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Influence of inferior border cut on lingual fracture pattern during bilateral sagittal split osteotomy with splitter and separators: A prospective observational study

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ABSTRACT

Bilateral sagittal split osteotomy (BSSO) is a widely used orthognathic surgery technique. This prospective observational study investigated the correspondence between the planned inferior border cut and the actually executed inferior border cut during BSSO. The influence of the inferior border cut on lingual fracture patterns was also analyzed.

Postoperative cone beam computed tomography (CBCT) scans of 41 patients, representing 82 sagittal split osteotomies, were investigated. The inferior border cut was intended to penetrate completely through the caudal cortex. Descriptive statistics were used to analyze the executed inferior border cuts. Mixed models were used to investigate the influence of independent variables such as the surgeon's experience on the inferior border cut. Secondarily the influence of the inferior border cut on lingual fracture patterns and the incidence of bad splits was assessed.

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

In this study, postoperative CBCT analysis revealed that the bone cuts during BSSO were often not placed exactly as planned. No significant relationship between the inferior border cut and lingual fracture patterns or bad splits was, however, detected.

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1. Introduction

Orthognathic procedures are widely used for the correction of maxillofacial deformities. One of the most popular techniques is the bilateral sagittal split osteotomy (BSSO). The technique originates from Schuchardt (1942), who introduced a modification of the horizontal subcondylar osteotomy previously described by Blair (1907). This modification consisted of two horizontal cortex osteotomies in the mandibular ramus, with the aim of bilaterally splitting the mandibular ramus. The first horizontal cut was placed just above the mandibular foramen at the lingual side of the ramus, and the second cut was positioned approximately 10 mm caudally at the buccal side (Schuchardt, 1942). This first version of the BSSO was subsequently popularized and further developed by Trauner and Obwegeser (1957). They extended the horizontal cut at the buccal side more caudally so that the distance between the bone cuts was approximately 25 mm.

Since then, several modifications have been suggested to improve the technique. Dal Pont (1961) extended the buccal bone cut more ventrally toward the second molar, to increase bony contact and stability. Hunsuck (1968) proposed a shorter horizontal bone cut at the medial side to achieve a controlled fracture in the lingual cortex, and was the first to complete the sagittal split by performing a controlled lingual fracture. Epker (1977) later emphasized the importance of an inferior border cut that extended

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completely through the inferior cortex, for ease of splitting. Several authors subsequently advocated a cut through the inferior cortex of the mandible (Epker et al., 1978; Wolford et al., 1987; Reyneke, 2007). With this technique, the full thickness of the lower border of the mandible remains on the proximal segment. The aim of this is to strengthen the proximal segment and thereby to increase control of the lingual fracture and prevent unfavorable splits (Agbaje et al., 2013).

The influence of the osteotomy design and orientation of the bone cuts on the lingual fracture pattern during BSSO has been the subject of recent research (Plooij et al., 2009; Verweij et al., 2015a, 2015b). Modification of the osteotomy design can increase the predictability of the sagittal split (Verweij et al., 2015b). An altered orientation of the bone cuts or incomplete bone cuts can, on the other hand, increase the risk of a bad split (Muto et al., 2012; Song and Kim, 2014). Recent reports show that accomplishing the bone cuts completely as planned is a challenge, due to limited visibility during BSSO (Plooij et al., 2009; Muto et al., 2012; Song and Kim, 2014). The course of the lingual split results from the design and the extent of the cortical bone cuts, including the type of manipulation during the splitting technique. Evaluation of the position of the bone cut as a factor in the sagittal split procedure is therefore important. Visualization of the lingual part and inferior border of the mandible is compromised during surgery, and is only possible using (postoperative) cone beam computed tomography (CBCT) scanning. The chance of an incomplete bone cut due to limited visibility could therefore be high when performing the inferior border cut that was proposed by Epker (1977).

In this study, the position of the inferior border cut was assessed, and secondarily the influence of this inferior border cut on lingual fracture patterns and unfavorable fractures was investigated.

2. Materials and methods

2.1. Study group

This study prospectively observed a consecutive group of 43 patients who received a BSSO alone or bimaxillary procedures either with or without genioplasty. The procedures were performed between January 2013 and July 2014 at the Department of Oral and Maxillofacial Surgery of the Leiden University Medical Center. In each case the procedure was performed by one of four experienced surgeons, usually supervising a resident on the contralateral side. All procedures were performed according to the same treatment protocol, which included the use of postoperative CBCT as part of the standard clinical follow-up.

The patients' medical files were screened for age at surgery, sex, malocclusion class, and simultaneous procedures (i.e., Le Fort I osteotomy or genioplasty). The postoperative CBCT scan was used to evaluate the position of the mandibular segments and the lingual fracture pattern within the first week after BSSO. All consecutive patients who received BSSO in the aforementioned time period were included. Patients were excluded when alternative surgical techniques were used and in the case of incomplete data: for example, when postoperative scans were not performed correctly and the bone cuts or fracture lines could not be visualized adequately.

The main outcome variable in this study was the position of the inferior bone cut, defined as made in the buccal cortex, in the inferior border, or through the inferior border reaching into the lingual cortex. Secondary outcome variables were the lingual split pattern and the occurrence of a bad split possibly influenced by the inferior border cut.

2.2. Evaluation with CBCT

A postoperative CBCT scan (Planmeca Promax®3D Max, 96 kV, 11 mA) was performed within the first week after BSSO. The patients' CBCT images were uploaded into Osirix v.5.7.1 32 in the form of DICOM files to generate a three-dimensional (3D) reconstruction of the mandible. The view settings used were as follows: WL/WW; CT bone, CLUT; 16 bit CLUT, opacity; linear table.

The mandible was separated from the scan and positioned in a symmetrical position by aligning the inferior borders, occlusal plane, and temporomandibular joints. A crop cube was generated and aligned with the inferior border of the mandible (Fig. 1). The caudal position of the crop cube and the aligned mandible were not changed. The cube and mandible were subsequently rotated 90° to achieve a perpendicular view of the caudal side of the mandible. This view was exported and subsequently used to derive measurements at the inferior border. The crop cube was then aligned with the buccal and lingual cortex of the distal segment and rotated to achieve a view perpendicular to the buccal and lingual side of the mandible. Once aligned, the region of interest was further explored by using the crop tool. Points of interest were specified in the CBCT and checked from the different views. Acquired projections were exported in standard format and subsequently used to derive further measurements. Contrast corrections were used only when difficulties involving split pattern tracing were present.

2.3. Measurements

The inferior border cut was categorized as ending in the buccal cortex, in the caudal cortex, or in the lingual cortex. If the inferior border cut was performed completely through the caudal cortex and extended into the lingual cortex, the length of the inferior border cut in the lingual cortex was measured.

The postoperative CBCT scan was evaluated in the above-mentioned standardized lingual view, caudal view, and buccal view. First, the lingual view (constructed perpendicular to the lingual cortex, with the inferior borders exactly aligned) was assessed. When the inferior border cut was visible from the lingual view, the lingual corticalis was thus affected and the inferior border cut was categorized as ending in the lingual cortex. Second, the caudal view (constructed perpendicular to the tangent to the caudal border) was assessed. When the inferior border cut was not visible from the lingual view but was visible in the caudal view, the cut was categorized as ending in the caudal cortex. When the inferior border cut was not visible from the lingual and caudal view and thus did not reach into the caudal cortex, it was categorized as a cut ending in the buccal cortex.

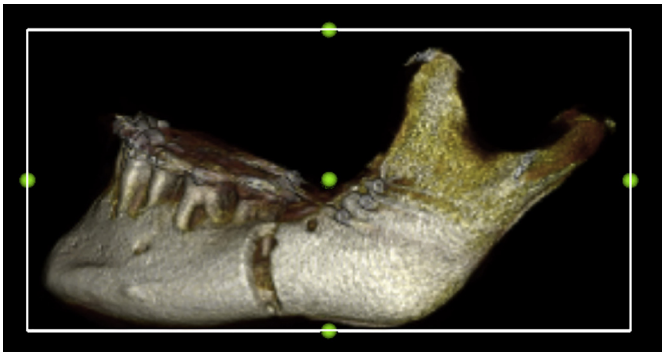

Fig. 1. Alignment of the inferior borders, occlusal plane, and temporomandibular joints of the mandible in the crop cube.

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