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

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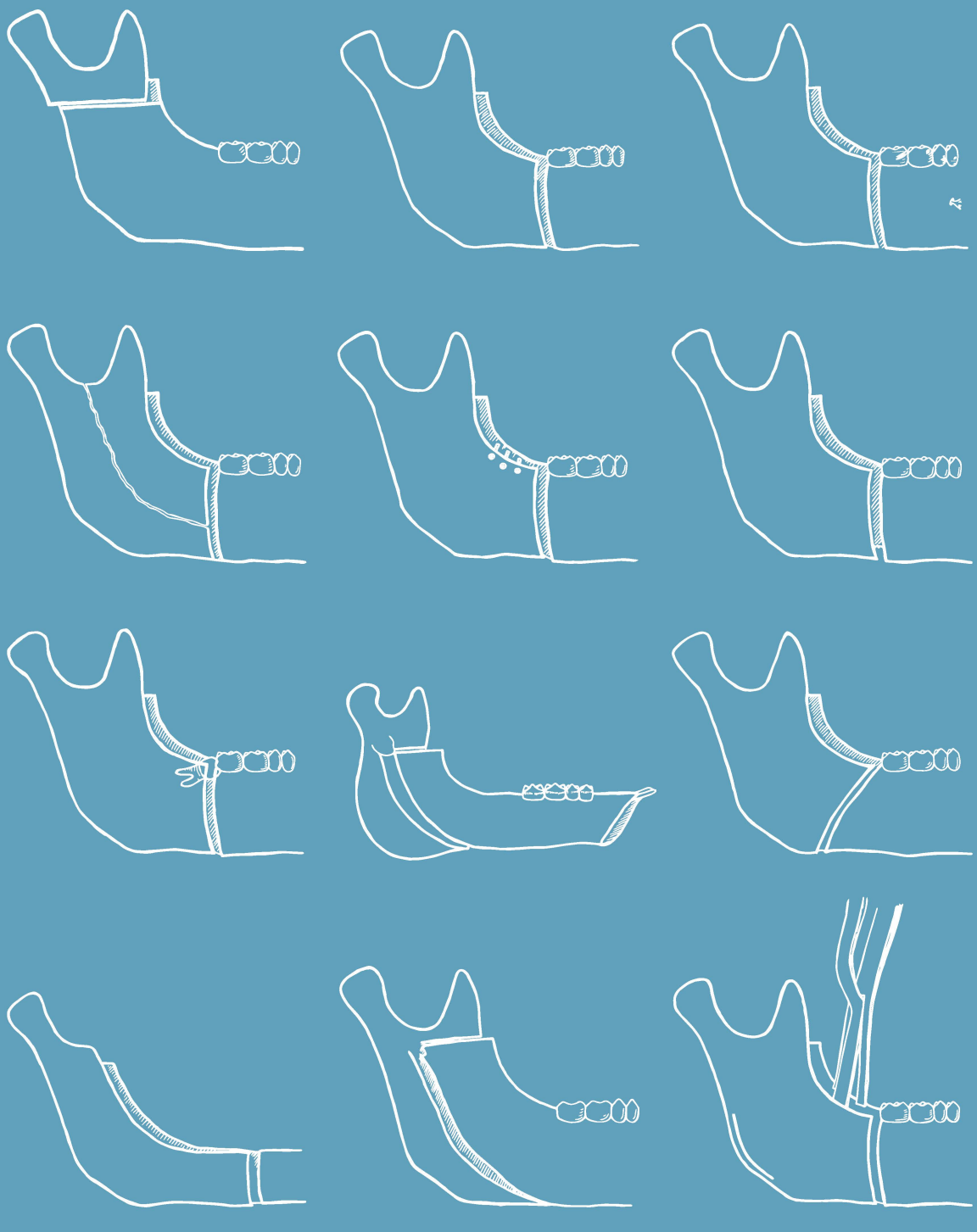

CHAPTER 13

Summary

SUMMARY

Chapter 1 provides a general introduction about bilateral sagittal split osteotomy (BSSO). The history and development of the technique are described. Clinical complications that frequently occur within the first postoperative year are discussed, including neurosensory disturbances of the lower lip, unfavourable fractures, postoperative infection, removal of osteosynthesis material and osseous mandibular inferior border defects.

This thesis aims to investigate the risk of complications associated with BSSO, performed with a splitter and separators. Specific risk factors for intra- and postoperative complications as well as factors influencing the predictability of the technique are analysed.

The purpose of this research is to enable individual counselling of patients before BSSO, and help maxillofacial surgeons attempt to minimise the risk of complications associated with this procedure.

In *Chapter 2*, a systematic review and meta-analysis of the literature regarding risk factors for common complications associated with BSSO is provided. After a systematic electronic database search, 59 studies could be included. For each complication, a pooled mean incidence was computed.

The mean incidences are reported for bad split (2.3% per site), postoperative infection (9.6% per patient), removal of the osteosynthesis material (11.2% per patient), and neurosensory disturbances of the lower lip (33.9% per patient). Relevant risk factors such as age, smoking habits, presence of third molars, the surgical technique and type of osteosynthesis material are discussed.

This information could help the surgeon to reduce the risk of these complications and inform the patient about the complication risks associated with BSSO.

In *Chapter 3*, the incidence of neurosensory disturbances (NSD) of the lower lip and chin after BSSO with splitter and separators is investigated in different age groups. The probability of sensory recovery is furthermore assessed in patients aged <19 years, 19–30 years and >30 years.

In this retrospective study, we subjectively and objectively assessed hypoaesthesia in the lower lip immediately postoperatively, 1 week and 1, 6 and 12 months after BSSO. Hypoaesthesia was considered permanent if it was present one year after BSSO.

In older patients, the frequency of NSD immediately after surgery was significantly higher. The cumulative incidence of recovery at 1 year was lower and the mean time to recovery was longer in older patients, although these differences were not statistically significant. Older age was a significant risk factor for permanent hypoaesthesia with an incidence of 4.8% per patient <19 years; 7.9% per patient 19-30 years; and 15.2% per patient > 30 years.

This shows that the risk of NSD after BSSO is significantly higher in older patients. The results can aid surgeons in pre-operative counselling specific age groups and help decide the optimal age to perform BSSO.

In *Chapter 4*, the occurrence of bad split after BSSO with splitter and separator is investigated. An unfavourable fracture pattern, known as bad split, is a common intra-operative complication in BSSO. The reported incidence of this complication with traditional techniques ranges from 0.5 to 5.5% per site.

Since 1994, BSSO is performed with splitter and separators instead of chisels in our clinic. In this retrospective cohort study of 427 consecutive patients (851 sites), the incidence of bad split was 2.0% per site. This is well within the range reported in the literature. The removal of third molars concomitant with BSSO was a significant risk factor for bad split. There was no significant association between bad splits and the patient's age, gender, occlusion class, or the experience of the surgeon.

In conclusion, BSSO performed with splitter and separators instead of chisels does not increase the risk of a bad split.

In *Chapter 5*, the removal of bicortical screws and other osteosynthesis material that caused symptoms is analysed. Rigid fixation with either bicortical screws or mini-plates is the current standard to stabilise the mandibular segments after BSSO. However, one complication of rigid fixation is the need to remove the osteosynthesis material because of associated complaints.

In our clinic, fixation after BSSO is performed with three bicortical screws unless otherwise indicated. Retrospective analysis of 251 consecutive patients (502 sites) showed the incidence of bicortical screw removal in our clinic was 2.9% per site. No significant association was noted between bicortical screw removal and age, gender, presence of third molars, or bad splits. Alternative methods of fixation were used at 16 sites. 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 that bicortical screw fixation after BSSO is associated with a low rate of symptomatic hardware removal. Reported incidences in the literature imply that the need of removal of bicortical screws is remarkably lower than the need of removal of mini-plates.

In *Chapter 6*, the occurrence of osseous inferior border defects after BSSO is retrospectively investigated using the pre- and postoperative radiography of 200 consecutive patients. Bone defects of the inferior border of the mandible can cause an unaesthetic postoperative result and in rare cases even necessitate secondary surgical procedures.

In this study, osseous inferior border defects were present at 28 out of 400 sides (7.0%/side) in 25 out of 200 patients (12.5%/patient). Significant risk factors for inferior border defects were increased mandibular advancement, more clockwise rotation of the occlusal plane, rotation of the proximal mandibular segment, and a type II split initiating in the lingual cortex. The presence of third molars and occurrence of bad splits were not significantly associated with inferior border defects.

These findings could help the surgeon to maximise the result of BSSO, increase patient satisfaction and minimise the risk of secondary procedures.

In *Chapter 7*, the influence of mandibular third molar removal during BSSO with splitter and separators is discussed. Timing of third molar removal in relation to BSSO is controversial, especially with regard to postoperative complications.

We performed a retrospective record review of 251 patients (502 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% and 1.5% of the respective sites. Presence of mandibular third molars significantly increased the risk of bad splits. The mean incidences of permanent neurosensory disturbances, postoperative infection, and symptomatic removal of the osteosynthesis material were 5.4%, 8.2%, and 3.4% per site respectively, without a significant influence of mandibular third molar status.

The presence of mandibular third molars during surgery increased the possibility of bad split, but did not affect the risk of other complications. Third molar removal concomitant with BSSO can save the patient additional preoperative procedures to remove third molars before surgery. Therefore, third molar removal can be advised concomitantly with BSSO performed with splitter and separators.

In *Chapter 8*, the lingual fracture pattern and status of the nerve after BSSO with the prying and spreading technique (splitter and separators) are compared to the traditional technique (mallet and chisels). Lingual fractures after sagittal split osteotomy in cadaveric pig mandibles were analysed using a lingual split scale and split scoring system. Iatrogenic damage to the inferior alveolar nerve was assessed.

Fractures started through the caudal cortex more frequently in the chisel group. This group also showed more posterior lingual fractures, although this difference was not statistically significant. Nerve damage was present in three cases in the chisel group, but was not observed in the splitter group.

A trend was apparent, that BSSO using the chisel technique instead of the splitter technique resulted in more posterior lingual fracture lines, although this difference was not statistically significant. Both techniques resulted in reliable lingual fracture patterns. Splitting without chisels could prevent nerve damage, which is why we propose a spreading and prying technique with splitter and separators.

In *Chapter 9*, further research is performed regarding lingual fractures, bad split and nerve status after BSSO with splitter and separator.

The conventional osteotomy design in BSSO includes a horizontal lingual bone cut, a connecting sagittal bone cut and a vertical buccal bone cut perpendicular to the inferior mandibular cortex. This buccal bone cut extends as an inferior border cut into the lingual cortex. This study investigated a modified osteotomy design including an angled oblique buccal bone cut that extended as a posteriorly aimed inferior border cut near the masseteric tuberosity.

The study sample comprised 28 cadaveric dentulous human mandibles. The angled osteotomy design resulted in a significantly higher number of lingual fractures originating from the inferior border cut, with a significantly more posterior relation of the fracture line to the mandibular canal and foramen. No bad splits occurred with the angled design, whereas three bad splits occurred with the conventional design, although this difference was not statistically significant. Inferior alveolar nerve (IAN) status was comparable between designs, although the IAN more frequently required manipulation from the proximal mandibular segment when the conventional design was used.

These results suggest that the angled osteotomy design promotes a more posterior lingual fracture originating from the inferior border cut. A trend was apparent that this might also possibly decrease the incidence of bad splits and IAN entrapment.

In *Chapter 10*, a clinical prospective observational study regarding the lingual fracture patterns after BSSO with splitter and separators is performed. This study investigated the correspondence between the planned inferior border cut and the actually executed inferior border cut during BSSO through postoperative cone-beam computed tomography (CBCT). The influence of the performance of the inferior border cut on lingual fracture patterns was analysed.

The inferior border cut reached the caudal cortex in all cases, but only reached the lingual cortex in 38% of the splits. There was no significant relationship between the inferior border cut and a specific lingual fracture line.

Postoperative CBCT analysis revealed that the bone cuts during BSSO were often not placed exactly as planned. Despite this, no significant relationship between the inferior border cut and lingual fracture patterns or bad splits was detected. Further research is needed to identify factors that could make the sagittal split more predictable.

In *Chapter 11*, a case is presented of BSSO in a reconstructed mandible. A 28-year old woman underwent a segmental mandibulectomy, due to a multicystic ameloblastoma in the left jaw. After primary plate reconstruction, final reconstruction was performed with a left posterior iliac crest cortico-cancellous autograft. Because of a pre-existing Class II malocclusion, the patient was analysed for combined orthodontic-surgical treatment. After one year of orthodontic treatment, the BSSO was planned. The sagittal split was performed in the remaining right mandible and on the left side in the iliac crest cortico- cancellous autograft. Ten months later, oral rehabilitation was completed with implant placement in the neo-mandible. Follow-up showed a Class I occlusion, with good function. The patient was very satisfied with the functional and aesthetic results.

This shows that BSSO can be performed in a reconstructed mandible, without side effects and with good functional and aesthetic results.

Chapter 12 discussed conclusions, clinical implications and future perspectives for the subjects of this thesis.