenient for the patient as he/she would have to undergo multiple procedures instead of just one combined procedure.

One would expect bad splits to occur more often with less experienced surgeons, like residents. However, no such differences were found between senior staff members and residents, most likely because the latter were closely supervised during BSSO and corrected when necessary.

	Year of publication	Number of bad splits	SSO's (n)	Patients (n)	Incidence per site (%)	Incidence per patient (%)
Doucet et al[10]	2011	21	677	339	3.1	6.2
Falter et al[11]	2010	14	2005	1008	0.7	1.4
Kriwalsky et al[12]	2007	12	220	110	5.5	10.9
Kim and Park[13]	2007	11		214		5.1
Van Merkesteyn et al[14]	2007	2	222	111	0.9	1.8
Teltzrow et al[15]	2005	12	2528	1264	0.5	0.9
Borstlap et al[16]	2004	20	444	222	4.5	9.0
Reyneke et al[17]	2002	4	139	70	2.9	5.7
Panula et al[18]	2001	12		515		2.3
Mehra et al[19]	2001	11	500	262	2.2	4.2
Acebal-Bianco et al[20]	2000	8		802		1.0
Precious et al[21]	1998	24	1256	633	1.9	3.8
Van de Perre et al[22]	1996	97	2466	1233	3.9	7.9
Turvey[23]	1985	9	256	128	3.5	7.0
Martis[24]	1984	5		258		1.9
Macintosh[25]	1981	16		236		6.8
Behrmann[26]	1972	10		600		1.7
White et al[27]	1969	1	32	17	3.1	5.9

Table 4: Reported incidences of bad split during BSSO

In our study sample, a bad split occurred in 17 of 851 sagittal splits, which is consistent with the average reported in the literature (Table 4). Therefore, the use of splitters and separators without chisels does not lead to a higher risk of bad splits. The bad splits were localised as 11 (64.7%) buccal plate fractures, 5 (29.4%) lingual plate fractures, and 1 condylar neck fracture (Figure 1 and 2). When a bad split occurred, additional fixation was usually necessary. Buccal and lingual plate fractures could be fixated with screws and/or plates and sometimes IMF, depending on the fracture lines. The condylar neck fracture resulted from a bad split of the buccal segment, with the condylar neck attached to the distal segment. Therefore, the condylar process was purposely removed from the distal segment and fixation to the proximal segment was attempted. Because fixation to the proximal segment was not possible eventually upper border wiring and IMF were required. This procedure was almost similar, although accidently, to the recently discussed supraforaminal horizontal oblique osteotomy.[25]

Although BSSO was planned in all patients, the procedure was converted to IVRO in 3 patients. IVRO is only possible during a setback and requires IMF, making it a suboptimal option. However, when a safe sagittal split is not possible, IVRO can be helpful in treating these difficult cases.

Since our goal in using splitters and separators was to reduce postoperative neurosensory disturbances after BSSO, the percentage of neurosensory disturbances after a bad split should not be increased. The incidence of persistent neurosensory disturbances after a bad split was 11.7% per patient in this study. Our reported incidence of neurosensory disturbances in previous studies using this technique was 10.5% per patient.[22] Therefore bad splits using this technique do not introduce significantly more postoperative neurosensory disturbances.

The chances of good functional success after a bad split are high, and as such bad splits are regarded as complications without long-term consequences.[5,21] Nevertheless, the number of bad splits should always be minimised because of negative short-term consequences, such as longer operation time, loss of surgeon concentration, use of intermaxillary fixation, and reoperation or conversion to IVRO with IMF. All patients in our group, including the patients with a bad split, functioned well after the operation(s).

CONCLUSION

The proportion of bad splits occurring during BSSO performed with splitting forceps and elevators is similar to the proportion of bad splits during conventional BSSO, performed with chisels. In our study, the only complicating factor that was predictive of a bad split was the removal of third molars concomitant with BSSO. The use of sagittal splitters and separators does not increase the risk of bad splits and is therefore a safe and predictable technique.

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