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# Table of Content

## Literature Review

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Pathogenesis of Oral Squamous Cell Carcinoma</td>
<td>3</td>
</tr>
<tr>
<td>H.Y. Yusuf</td>
<td></td>
</tr>
<tr>
<td>Bad Split Osteotomy : A Complication Associated with Orthognathic</td>
<td>11</td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
</tr>
<tr>
<td>I. Damayanti, B.S. Latief</td>
<td></td>
</tr>
</tbody>
</table>

## Original Research Article

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation of E-Cadherin Immunoexpression with Oral Squamous Cell</td>
<td>16</td>
</tr>
<tr>
<td>Carcinoma Gradation</td>
<td></td>
</tr>
<tr>
<td>E. Hermanto</td>
<td></td>
</tr>
<tr>
<td>Assessment of Quality of Life (QoL) in Patients After Head and Neck</td>
<td>22</td>
</tr>
<tr>
<td>Tumor Surgery</td>
<td></td>
</tr>
<tr>
<td>S. Anggraeni, C. Johan, L.A. Seniati</td>
<td></td>
</tr>
</tbody>
</table>

## Case Report

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Le Fort 1 Osteotomy and Bilateral Sagittal Split Osteotomy (BSSO) for</td>
<td>29</td>
</tr>
<tr>
<td>Treatment of Mandibular Prognathism and Maxillary Retrusion</td>
<td></td>
</tr>
<tr>
<td>J. Binarto, A. Arumsari, S. Adiantoro, M. Sylvyana, A.T. Yuza</td>
<td></td>
</tr>
<tr>
<td>Gap Arthroplasty with Mersilene Mesh Interpositional Placement of</td>
<td>39</td>
</tr>
<tr>
<td>Bilateral Temporomandibular Joint Ankylosis</td>
<td></td>
</tr>
<tr>
<td>A. Setyawan, R. Baehaqi</td>
<td></td>
</tr>
<tr>
<td>Management of Giant Maxillary Ameloblastoma Employing</td>
<td>46</td>
</tr>
<tr>
<td>Hemimaxillectomy Surgery and Surgical Obturator Application</td>
<td></td>
</tr>
<tr>
<td>S.S. Kamadjaja, A. Wibowo, R. Baehaqi</td>
<td></td>
</tr>
<tr>
<td>Dermoid Cyst of the Floor of the Mouth: A Case Report and Review of</td>
<td>54</td>
</tr>
<tr>
<td>Anatomo-Surgical Classification</td>
<td></td>
</tr>
<tr>
<td>W.S. Yasa, O. Prasetio</td>
<td></td>
</tr>
</tbody>
</table>
Bad Split Osteotomy: A Complication Associated with Orthognathic Surgery

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Abstract

The definition of what constitutes a complication in orthognathic surgery varies between clinicians. By understanding the medical history and physical findings of patient who presents with dento facial deformity, such as any conditions associated malformations, patients baseline psychosocial health and any head and neck dysfunction, patient-specific complication can be minimized. An unfavourable fracture, known as bad split, is a common operative complication in bilateral sagittal split ramus osteotomy (BSSO). An increased percentage of bad splits could be expected with this technique. However, the procedure still presents a certain degree of technical difficulty and is associated with several potential complication nowadays. The incidence of bad split at sagittal split osteotomy site ranges from 0.5 to 5.5\%. The unwanted fracture is normally located in either the distal (lingual plate fracture) or proximal cortical plate (buccal plate fracture) of the mandible. Numbers of bad split should be minimized and when bad split happens that should be adequately treated through there may be some limitations. Even when this bad split occurs, the successful healing of the segments will generally occur.

Keywords: bad split, bilateral sagittal split osteotomy, orthognathic surgery

Introduction

Segmenting the mandible in an orthognathic procedure to reposition the tooth-bearing part is generally known as a Bilateral Sagittal Split Osteotomy (BSSO). The Trauner and Obwegeser technique (1955), the Dal-Pont modification (1961), and the Hunsuck modification (1968) are the best documented (Figure 1).\textsuperscript{3}

Bilateral sagittal split osteotomy (BSSO) is a successful and common treatment for mandibular hypo-and hyperplasia. Multiple studies have reported persistent hypoesthesia of the IAN after BSSO, with incidences ranging from 0\% to 82\% with the use of various tests.\textsuperscript{1}

Neurosensory disturbance (NSD)
of the IAN is a considerable morbidity for patients, especially given the elective nature of this surgery. IAN disturbance is caused by iatrogenic damage, especially from incorrect splitting techniques or osteotomies.\textsuperscript{1}

Nerve damage may also result from excessive nerve manipulation (after soft tissue dissection at the medial aspect of the mandibular ramus), nerve laceration, incorrect placement of position or lag screws during segment fixation, large mandibular advancement, impingement by bony spiculae, or bad splits.\textsuperscript{1}

Iatrogenic damage of the nerve may also be a secondary consequence of surgery-induced hypoxia and edema, which frequently results in a combination of neurapraxia and partial axonotmesis. Thus, surgical techniques should be discussed and critically evaluated to minimize potential complications of BSSO.\textsuperscript{1}

The definition of what constitutes a complication in orthognathic surgery varies between clinicians. By understanding the medical history and physical findings of patient who presents with dentofacial deformity, such as any conditions associated malformations, patient’s baseline psychosocial health and any head and neck dysfunction, patient-specific complication can be minimized.

The unwanted fracture is normally located in either the distal (lingual plate fracture) or proximal cortical plate (buccal plate fracture) of the mandible. Other bad split site affects the coronoid process or the condylar neck.\textsuperscript{1}

Unfavorable proximal segment (buccal plate) fractures or distal segment (lingual plate) fractures can lead to difficult splitting, difficult fixation, sequestration of the fragment, infection, delayed union, or even malunion of the osteotomy site.

Numerous risk factors influencing this complication have been identified, including difficult anatomy, incomplete osteotomies, poor osteotomy design, and presence of a mandibular third molar.

Intraoperative complications include nerve injury, bleeding, and mechanical problems, such as irregular split patterns. The incidence of bad split at sagittal split osteotomy site ranges from 0.5 to 5.5%.\textsuperscript{1} Other study reported incidence of bad split was 2.3% of sagittal splits.\textsuperscript{2}

**Discussion**

Bad splits may cause mechanical instability, a disturbance in bony union, and lead to bone sequestration with subsequent infection. In addition, it has been proposed that temporomandibular joint (TMJ) dysfunction and inferior alveolar nerve damage may arise due to excessive intraoperative manipulation in an attempt to reposition the fractured segments, and that subsequent difficulty in positioning the condyle in the glenoid fossa may increase the risk of relapse.
The various types of bad split may require different salvage approaches. Based on SA Steenen and AG Becking review of fracture's pattern, bad split can be divided into 4 fracture's type.

Type 1 is proximal segment (buccal) fractures. The buccal cortical plate of the mandible in some patients is rather thin and susceptible to fractures posterior to the second molar, which may explain the frequently reported 1A, 1B, and 1C fracture types (Figure 2).

The difficulty of proximal segment fracture reduction depends on the fractured segment size and anatomical location. Small segments that have been stripped from the periosteum (e.g., type 1A fractures) may be removed to prevent sequestration. Larger fractured fragments (e.g., types 1B, 1C, 1E, and 1F) with an intact periosteum are best secured immediately, and simply and quickly reduced with plate osteosynthesis, in order to reduce stretching forces on the inferior alveolar nerve, which may occur if chisels are used to finish the split.

The split can be completed in the usual way with moderate force. If the fractured buccal fracture line runs above the lingula (type 1D), the condylar segment is entirely free. Securing its position in the fossa requires securing the condylar stump to the remaining buccal cortex. In this situation, additional removal of the coronoid process to eliminate traction of the temporalis muscle may be necessary. The coronoid process may then instead be used as a free cortical graft.

Type 2 is distal segment (lingual) fractures. In the early 1980s, the lingual split technique described by Hunsuck was still considered to be a bad split by some. To date, the Hunsuck modification has commonly been employed, and normal variations of the lingual split line have been studied extensively. Lingual segment fractures may be challenging to repair (Figure 3).

Greenstick fractures of the lingual segment have frequently been reported. 32.9% of distal segment bad splits vs. 0% of proximal segment bad splits. This may be attributable to greater cortical elasticity in younger patients. Repositioning the fractured segments and positioning the condyle in the glenoid fossa may be difficult, but can be assessed during surgery if intermaxillary fixation (IMF) is released. Restoring the anatomy in this type of bad split requires securing the condyle in the fossa by whatever means possible, followed by careful dissection to visualize the fracture.
In the case of a vertical fracture (type 2A), the split can be completed and the lingual plate will remain unattached; fixation can only be accomplished with buccal plating and monocortical screws. If desired, the lingual fragment can be fixed with one or two bicortical screws. If alignment is accomplished, fixation does not appear to be necessary in all cases.

In the case of a horizontal fracture (type 2B), the situation does not hamper the surgery, and fixation can still be accomplished within the same surgical session with plate osteosynthesis or upper border bicortical screws. Lower border bicortical screws will not fix the two major fragments but might fix the lingual fragment if desired.

In some cases, a lingual fracture may be induced deliberately. In cases of asymmetry, the proximal and distal segments do not always align passively to one another during the intraoperative application of IMF, causing displacement of the con-dyles within the fossa. To reduce this gap between the proximal and distal segments, Ellis described a method whereby lingual bony interferences at the point of first contact of the segments are removed. Lingual bad splits do not seem to influence the final outcome in sagittal split osteotomy, however the fixation method needs to include a monocortically fixed plated, since bicortical screws will not stabilize the proximal fragment.

Type 3 is coronoid process fracture. These fractures probably result from incorrect positioning of the bone-cuts. In this type of fracture, the free coronoid may be left in place without consequences (Figure 4).

Type 4 is condylar neck fractures. Incorrect positioning of the bone-cuts most likely plays a role in their occurrence as well. This type of bad split may be the most difficult to reduce, especially if the condyle remains attached to the distal tooth-bearing segment (fig. 4). This type of fracture is best managed by aligning the bony fragments and semi-rigid plating. This may be a difficult procedure, necessitating routines in open reduction and internal fixation in condylar fracture treatment and transcutaneous access. Discontinuing the procedure and a secondary attempt after consolidation may be the best choice.

Fig. 4. Bad split patterns reported in the literature (1971–2015) type 3 coronoid process fractures and type 4: condylar neck fractures 2

Bilateral sagittal split osteotomy is the most widespread orthognathic procedure which gives good results and severe complications are rare. Risk factors should be identified and reduced so far as possible, particularly because it is an elective operation.

This is still controversy about whether the presence of a retained or impacted third molar in the lower jaw increases the risk of a bad split or not. And the question is should it be removed before orthognathic surgery or during SSO?

Some authors have suggested that the presence of mandibular third molars during SSOs will increase the incidence of unfavorable splits, as well as operating time, manipulation of the inferior alveolar neurovascular bundle (IAN), and technical difficulty of the procedure, and recommend their removal at least 6 months before the procedure. Other clinicians advised removal of third molars at the same time as orthognathic surgery. However, a study before showed that all cases of bad splits occurred in patient with retained or impacted third molars, and
all patients were under 20 years old.\textsuperscript{5}

This fracture is most likely to occur in the third molar region where cortical bone is thin and not easily stabilized, possibly resulting from excessive lateral inclination of the osteotome. It has been proposed that surgical sectioning of the impacted third molar and removal in segments may help to prevent this type of bad split from occurring.

A research before reported that the presence of a mandibular third molar during sagittal split osteotomy is not associated with an increased frequency of unfavorable fractures of the mandible. It also mentioned that the presence of a mandibular third molar during sagittal split osteotomy decreases the rate and severity of neurovascular bundle entrapment, thus reducing the requirement for manipulation of the inferior alveolar nerve and the presence of a mandibular third molar during sagittal split osteotomy increases the operating time by less than two minutes per side.\textsuperscript{6}

A study assessed that there is no association between bad split and patient’s sex or surgeon’s experience has been reported. The conclusion of the study also mention that the splitter-separator technique does not raise the risk of bad splits compared with the use of chisels, but a slight increase is possible when third molars are present during BSSO.\textsuperscript{1}

A journal reported that advancing age can increase the risk of a bad split and should be considered a complicating factor.\textsuperscript{3} Another study also showed statistical significance in the correlation between the age of the patient and the occurrence of a bad split.\textsuperscript{4}

Conclusion

The exact combination of factors that result in a bad split is unknown. Bad split can be provoked by the following: (1) an anatomically thin mandibular ramus; (2) a high mandibular lingual; (3) the presence of third molars; (4) the length of the medial osteotomy; or even (5) by the inexperience or lack of attention of the surgeon. Some authors suggested that the use of heavy osteotomes, twisting techniques, or the incomplete split of the inferior border of the mandible could be the main cause of bad splitting.

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