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Resorptive remodeling in maxillary anterior region after bimaxillary surgery for skeletal Class III deformities

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Abstract

The aim of this retrospective study was to evaluate bony remodelling in the anterior region of the maxilla after bimaxillary surgery for skeletal Class III deformities preoperatively, immediately postoperatively, and 6 months postoperatively. For accurate analysis, cone-beam computed tomographic (CT) images of 29 patients (12 men and 17 women; mean age 22 (range 19 to 44) years) were used. The nasopalatine canal, unaffected by the maxillary Le Fort I osteotomy, was used for the reference points (posterosuperior, midpoint, and posteroinferior). The changes in the distance from each of the points on the nasopalatine canal to the corresponding anterior border of the maxilla were measured and analysed at the 3 stages ($p<0.05$). Bony resorption was apparent during the postoperative period, and the mean resorption was -1.13 (1.53) mm at the posterosuperior level, -0.92 (0.83) mm at the midpoint, and -0.83 (0.88) mm at the posteroinferior level ($p<0.01$). These findings show that there had been resorptive remodelling postoperatively in the anterior maxillary region after bimaxillary surgery with superior maxillary movement, which suggests that the postoperative change in the position of point A is affected by operative movement as well as by postoperative relapse and bony remodelling.

Keywords: Remodelling; Point A; Orthognathic surgery

Introduction

In orthodontic evaluation of dental and skeletal relations, cephalometric analysis is essential. Cephalometric landmarks are used to indicate the corresponding structures in the dentofacial area. Among them are the anterior nasal spine (ANS) and point A, which have been used as the skeletal landmarks of the maxilla to evaluate the anteroposterior position of the maxilla relative to the cranial base. Point A is defined as the deepest point between the ANS and the crest of the maxillary alveolar process. However, point A in the cephalometric analysis can change on radiographic analysis as a result of remodelling of the alveolar bone associated with orthodontic movement of the upper incisors, and several studies have reported this.[1–3] van der Linden et al.[1] showed that upper incisors that are inclined more labially are associated with a point A that is more anterior. Al-Abdwani et al.,[2] reported that each 10° proclination of the upper incisors resulted in a horizontal change of 0.6 mm in the position of point A, whereas Cangialosi and Meistrell[3] reported a 1.7 mm change for a 12.3° proclination.

However, in the case of combined orthodontic-orthognathic treatment, point A can be influenced not only by dentoalveolar remodelling as a result of orthodontic movement of teeth, but also by bony remodelling

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associated with orthognathic operations. In orthognathic surgery, point A is influenced by the combined effects of orthodontic movement of the upper incisors and Le Fort I osteotomy, after which more active bony remodelling of the anterior maxillary region than is usual in orthodontic treatment is inevitable. However, we know of few studies that have attempted to investigate the effect of bimaxillary orthognathic surgery on the remodelling of the anterior maxillary region as shown by changes in the position of point A.

Cone-beam computed tomography (CT) has several advantages that prevent the anatomical distortion seen on conventional cephalograms[4]: lower dose of radiation, shorter duration of radiation, and higher spatial resolution. Additionally, for improved analytical accuracy, cone-beam CT images can be manipulated using 3-dimensional image software. The cone-beam CT superimposition method and the resultant superimposed images can also be particularly useful for comparative analysis of bony remodelling.[5]

Our purpose was to use superimposed cone-beam CT images to evaluate bony remodelling in the maxillary anterior region after bimaxillary surgery for skeletal Class III deformities. The specific aims were: to investigate bony remodelling preoperatively, immediately postoperatively, and postoperatively, and to calculate the relations between bony remodelling in the anterior maxillary region, movement of the incisors, and maxillary surgery.

Patients and Methods

We studied 29 patients (12 men and 17 women, mean age 22 (range19 to 44) years) diagnosed with skeletal Class III deformities, all of whom had had orthodontic and surgical correction (Le Fort I osteotomy and mandibular setback sagittal split ramus osteotomy) at the Department of Orthodontics and Oral and Maxillofacial Surgery, 0000000 Hospital, between January 2011 and December 2013. The exclusion criteria were facial asymmetry, craniofacial syndrome, and any history of trauma. This study was approved by the Institutional Review Board of Pusan National University Dental Hospital (PNUDH-2014-008).

Acquisition of cone-beam CT images

The images were obtained using a cone-beam CT scanner (Zenith3D, Vatech Co., Seoul, Korea) with the Frankfort-horizontal (FH) plane adjusted parallel to the floor. The scanner was set at a 90 KvP tube voltage, a 4 mA tube current, and a 24-second scan time. Cone-beam CT images were obtained within 1 month of operation, within 1 week postoperatively, and 6 months after operation. The data were processed in 3-dimensional images using a software program (Ondemand3D, Cybermed Co., Seoul, Korea). For more accurate measurement of bony remodelling in the anterior maxillary region, the cone-beam CT images were extracted from the maximum width of the nasopalatine canal on the axial plane (Fig. 1). The cephalometric images obtained were then measured using a cephalometric analysis program (V-ceph 6.0, Osstem implant Co., Seoul, Korea).

Reference planes and measurements

For analysis of the skeletal changes before and after operation, reference planes and measurement points were defined as indicated in Table 1 and Fig. 1. The vertical and horizontal distances and angles from the reference planes to the measurement points of the maxillary landmarks were measured. To measure the extent of surgical changes and relapse at the maxillary skeletal landmarks, the distances of the anterior nasal spine (ANS), posterior nasal spine (PNS) and point A from the reference planes were each measured at the 3 specified time intervals. To assess bony remodelling in the anterior maxillary region, the changes in distance from the 3 points on the nasopalatine canal ($NP_{1\text{-}3}$) to the corresponding anterior border of the maxilla (Fig. 1) were also measured parallel to the palatal plane (a plane that connects PNS and NP_2). Finally, to evaluate the effect of orthodontic treatment on bony remodelling in the anterior maxillary region, the changes in the inclination of the maxillary incisors (the angle between the FH plane and the upper central incisor axis, U1-FH) were also measured.

Statistical analysis

The data were analysed with the help of IBM SPSS statistical software (version 21.0, IBM Corp, Armonk, NY, USA). The mean (SD) were calculated for the cephalometric variables at the 3 specified time points. We used a paired t test to assess the significance of differences among the stages and verify the bony remodelling in the anterior maxillary region at the specified time points. The significance of the correlation between the extent of surgical change and bony remodelling was assessed by Pearson's correlation analysis. To find out whether the bony remodelling in the maxillary anterior region had resulted from orthodontic movement of teeth, we also analysed changes in the inclination (U1-FH) of the maxillary incisors. Probabilities of less than 0.05 were accepted as significant.

The reliability of the measurements between and within examiners were evaluated according to the cone-beam CT images of 10 subjects who were randomly selected and measured by investigators 2 weeks after the initial measurements had been made.

Results

The intraclass correlation coefficients (ICC) between and within examiners (means: 0.98 and 0.87, respectively) were high.