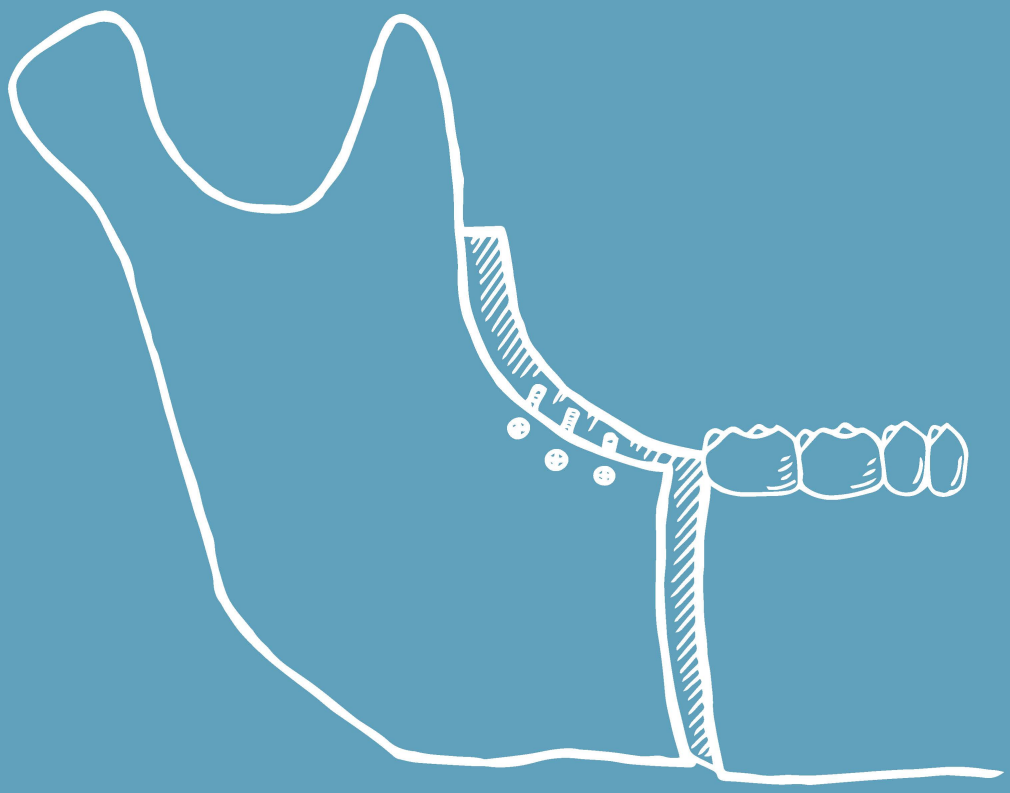
Bilateral sagittal split osteotomy : risk factors for complications and predictability of the splitter-separator technique

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



CHAPTER 5

Removal of bicortical screws and other osteosynthesis material that caused symptoms after bilateral sagittal split osteotomy: a retrospective study of 251 patients, and review of published papers

This chapter is based on the manuscript:

Verweij JP, Houppermans PNWJ, Mensink G, van Merkesteyn JPR

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British Journal of Oral and Maxillofacial Surgery 2014; 52: 756-760.

ABSTRACT

Rigid fixation with either bicortical screws or mini-plates is the current standard to stabilise the mandibular segments after bilateral sagittal split osteotomy (BSSO). Both techniques are widely used and the superiority of any one method is still under debate. One complication of rigid fixation is the need to remove the osteosynthesis material, due to associated complaints. The aim of this retrospective study was to analyse the incidence of symptomatic removal of bicortical screws after BSSO in our clinic. By reviewing the literature, we furthermore investigated the reported rates of screw and mini-plate removal. The mean (SD) follow-up duration of 251 patients (502 sites) was 432 (172) days. Incidence of bicortical screw removal in our clinic was 2.9% (14/486 sites). Alternative methods of fixation were used at 16 sites. No significant association was noted between bicortical screw removal and age, gender, presence of third molars, or bad splits. In the literature, reported rates of removal of bicortical screws and mini-plates are 3.1–7.2% and 6.5–22.2% per site, respectively. These findings show bicortical screw fixation after BSSO is associated with a low rate of symptomatic removal of the osteosynthesis material. Reported incidences in the literature imply a lower removal rate with screw fixation compared to miniplates.

INTRODUCTION

Bilateral sagittal split osteotomy (BSSO), first described by Trauner and Obwegeser[1], is a frequently used technique in orthognathic surgery. Dal Pont, Epker, and Hunsuck subsequently described widely used modifications of the original operative technique.[2-4] Initially, the proximal and distal mandibular segments were fixed with a wire looped around the ramus, combined with jaw immobilisation and intermaxillary fixation (IMF).[1] In 1974, Spiessl introduced rigid fixation with lag screws, avoiding IMF.[5] A few years later, Lindorff advocated placing position screws without compression, to prevent entrapment of the inferior alveolar nerve (IAN).[6] Rigid fixation with mini-plates was popularised by Champy and has since become another method of choice for stabilising the mandibular segments after BSSO.[7]

Although rigid fixation has many advantages over the earlier techniques, post-operative complications associated with the osteosynthesis material can occur.[8-10] One complication is the need to remove the osteosynthesis material because of related infection or irritation, or wound dehiscence. Although long-term consequences are rare, removal of the osteosynthesis material causes morbidity. Therefore, its incidence should be minimised, especially considering the elective nature of orthognathic surgery.

The aims of this retrospective study were to analyse the incidence of bicortical screw removal after BSSO in our clinic and compare in the literature reported rates of bicortical screw and mini-plate removal.

MATERIAL AND METHODS

The clinical records and radiographs of 259 consecutive patients who had undergone either BSSO or bimaxillary osteotomy, with or without genioplasty, were reviewed. The procedures had been performed between January 2004 and December 2011.

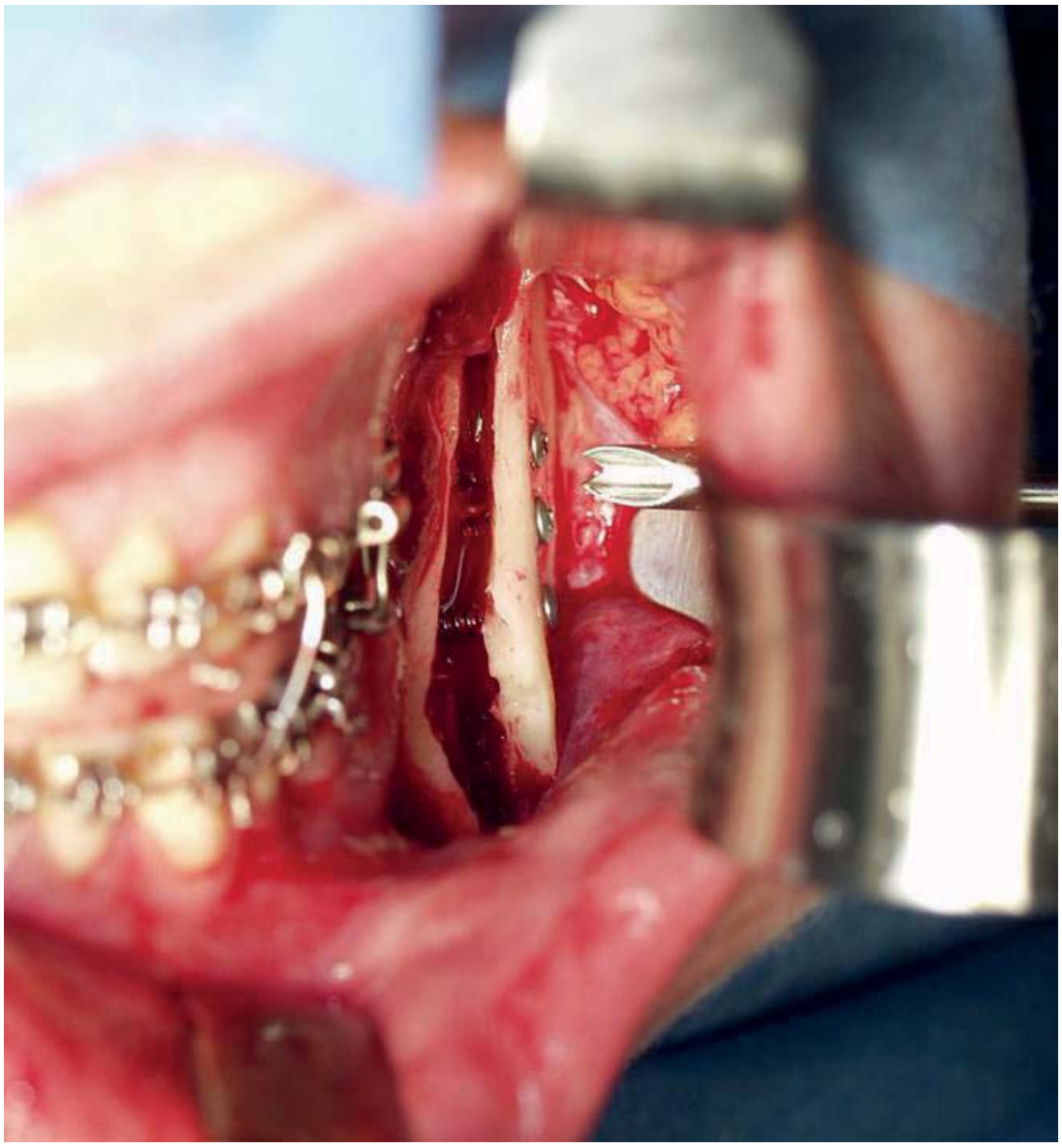

Figure 1: Intraoral view of the buccal cortex showing bicortical screw placement after BSSO.

The same procedures and clinical care had been applied in all cases. Preoperatively, the patients had received single-shot antimicrobial prophylaxis (penicillin, 1 × 106 units intravenously) and steroids (methylprednisolone intravenously, 2 × 25 mg on day 1, 2 × 12.5 mg on day 2, and 1 × 12.5 mg on day 3). Three senior staff surgeons operated in all cases, supervising a resident on the other side in almost all patients. BSSO had been performed with sagittal splitter and separators, without the use of chisels.[11,12] After the sagittal split procedure, the mandible had been placed in the

new intermaxillary relationship and rigid fixation with 3 bicortical screws (Martin GmbH, Tuttlingen, Germany; 9, 11, or 13 mm in length and 2.0 mm in diameter) had been planned (Fig.1). If fixation with bicortical screws had been unfavourable, mini-plates (Martin GmbH; 4- or 6-hole Champy mini-plates) had been used. The patients had been discharged 2 days after surgery and instructed to return to the clinic if they had any complaints. Clinical and radiographic evaluation had been planned at 1, 2, and 3 weeks and 3, 6, and 12 months post-operatively.

The patients' medical files were reviewed for information on the patients' gender, age, pre-operative diagnosis, the status of the mandibular third molars, other simultaneous procedures, method of fixation, and post-operative removal of bicortical screws. If the osteosynthesis material had been removed, the reason had been noted: infection at the osteosynthesis site with inflamed tissue, granulation tissue, or intraoral fistula; wound dehiscence with visible osteosynthesis material; or radiographic bone loss around the material without symptoms. The osteosynthesis material could also be removed on the patient's request, usually because of irritation or tenderness at the osteosynthesis site without infectious symptoms.

Statistical analysis

Statistical evaluation was performed with SPSS version 20.0 for Windows software (IBM Corporation, Armonk, NY, USA). Cross tabulation, Pearson's chi-square test, Fisher's exact test, and logistic regression were used, as appropriate, to assess the significance of differences among the variables. All statistical associations are reported with the odds ratio (OR) and 95% confidence interval (CI). P-values less than 0.05 were considered significant.

RESULTS

Of the 259 patients enrolled in the study, the records of 8 patients were excluded because of incomplete data. Therefore, the final study group comprised 251 patients. Their characteristics are listed in Table 1. The mean (SD) follow-up period was 432 (172) days. Twenty-one patients had not attended the clinical evaluation at 12 months and had been contacted by telephone.

Category	No of patients (%)	Mean (SD)	Range
Sex			
Male	90 (35.9)		
Female	161 (64.1)		
Age (years)		28 (11)	14-56
Occlusion Class			
II	219 (87.3)		
III	32 (12.7)		
Third molars (right side)			
Absent prior to BSSO	165 (65.7)		
Present during BSSO	86 (34.3)		
Third molars (left side)			
Absent prior to BSSO	168 (66.9)		
Present during BSSO	83 (33.1)		
Procedure			
BSSO	146 (58.2)		
+ Le Fort I	63 (25.1)		
+ genioplasty	11 (4.4)		
+ Le Fort I + genioplasty	31 (12.4)		
Follow-up time (days)		432 (172)	163-1465

Table 1: Patient characteristics.

Sagittal split osteotomy had been performed at 502 sites. Screw fixation had been performed in 246 patients (98.0%), bilaterally in 240 patients and unilaterally in 6 patients, with mini-plate fixation on the contralateral side. Mini-plates had been fixed on the right side in 5 patients and combined with one bicortical screw on the left side in 1 patient. The reasons for unilateral mini-plate fixation were bad splits (n = 3), decreased lingual cortical bone volume after third molar extraction (n = 1), a small mandibular body with possible danger to the IAN by bicortical screw fixation because of its anatomical position (n = 1), and burr malfunction and mini-plate fixation with other equipment (n = 1). Two patients (0.8%) had undergone bilateral mini-plate fixation because of decreased lingual cortical bone volume after third molar extraction. Three patients had undergone IMF because of bad splits.

	Patients	Sites
Screw fixation	246	486
Removal indicated (%)	12 (4.9)	14 (2.9)
Plate fixation	8	10
Removal indicated (%)	2 (25.0)	3 (30.0)
IMF	3	6

Table 2: Modes of fixation after BSSO with incidence of removal of osteosynthesis material. Removal of osteosynthesis material is indicated as number (%) of either patients or sites.

The different methods of fixation and incidence of removal of the osteosynthesis material are shown in Table 2. Removal of bicortical screws had been necessary at 14 of 486 sites. The incidence of screw removal was 2.9% per site. At 11 sites (78.6%), the reason for removal was related infection, including intraoral fistula in 6 cases. The screws at 3 sites had been removed on the patient's request, because of related irritation or tenderness. Of the 10 sites with mini-plates, removal of the osteosynthesis material had been necessary at 3 sites (2 patients). In one patient, bilateral mini-plates had been removed because of related infection with intraoral fistula on the left side. In the other patient, unilateral mini-plate fixation had been combined with one bicortical screw. The mini-plate had been removed because of intraoral fistula originating from the material, and the unaffected bicortical screw had been retained. In total, removal of the osteosynthesis material had thus been necessary in 14 of 248 patients (5.6%) at 17 of 496 sites (3.4%). All the patients had recovered well after removal of the osteosynthesis material.

Risk factors for screw removal were analysed between the removal and the non-removal groups of patients. Screw removal was indicated in 7 male and 5 female patients. The mean age in the removal group was 26.7 years (range, 15.0–37.7 years), compared with 27.8 years (range, 13.8–55.6 years) in the non-removal group. Gender (OR, 0.38; 95% CI, 0.12–1.23; p = 0.10) and age (OR, 0.99; 95% CI, 0.93–1.05; p = 0.71) were not significantly associated with removal of the osteosynthesis material. Further, pre-operative occlusion did not differ significantly in the removal group, consisting of 9 and 3 patients with class II and III malocclusions, respectively (OR, 2.87; 95% CI, 0.85–9.72; p = 0.08).

The association between presence of third molars during BSSO and post-operative removal of screws was also analysed. On the right side, screws had been removed at 7 sites, and third molars were present at 2 of these sites. On the left side, screw removal was indicated at 7 sites, but none of them contained third molars during BSSO. Presence of third molars was not significantly associated with screw removal (OR, 0.97; 95% CI, 0.92–1.03; p = 0.37).

Bad splits had occurred at 9 of the 502 sites (1.8%). These were sometimes an indication for an alternative method of fixation, but no osteosynthesis material had been removed in any of these patients.

DISCUSSION

In this study, the incidence of symptomatic removal of the osteosynthesis material after BSSO was analysed and compared with the reported rates of bicortical screw and mini-plate removal in the literature. The study showed a low incidence of symptomatic removal of bicortical screws (2.9% per site).

Rigid fixation has evident advantages over IMF in terms of function, patient comfort, stability, and relapse.[13] Therefore, rigid fixation with bicortical screws or mini-plates and monocortical screws is the treatment of choice after BSSO and IMF is solely used if stabilisation of the bony segments cannot be achieved in another way. The superiority of any of these two fixation methods is controversial.[14,15] Many different factors play a role in the choice for one osteosynthesis material and specific conditions sometimes require the application of one fixation technique instead of the other. The primary fixation method of choice in our clinic had been the placement of three bicortical positional screws in the superior border of the mandibular segments. In our opinion this provides a reliable rigid fixation specifically designed to fixate osteotomies. Bicortical screws seem to provide a more rigid fixation than mini-plates. Some authors therefore prefer screw fixation in asymmetric mandibles, although others specifically favour plate fixation in these cases.[15] Further, a more natural seating of the condyle is achievable during bicortical screw fixation, because mini-plates could reduce the degree of adaption and thus induce changes in the condylar position. However, less rigid fixation with mini-plates creates less torque on the condylar process and minor occlusal discrepancies are probably adjusted more easily after surgery. Patients with mini-plates also tend to recover their masticatory function faster.[16] Mini-plate fixation is furthermore indicated at sites with thin lingual cortex, such as after third molar extraction or bad splits.[17]

In this study, the patients had been scheduled to undergo rigid fixation with bicortical screws, which had been performed in almost all cases (96.8%). Fixation with mini-plates had been used when screw fixation had not been possible, for example, because of difficulty in achieving proper configuration of bicortical screws due to the mandibular anatomy or (in most cases) lack of the lingual cortex of the distal segment after third molar extraction or bad splits. IMF had been applied only after bad splits. The incidence of symptomatic removal of bicortical screws was 2.9% per site in our group. At three out of 10 sites, plate removal was necessary. The patients receiving plate fixation were however a small biased group, selected on the inability to use bicortical screws. Therefore, only screw removal was further analysed in our study.

First author	Year of publication	Number of patients	Number of sites	Screw removal (per patient)	Screw removal (per site)	Incidence per patient (%)	Incidence per site (%)
Bouwman[7]	1995	667	-	20	-	3.0	-
Lacey[17]	1995	83	166	12	12	14.5	7.2
Becelli[8]	2004	241	482	15	15	6.2	3.1
Verweij	Present study	246	486	12	14	4.9	2.9

Table 3: Reported incidence of screw removal.

First author	Year of publication	Number of patients	Number of sites	Plate removal (per patient)	Plate removal (per site)	Incidence per patient (%)	Incidence per site (%)
Brown[9]	1989	-	18	-	4	-	22.2
Theodossy[18]	2006	80	160	16	25	20	15.6
Alpha[19]	2006	533	1066	54	70	10	6.5
Kuhlefelt[20]	2010	159	306	29	56	18.6	18.2
Falter[21]	2011	310	-	80	-	25.8	-

Table 4: Reported incidence of plate removal.

In the literature, the incidence of screw removal after BSSO varies between 3.1% and 7.2% per site (Table 3).[8,9,18] The reported incidence of mini-plate removal after BSSO varies between 6.5% and 22.2% per site (Table 4).[10,19-22] Infection is the main reason for removal of both screws and mini-plates.[8-10,18-22] In the literature reported incidences of screw removal are remarkably lower than those of mini-plate removal. Research in the field of traumatology has shown that the design, size, and morphology of an implanted material influences the incidence of post-operative infection.[23] Mini-plates have multiple concavities and holes and are larger than screws. Their morphology thus enlarges the area for bacterial colonisation, increasing susceptibility to infection. If mini-plates are positioned too high in relation to the superior border of the mandible, necrosis and sequestration cranial to the material can occur.[14] Furthermore, palpability of mini-plates could lead to irritation or sensitivity.

Removal of the osteosynthesis material is however only one measure of surgical outcome after BSSO and the key measures evidently are final occlusion and patient satisfaction. Moreover, other factors govern the choice between screw and mini-plate fixation after BSSO. After orthognathic surgery with rigid fixation, the condylar position in the glenoid fossa changes, leading to condylar remodelling and resorption.[24,25] Bicortical screw fixation could increase the torque on the condyle. However, no comparative studies have been performed and the reported risk of condylar resorption after both fixation methods is similar.[24]

The stab incision to place bicortical screws is not needed in mini-plate fixation, so no extra-oral scar can form and localised skin burns are avoidable. However, in our experience, the stab incision results in a small extra-oral scar, which is inconspicuous to the patient. Skin burns occur only because of the use of poor technique and are avoidable. Bouwman et al. reported a higher incidence of neurosensory disturbance with bicortical screw fixation than with IMF.[8] Therefore, in bicortical screw fixation, care should be taken during screw placement with consideration of the IAN. Furthermore, the mandibular segments should be fixed with gentle force to prevent entrapment of the nerve, which can occur when the cortices are forcefully pressed together. These technical aspects depend mainly on the skill of the surgeon. Use of bicortical screws with the proper technique has been shown to be associated with a low incidence of neurosensory disturbances.[11,12] However, the possibility of nerve injury remains; mini-plate fixation had been performed in one case to avoid this problem.

In conclusion, the findings of our retrospective review show that rigid fixation with 3 bicortical screws after BSSO is a reliable method with a low rate of post-operative removal of the osteosynthesis material. Reported incidences in the literature indicate a lower removal rate of bicortical screws compared to miniplates. These findings could help the surgeon to choose the appropriate method of fixation in the (controversial) decision between mini-plates and bicortical screws.

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