

# Interproximal bone in maxillary anterior teeth in subjects with Class III facial deformity: Are there options for segmental maxillary osteotomy in “surgery first”?

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## Abstract

Our aim was to give a morphometric description of the interproximal bone between the anterior maxillary teeth of subjects with class III facial deformity, who were candidates for segmented Le Fort I osteotomy. We measured the width of the interproximal bone from the upper right canine to the upper left canine in cone-beam computed tomographic images of 35 subjects, and identified five interproximal areas of measurement. The lower and upper measurements were established 5 mm and 10 mm from the cervical crest of the interproximal bone. A paired samples *t* test and Pearson's correlation coefficient were applied and probabilities of less than 0.05 were accepted as significant. In all the scans of interproximal bone, the apical zone was significantly wider than the inferior zone ( $p < 0.001$ ). The area between the central incisors was the widest, with a mean (SD) of 2.42 (0.68) mm in the lower, and 4.27 (0.99) mm in the upper, region followed by the space between the canines and lateral incisors. The minimum interproximal spaces in the lowest area were between 1.1 and 1.5 mm, which suggested the potential for damage to the teeth during segmental osteotomy. The interproximal spaces were at potential risk of dental and periodontal injuries, and the area between the central incisors seemed to be most suited to interproximal osteotomies in “surgery first”.

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**Keywords:** Orthognathic surgery; Surgery first; Segmental osteotomy

## Introduction

Class III dentofacial deformities can present with maxillary retrusion and transverse maxillary deficiencies, which govern which operations can be used for transverse increase by osteotomy.<sup>1–2</sup> The Le Fort I osteotomy is widely

used in orthognathic surgery, as it is versatile, safe, and efficient.<sup>3</sup> Maxillary segmental osteotomy, however, involves an osteotomy in the interproximal bones of two or more teeth, and carries some risks of injury such as periodontal and apical injuries among others.<sup>4,5</sup> Traditionally, preoperative orthodontics plan the segmental osteotomy by separating the roots to increase the interproximal bone space, and consider a separation of 5 mm adequate.<sup>6</sup> However, in “surgery first” techniques, that preparation is not possible.

“Surgery first” has gained acceptance in recent years, for reasons such as the speed of the treatment and the fact that the

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patient does not pass through a stage of worsening dentofacial cosmesis. These justify accelerating the operations,<sup>7,8</sup> and so maxillary segmental osteotomies may be necessary to obtain both occlusal stability and the transverse modification needed in the maxilla.<sup>11</sup> These in turn mean that we need to know the interproximal structure of the bone in the maxillary anterior sector in subjects who have not had orthodontic treatment.

The aim of this study was to describe morphometrically the interproximal bone of the teeth of the maxillary sector in patients with a class III defect, and to define safe areas to make maxillary segmentation osteotomies and install fixation systems such as intermaxillary fixation screws.

**Patients and methods**

A descriptive study was designed that included white European male and female subjects aged between 18 and 30 years who attended the Division of Oral, Facial, and Maxillofacial Surgery at the Universidad de La Frontera, Chile, for surgical treatment of a dentofacial deformity and to assess the possibility of orthognathic surgery. The study was approved by the Scientific Bioethics Committee of the Universidad de La Frontera (protocol no. 016/15).

Inclusion criteria were: a class III facial deformity characterised by an Angle class III relation, negative overjet from –1 mm and an ANB angle of less than or equal to 0°, as well as cone-beam computed tomographic (CT) studies obtained before presentation on a PAX Zenith 3D unit (Vatech Co). Subjects were excluded if they had had previous maxillofacial operations or orthodontic treatment, previous extractions (except third molars), or if they had a facial malformation.

The measurements were made with a single, previously-calibrated machine on two occasions with a 15-day interval, using the EZ-plus 3D software (E-WOO Technology Co Ltd). The morphometric measurements were made of the interproximal spaces of the teeth of the anterosuperior sector on the coronal plane using the spaces from the right canine to the left canine (right upper canine (RC), right lateral incisor (RLI), right central incisor (RCI), left central incisor (LCI), left lateral incisor (LLI), and left upper canine (LC)).

First, a line (PB) was drawn through the interproximal alveolar bone crest of the teeth. A perpendicular line was then drawn from this line on each of the interproximal spaces to obtain standard distances from the PB line and to reach heights of 5 mm and 10 mm in the apical direction. At 5 mm a second line was drawn parallel to the PB line, and a second parallel line at 10 mm from the PB line, which were called “L” (lower line) and “U” (upper line) (Fig. 1). The interproximal spaces were divided from 1 to 5 to define the relations, beginning on the right and ending on the left. To make the measurement the distance across each interproximal space (lower or upper) was obtained from the lateral point of the root of each tooth. The EZ-plus 3D software was calibrated with a pilot test of 10 subjects with measurements recorded on two different occasions with a 15-day interval, after which

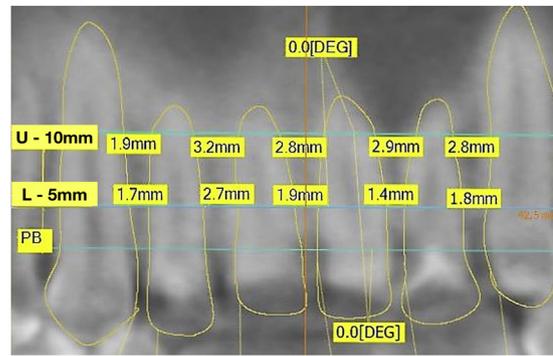


Fig. 1. Position of the PB line (the most cervical bone), line “L” (5 mm over the PB line), and line “U” (10 mm over the PB line). Interproximal bone between the five maxillary teeth from the right canine to the left canine.

Table 1  
Linear morphometry in 35 subjects with class III dentofacial defects who were candidates for orthognathic surgery. Interproximal spaces were measured 5 mm and 10 mm from the bony crest.

Measurement (mm)	Interproximal space	Mean (SD)	Range
Interproximal width measured 5 mm from the alveolar crest (lower)	RC – RLI (L1)	2.68 (0.74)	1.2–3.8
	RLI – RCI (L2)	2.06 (0.69)	1.2–3.9
	RCI – LCI (L3)	2.42 (0.68)	1.1–3.6
	LCI – LLI (L4)	1.70 (0.32)	1.2–2.4
	LLI – LC (L5)	2.59 (0.60)	1.5–3.8
Interproximal width measured 10 mm from the alveolar crest (upper)	RC – RLI (U1)	3.77 (1.28)	1.1–6.2
	RLI – RCI (U2)	3.33 (0.83)	2.1–5.2
	RCI – LCI (U3)	4.27 (0.99)	2.5–6.0
	LCI – LLI (U4)	2.82 (1.05)	1.4–5.2
	LLI – LC (U5)	3.45 (1.07)	1.9–5.5

RC=right upper canine, RLI=right lateral incisor, RCI=right central incisor, LCI=left central incisor, LLI=left lateral incisor, and LC=left upper canine.

an intraclass correlation (ICC) test was applied assuming a value of p < 0.05.

*Statistical analysis*

The data were tabulated in Microsoft Excel 2016 and the statistical analysis made with the help of IBM SPSS Statistics for Windows (version 22, IBM Corp) using mean (SD) and an ICC. Bland and Altman plots were used to calculate 95% CI, after which Pearson’s correlation coefficient and a paired-samples t test were applied to assess the significance of differences between groups. Probabilities of less than 0.05 were accepted as significant.

**Results**

There were 16 men and 19 women, mean (range) age 20 (18–30) years. The results of the ICC were 0.92 indicating that an adequate number of measurements had been made at both 5 mm and 10 mm.

Table 1 shows the measurements made at 5 and 10 mm. Analysis of the minimum values on the lower line was

unfavourable, however, as it showed them to be between 1.1 mm in L3 and 1.5 mm in L5 and the upper line, which were between 1.1 mm in U1 and 2.5 mm in U3.

Comparison of the lowest and highest measurements is shown in Table 2.

## Discussion

Osteotomies in the anterosuperior sector, the installation of plates and screws for osteosynthesis, and the use of screws for intermaxillary fixation in this area are common in maxillary surgery. “Surgery first” has been characterised by its need for increasingly precise indications,<sup>10</sup> so it is necessary to know the dentoalveolar morphology of the area where segmental osteotomies will be made to reduce the risk of dental injuries.

In subjects with a class III deformity and transverse maxillary deficiency, the choice of treatment governs the degree of surgical expansion of the maxilla during the first operation, and the orthognathic surgery for sagittal or vertical movements, or both, during the second operation. The second choice is related to maxillary segmentation and transverse mobilisation, and sagittal or vertical mobilisation, or both, in a single operation (which has the advantage of a shorter treatment time, less operating time, and a lower financial cost for the patient).<sup>11</sup> In this context, “surgery first” enables even faster surgical resolution associated with a shorter treatment time.<sup>12</sup>

A segmental Le Fort I maxillary osteotomy in subjects with transverse deformities is often indicated to correct a maxillary deformity when using “surgery first” protocols.<sup>13</sup> In “conventional” surgery, maxillary segmentation is necessary to achieve divergence of roots by distances of 5 mm so that there is room for the cutting system<sup>6</sup> and to reduce the risks of the osteotomy. However, in “surgery first” it is not possible to do this, so a shorter distance between the roots is to be expected.

Maxillary segmentation with preoperative orthodontics is considered to be successful. Kahnberg et al<sup>14</sup> reported only four teeth with some degree of slight resorption in 82 patients, and Posnick et al<sup>15</sup> reported that only 1.5% of 262 patients who had maxillary segmentation presented with gingival recession. Morgan and Fridrich<sup>16</sup> found no significant differences in the depth of periodontal probing in the preoperative and postoperative stages of a two-year follow up, and Ho et al<sup>17</sup> (who made segmentations between canines and premolars with different formats) reported a low rate of complications. These were mainly associated with adequate preparation of previous orthodontics with minimum interdental separations of 2 mm in the cervical zone and 4 mm in the apical zone.

Our results show that at the level of the “L” line (5 mm from the dental cervical line), the minimum interdental width was 1.1, 1.2, and 1.5 mm at the different sites, which suggests a high potential for damage to the teeth, and raises doubts about the way in which the cutting tip would enter the inter-

proximal space. At the highest level, on the “U” line (apical level), there were interdental distances with minimum measurements of 1.1, 1.4, 1.9, 2.1 and 2.5 mm, which can result in the same potential complications observed for the “L” line zone. Usually the mean interdental distances showed that the circumstances did not favour the execution of a low-risk interdental osteotomy. The mean (SD) difference observed in the transition from “U” to “L” was from 0.86 (0.79) mm to 1.85 (0.70) mm, and it was significant in all spaces, which indicated that the superior area was consistently larger. This implies that the surgeon must consider this transition on the insertion of the cutting system.

Maxillary segmentations have been done without preparatory orthodontics in the past. Dorfman and Turvey<sup>18</sup> reported appreciable loss of bone with a reduction in the bony crest when interdental osteotomies were made with a low level of separation between the teeth. Later, Kwon et al<sup>19</sup> prospectively studied 34 interproximal sites with osteotomies that showed a significant reduction in the inserted gingiva of 0.84 mm. In 1984, Sher<sup>20</sup> published a high incidence of dental complications associated with segmentations, and concluded that the patients would have had to be treated with previous orthodontics and that segmentation should be avoided in cases where the distance between the teeth was reduced. Schultes et al<sup>21</sup> found 35 sites of periodontal defects and loss of teeth in 74 segmentation sites of subjects treated mainly without previous orthodontics.

These possible dental injuries are related to small interdental spaces, or associated with the intraoperative technique of the osteotomy, or to postoperative tissue repair with a reduction in irrigation of the sites with segmentations. Considering the historical perspective, new techniques such as piezoelectric systems are used in these operations, which means less risk of dental injuries.<sup>22</sup> However, the reduced interdental separation clearly holds the potential for dental and periodontal damage.

We know of no statistics about the requirements of maxillary segmentations in “surgery first”, but because of the lack of orthodontic preparation, it is possible to speculate about the increased need for segmentations compared with traditional operations.<sup>23</sup> In the series reported by Hernández-Alfaro et al<sup>24</sup> seven of 45 patients had maxillary segmentations and, in addition, 2.0 mm miniscrews were used in all cases for intermaxillary fixation between the canine and premolar or between the canine and lateral incisor. This also demands interdental spaces to achieve adequate installation and these could also be limited.

The largest interdental zones were found first between the central incisors, and secondly between the lateral incisors and canines. Our results show that maxillary segmentations can be done between central incisors as they present a greater distance, and consequently less potential risk of dental injuries. Mordenfeld and Andersson<sup>25</sup> studied 16 patients, and assessed the postoperative results of a vertical osteotomy between central incisors after 12 months in subjects who had no previous orthodontics. They identified 5% with slight

Table 2

Comparison of the measurements (mm) obtained at the lowest (L) and at the highest (U) level of each of the interproximal spaces.

Interproximal space	Mean (SD) differences between greatest (U) and least (L) width	95% CI	Simple linear regression equation	p value
RC – RLI: U1/L1	1.08 (0.79)	0.81 to 1.36	$y = -0.80 + 0.58x$	0.00
RLI – RCI: U2/L2	1.27 (0.68)	1.04 to 1.51	$y = 0.65 + 0.22x$	0.00
RCI – LCI: U3/L3	1.85 (0.70)	1.61 to 2.10	$y = 0.41 + 0.43x$	0.00
LCI – LLI: U4/L4	1.11 (0.90)	0.82 to 1.43	$y = -1.68 + 1.24x$	0.00
LLI – LC: U5/L5	0.86 (0.79)	0.59 to 1.33	$y = -1.12 + 0.65x$	0.00

RC = right upper canine, RLI = right lateral incisor, RCI = right central incisor, LCI = left central incisor, LLI = left lateral incisor, and LC = left upper canine.

injuries to roots despite the significant reduction in the height of the bony margin, and concluded that the level of complications associated with the operation was low.

Considering that the mean (SD) interproximal space between the central incisors was 2.42 (0.68) mm at “L” level and 4.27 (0.99) mm at D2, it would be possible to do the osteotomy in this sector. However, Haas Junior et al.<sup>13</sup> indicated that such segmentations between the central incisors would have poor stability postoperatively and therefore would be dependent on preoperative and postoperative orthodontics.

Finally, we conclude that there are limited interproximal distances in the anterior sector of the maxilla in subjects with class III facial deformity, which alerts us to the potential dental and periodontal risks for interdental osteotomies. Because all the participants were white Europeans, there could be differences in the interproximal bone in ethnic groups, and new research is necessary.

### Conflict of interest

We have no conflicts of interest.

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### Ethics statement/confirmation of patients' permission

This study was approved by the Scientific Bioethics Committee of the Universidad de La Frontera (protocol no 016/15).

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