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

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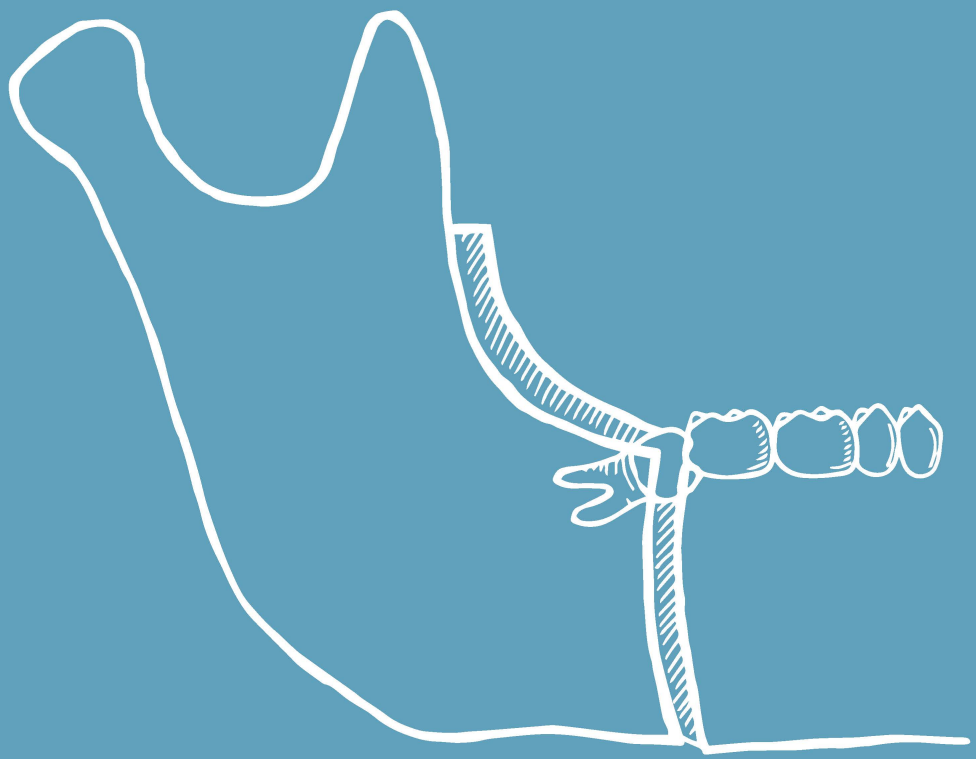

CHAPTER 7

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

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ABSTRACT

Timing of third molar removal in relation to bilateral sagittal split osteotomy (BSSO) is controversial, especially with regard to postoperative complications. We investigated the influence of mandibular third molar presence on complications after BSSO with sagittal splitters and separators by a retrospective record review of 251 patients (502 surgical sites).

Mandibular third molars were present during surgery at 169 sites and removed at least 6 months preoperatively in 333 sites. Bad splits occurred at 3.0 % (5/169) and 1.5% (5/333) of the respective sites. Presence of mandibular third molars significantly increased the risk of bad splits (OR 1.08, CI 1.02-1.13, $p < 0.01$). The mean incidences of permanent neurosensory disturbances, postoperative infection, and symptomatic removal of the osteosynthesis material were 5.4% (OR, 0.89; 95% CI, 0.79–1.00; $p = 0.06$), 8.2% (OR, 1.09; 95% CI, 0.99–1.20; $p = 0.63$), and 3.4% (OR, 0.97; 95% CI, 0.92–1.03; $p = 0.35$) per site, respectively, without a significant influence of mandibular third molar status.

In conclusion, the presence of mandibular third molars during surgery increases the possibility of bad splits, but does not affect the risk of other complications. Therefore, third molars can be removed concomitantly with BSSO using sagittal splitters and separators.

INTRODUCTION

Bilateral sagittal split osteotomy (BSSO) is one of the most popular techniques in orthognathic surgery nowadays. Since it was first described by Trauner and Obwegeser (1957), many attempts have been made to improve this technique in order to minimise post-operative complications.[1-6] The most common complications associated with BSSO are: an unfavourable fracture pattern during osteotomy, termed 'bad split'; neurosensory disturbances of the inferior alveolar nerve (IAN), resulting in altered sensation of the lower lip; infection at the surgical site; and symptomatic removal of the osteosynthesis material.[7]

BSSO is often performed to correct malocclusion in relatively young patients.[8, 9] These patients generally have third molars at the first consultation. If indicated, mandibular third molar removal is recommended at least 6 months before BSSO.[10] Although concomitant removal with BSSO is also possible, the influence of this procedure on the incidence of post-operative complications is still under debate.[11, 12] Therefore, timing of third molar removal in relation to BSSO is controversial.[13, 14]

The aim of this retrospective study was to investigate the association between third molar status during and common complications after BSSO with sagittal splitters and separators.

MATERIAL AND METHODS

Patients and surgical procedures

We reviewed the medical files and radiographs of 259 consecutive patients who had undergone BSSO at our centre between 2004 and 2011. Eight patients were excluded from this study due to incomplete records, so data concerning 251 patients were analysed.

BSSO was performed according to the Hunsuck modification with sagittal splitters and separators, without using chisels.[5, 15] Additional procedures included Le Fort I osteotomy and/or genioplasty. Maxillary third molars were removed if indicated. Mandibular third molars were left in situ if they occluded with maxillary second molars, because of absent mandibular premolars or second molars. If mandibular third molar removal was indicated, the patients could choose removal at least 6 months before or concomitant with BSSO. The possibility of bad splits due to the presence of third molars during BSSO was explained.[16]

All the patients were discharged within a week after surgery. Follow-up examinations were performed at 1, 2, and 3 weeks and 3, 6, and 12 months. The patients were instructed to return to the clinic if they had any complaints.

Outcomes

The primary outcome variables were complications of BSSO: bad split, neurosensory disturbances of the IAN, infection at the surgical site, and symptomatic removal of the osteosynthesis material. The secondary outcome variables were intra-operative factors: IAN status, operative time, and blood loss. Independent variables were third molar status during BSSO, patient age and gender, and preoperative malocclusion class.

A bad split was defined as an irregular or unfavourable fracture pattern in the distal or proximal part of the mandible after osteotomy; it was recorded as present or absent. Neurosensory disturbances of the IAN were evaluated by objective tests and subjective assessment. The disturbances were considered permanent if they were present one year after BSSO. IAN status during BSSO was recorded as not visible in the distal segment, less than half visible in the distal segment, more than half visible in the distal segment, prepared out of the proximal segment with blunt instruments, or prepared out of the proximal segment with burr. Infection at the surgical site was defined as infectious symptoms (swelling with granulation tissue, pus, or intraoral fistula) treated with antibiotics. Osteosynthesis material was removed because of infection, wound dehiscence, or irritation/ tenderness at the osteosynthesis site.

Statistical analysis

Statistical analyses were performed with SPSS version 20.0 for Windows (IBM, Armonk, NY, USA). Descriptive analyses concerning the study population were performed at first. To study the effect of mandibular third molar status on bad splits, neurosensory disturbances, infection and removal of osteosynthesis material, respectively, a multivariate generalised linear mixed model had been employed to account for information on the left and right sides within the same patient. Gender, age at surgery and occlusion class had been incorporated in the mixed model. Linear regression models, adjusting for gender and age at surgery, were used to investigate the association of mandibular third molar status with operative time and blood loss.

RESULTS

General findings

In total, 502 sagittal split osteotomies (sites) were performed in 251 patients. The study population consisted of 90 male and 161 female patients, with a mean age of 27.7 years (SD, 10.8 years; range, 13.8–55.6 years). The surgical indications were mandibular advancement and setback for class II and III malocclusions in 219 and 32 patients, respectively. BSSO was performed singly in 146 patients and combinatorially with genioplasty, Le Fort I osteotomy, or Le Fort I osteotomy and genioplasty in 11, 74, and 20 patients, respectively. Mandibular third molars were present during surgery at 169 sites (Figure 1) ; they were congenitally absent or removed at least 6 months preoperatively at 333 sites (Table 1). The mean follow-up duration was 432 days (SD, 172 days; range, 163–1465 days).

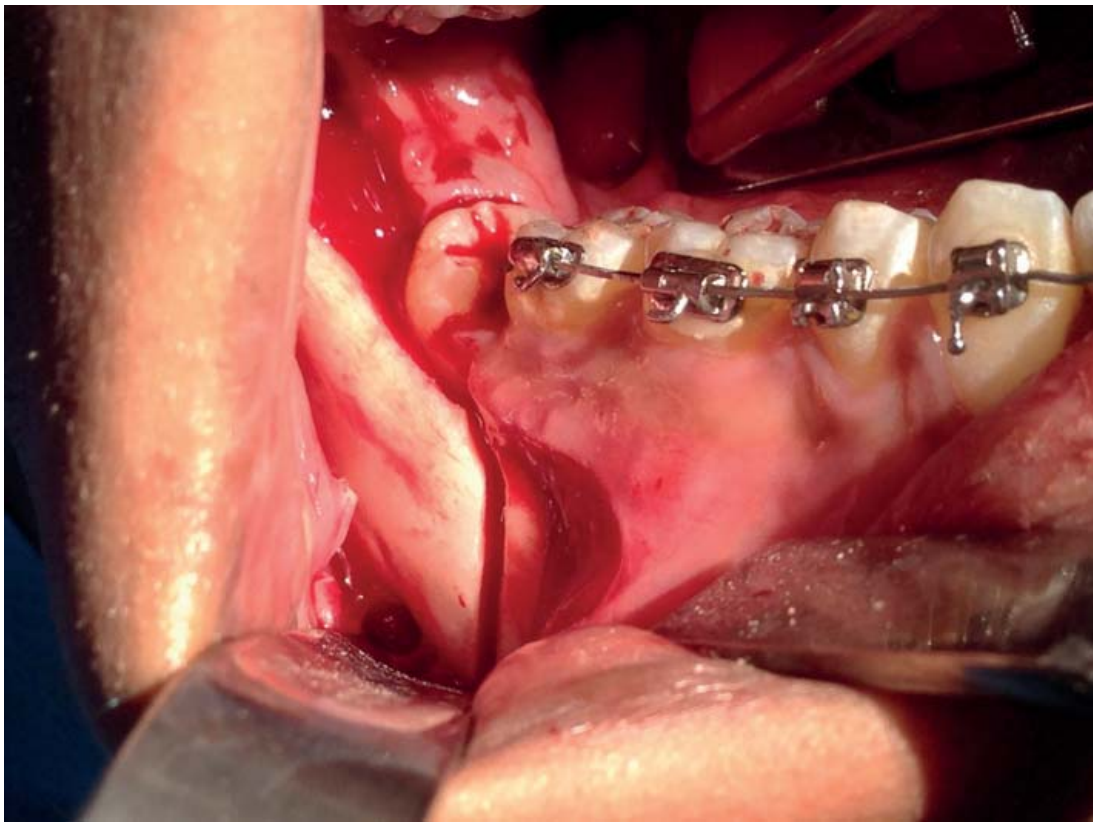

Figure 1: Intra-operative photograph of a sagittal split osteotomy with the third molar present during the split.

The mean incidences (per site) of the complications of BSSO were as follows: bad splits, 2.0%; permanent neurosensory disturbances of the IAN, 5.4%; infection at the surgical site, 8.2%; and symptomatic removal of the osteosynthesis matetrial, 3.4%.

Status	**Mandibular third molars**		**Maxillary third molars**	
	Right	*Left*	*Right*	*Left*
Absent at first consultation	97 (38.6)	102 (40.6)	99 (39.4)	96 (38.2)
Removed >6 months preoperatively	68 (27.1)	66 (26.3)	49 (19.5)	54 (21.5)
Removed during BSSO	84 (33.5)	81 (32.3)	67 (26.7)	66 (26.3)
Present after BSSO	2 (0.8)	2 (0.8)	36 (14.3)	35 (13.9)

Table 1: Status of third molars in the study population. Data represent the number of teeth (%).

Group characteristics

Groups with and without mandibular third molars during BSSO were compared. No significant differences have been found, but patients' age (Table 2). Patients with mandibular third molars during BSSO were significantly younger. Table 3 shows the incidences of the complications in both groups, with and without third molars.

Parameter	Third molars present	Third molars absent	Significance*
Total number of patients	93 (37.1)	158 (62.9)	
Mean (SD) age, age range (years)	21.5 (8.1), 13.8–52.9	31.6 (10.5), 16.9–55.6	<0.01
Gender			0.52
Male	31 (33.3)	59 (37.3)	
Female	62 (66.7)	99 (62.7)	
Malocclusion class			0.65
II	80 (86.0)	139 (88.0)	
III	13 (14.0)	19 (12.0)	
Additional procedures			0.20
BSSO	62 (66.7)	84 (53.2)	
BSSO + Le Fort I osteotomy	21 (22.6)	53 (33.5)	
BSSO + genioplasty	4 (4.3)	7 (4.4)	
BSSO + Le Fort I osteotomy + genioplasty	6 (6.5)	14 (8.9)	

Table 2: Groups' characteristics with and without mandibular third molars during BSSO. Data represent the number of patients (%) unless otherwise indicated.
**p-values of less than 0.05 were considered statistically significant.*

Complication	Third molars present	Third molars absent
Bad splits (%)	3.0	1.5
Neurosensory disturbances of the IAN (%)	3.6	6.3
Infection at the surgical site (%)	10.7	6.9
Symptomatic removal of osteosynthesis material (%)	2.4	3.9

Table 3: Incidence of post-operative complications per site in the groups with and without mandibular third molars during BSSO.

Bad split

Bad splits occurred at five of the 169 sites with mandibular third molars (3.0%) and five of the 333 sites (1.5%) without mandibular third molars. Bilateral bad splits did not occur. A generalised mixed model had been employed to account for patient's information on the right and left side, adjusting for age and gender. Presence of mandibular third molars significantly increased the risk of bad splits (OR, 1.08; 95% CI, 1.02–1.13; $p < 0.01$). Age (OR, 1.03; 95% CI, 0.98–1.09; $p = 0.22$) and gender (OR, 1.01; 95% CI, 0.97–1.05; $p = 0.61$) did not significantly influence the occurrence of bad splits.

IAN status and neurosensory disturbances

The IAN was visibly damaged unilaterally in seven patients; bilateral damage did not occur (Table 4). No significant association was present between mandibular third molar status and IAN status (OR, 1.00; 95% CI, 0.68–1.48; p = 0.98), with adjustment for age and gender.

IAN status	Third molars present	Third molars absent
Total number of surgical sites	169	333
IAN not visible in the distal segment	33 (19.5)	56 (16.8)
Less than half of the IAN visible in the distal segment	29 (17.2)	47 (14.1)
More than half of the IAN visible in the distal segment	74 (43.8)	148 (44.4)
IAN prepared blunt from the proximal segment	17 (10.1)	36 (10.8)
IAN prepared with burr from the proximal segment	12 (7.1)	43 (12.9)
IAN visibly damaged	4 (2.4)	3 (0.9)

Table 4: IAN status at the surgical sites with and without mandibular third molars during BSSO. Data represent the number of surgical sites (%).

Permanent neurosensory disturbances were present at six of the 169 sites (3.6%) with mandibular third molars and 21 of the 333 sites (6.3%) without mandibular third molars. No significant difference in neurosensory disturbances was found between the groups (OR, 0.89; 95% CI, 0.79–1.00; p = 0.06). As before, patient's age and gender had been incorporated in the model. Further analysis revealed an increased risk of neurosensory disturbances when the IAN was prepared from the proximal segment (OR, 1.14; 95% CI, 1.05–1.23; p < 0.01). Increasing age was also a significant risk factor for nerve dysfunction (OR, 1.05; 95% CI, 1.02–1.08; p < 0.01). Gender (OR, 1.37; 95% CI, 0.74–2.54; p = 0.31) and bad split status (OR, 0.90; 95% CI, 0.61–1.35; p = 0.62) were not significantly associated with permanent neurosensory disturbances.

Infection

Infection was present at 18 of the 169 sites (10.7%) with mandibular third molars and 23 of the 333 sites (6.9%) without mandibular third molars. Two patients with mandibular third molars and one patient without mandibular third molars developed infection bilaterally. Presence of mandibular third molars did not significantly increase the risk of infection at the surgical site, adjusting for gender and age (OR, 1.09; 95% CI, 0.99–1.20; p = 0.09). Age (OR, 0.99; 95% CI, 0.97–1.03; p = 0.72), gender (OR, 1.02; 95% CI, 0.95–1.09; p = 0.63), and bad split status (OR, 1.01; 95% CI, 0.72–1.41; p = 0.94) showed no significant association with the development of infection.

Removal of the osteosynthesis material

Symptomatic removal of the osteosynthesis material was indicated at 17 sites, including four of the 169 sites (2.4%) with mandibular third molars and 13 of the 333 sites (3.9%) without mandibular third molars. No significant association was found between mandibular third molar status and symptomatic removal of the osteosynthesis material (OR, 0.97; 95% CI, 0.92–1.03; p = 0.35), with adjustment for age and gender. Age (OR, 0.99; 95% CI, 0.93–1.05; p = 0.71) and gender (OR, 0.38; 95% CI, 0.12–1.23; p = 0.10) were not significantly associated with removal of osteosynthesis material.

Operative time and blood loss

The mean operative time and blood loss during BSSO in the groups with and without mandibular third molars are listed in Table 5. Mandibular third molar status had no significant influence on the total operative time ($p = 0.80$) and blood loss during surgery ($p = 0.09$).

Surgery	Third molars present				Third molars absent			
	Operative time (min)		Blood loss (ml)		Operative time (min)		Blood loss (ml)	
	Mean (SD)	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*
BSSO	147 (45)	60–295	349 (200)	40–900	131 (34)	65–221	360 (338)	50–2500
BSSO + genioplasty	192 (46)	140–235	335 (255)	150–690	158 (76)	105–300	358 (291)	100–900
BSSO + Le Fort I osteotomy	269 (48)	185–353	719 (347)	250–1600	271 (58)	161–397	858 (357)	250–1800
BSSO + Le Fort I osteotomy + genioplasty	315 (70)	210–408	992 (641)	150–1700	268 (68)	180–408	835 (484)	400–2000

Table 5: Operative time and blood loss during various surgical procedures.

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DISCUSSION

Some authors advocate third molar removal during BSSO to avoid an additional surgical procedure and minimise unwanted post-surgical consequences.[11, 13, 17] However, presence of third molars during surgery increases the surgical difficulty and third molar removal concomitant with BSSO is challenging even for experienced surgeons.[10, 18] Other authors therefore recommend removal of third molars at least 6 months preoperatively.[14, 19, 20] In this study, we analysed the influence of third molar status on the common complications of BSSO performed with sagittal splitters and separators. We found that the presence of mandibular third molars during BSSO significantly increased the risk of bad splits but not that of neurosensory disturbances of the IAN, infection at the surgical site, or symptomatic removal of the osteosynthesis material.

Mandibular third molar removal during BSSO significantly increased the risk of bad splits in our study. Third molar removal during surgery can weaken the bony cortex or cause bone defects near the alveolus, predisposing to a bad split. The patients with mandibular third molars during BSSO were significantly younger, but patient age did not have a significant influence on the incidence of bad splits. Age and gender have been included in all multivariate generalised mixed models to account for possible confounding effects, due to the significant difference in age between both groups. Reyneke et al. and Mehra et al. recorded an increased incidence of bad splits when third molars were present, especially in younger patients.[10, 12] Further, Mensink et al. reported a significant association between presence of third molars and occurrence of bad splits independent of patient age.[16] Other authors, however, reported no clinical influence of peri-operative third molar removal on the occurrence of bad splits. Kriwalsky et al. reported older age as a risk factor for bad splits without an association with third molar removal.[21] Doucet et al., Precious et al. and Tucker et al. also found no significant association between the presence of third molars and the occurrence of bad splits.[11, 17, 22] Patients generally recover well after a bad split.[16] In our study, bad splits had no impact on patient recovery and all the patients had good functional outcomes one year after BSSO.

The IAN was manipulated during BSSO, but presence of mandibular third molars did not influence IAN status. This is in concordance with the findings of Doucet et al. who also reported no significant association between third molar removal and nerve manipulation.[23] In contrast, Reyneke et al. reported slightly more frequent manipulation of the nerve in patients with third molars.[10] IAN manipulation is an important factor, because it increases the possibility of permanent neurosensory disturbances after BSSO.[24] In our study group the incidence of IAN manipulation of the nerve was similar between the patients with and without mandibular third molars during surgery, therefore being no influencing factor in the possible post-operative neurosensory disturbances.

The incidence of permanent neurosensory disturbances of the IAN was lower in the group with mandibular third molars (3.6% per site) than in the group without mandibular third molars (6.3% per site). Patients in the group without mandibular third molars were, however, significantly older, predisposing to neurosensory disturbances. The difference between these groups was not significant after adjusting for age and gender. Contradicting earlier findings, Doucet et al. and August et al. reported significantly less neurosensory dysfunction of the lip and chin area when third molars were removed concomitantly with BSSO.[23, 25] Six months post-operatively, the reported incidence of neurosensory disturbances in their study was 32.1% per patient without third molars and 9.5% per patient with third molars during surgery.[23] The authors hypothesised that the presence of a third molar could result in distal positioning of the IAN, avoiding nerve manipulation during surgery. Given our findings, an association of mandibular third molar status with direct manipulation of the nerve seems unlikely.

The relationship between third molar removal concomitant with BSSO and post-operative infection has scarcely been examined. We noted a lower incidence of infection at the surgical site when mandibular third molars were absent before BSSO. However, this association was not significant. Lacey et al. reported increased incidence of infection associated with osteosynthesis material after third molar removal concomitant with surgery.[26] They hypothesised that the empty alveolus increases exposure of bicortical screws to bacteria, thus increasing the infection rate.

Bicortical screws were removed in only a few cases. Mandibular third molar status did not affect the incidence of symptomatic removal of the osteosynthesis material, in contrast with the findings of Lacey et al.[26] The osteosynthesis material was removed mainly because of infection, irritation, and tenderness.

Operative time and blood loss during surgery did not differ significantly between the patients with and without mandibular third molars. Other authors also report no clinically significant influence on the time to accomplish the osteotomy and peri-operative blood loss.[10, 11]

CONCLUSION

We found only a slightly increased risk of bad splits when mandibular third molars were present during BSSO, without long-term consequences. Presence of mandibular third molars did not increase the risk of other post-operative complications. These results imply that mandibular third molar removal can be performed concomitantly with BSSO with sagittal splitters and separators; its timing depends on the surgeon's discretion and patient's choice.

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