Mesial and distal alveolar bone morphology in maxillary canines moved into the grafted alveolar cleft: Computed tomography evaluation

Daniela Garib,[a] Camila Massaro,[a] Marilia Yatabe,[a] Guilherme Janson,[a] and José Roberto P. Lauris[b]
Bauru, São Paulo, Brazil

Introduction: The aims of this study were to qualitatively assess the mesial and distal alveolar bone of maxillary canines mesially moved to replace absent lateral incisors in patients with unilateral cleft lip and palate after secondary alveolar bone graft and to assess the reproducibility of the proposed cone-beam computed tomography (CBCT) method. **Methods:** The sample comprised CBCT examinations of 30 patients with unilateral cleft lip and palate from 1 center. CBCT images were taken at least 6 months after comprehensive orthodontic treatment. The noncleft side was used as the control group. Using axial sections, scores from 0 to 4 (bone absence to complete bone filling, respectively) were given to the mesial and distal alveolar bones of the maxillary canines. Interexaminer and intraexaminer reproducibility was assessed using kappa statistics. Intergroup comparisons were performed using Wilcoxon tests. **Results:** Interexaminer and intraexaminer agreement was excellent. Intergroup comparison identified smaller scores at the cervical and middle root levels of the cleft side mesial alveolar bone of the maxillary canines. At the cleft side, 85 mesial sites showed favorable scores (3 or 4); 1 had a score of 1, and 4 had scores of 2. At the distal surface, 78 sites were evaluated, and only 1 site received a score of 1. The noncleft side had scores of 4 for all sites. **Conclusions:** The new CBCT scale showed good reproducibility. CBCT axial sections are reliable for a qualitative appraisal of alveolar bone in a grafted alveolar cleft. Mesial bone defects can be observed in maxillary canines moved into grafted areas after comprehensive orthodontic treatment, especially at the cervical root half. (Am J Orthod Dentofacial Orthop 2017;151:869-77)

Agenesis of a maxillary lateral incisor is the most common dental anomaly in patients with cleft lip and palate,[1,2] and a multidisciplinary oral rehabilitation is the best treatment option.[3] One of the most important procedures of the rehabilitation is the alveolar bone graft (ABG), and the gold standard treatment plan for these patients involves mesial movement of the posterior teeth after ABG surgery to replace the missing tooth.[4] This choice provides favorable esthetics, avoids the need for a prosthesis in an esthetic/anterior region, and contributes to the periodontal health and the maintenance of the ABG at the cleft area.[5-8] It was previously suggested that the functional stimulus on the grafted bone caused by postsurgical orthodontic treatment can lead to alveolar remodeling and better ABG outcomes.[5,9,10]

In addition to the clinical and periodontal evaluations, periapical radiographs have been used to assess the grafted area.[11-13] A radiographic evaluation indicates the amount and distribution of the new bone tissue and its relationship with the adjacent teeth.[12] Several radiographic scales can be used to assess the long-term quality of the bone grafted area. The scale of Bergland et al[14] is used when the maxillary canine is completely erupted. It is a 4-level classification of the bone septum height formed after the ABG. The scoring system of Kindelan et al[15] uses a 4-point scale to assess the percentage of bone filling after 4 to 6 months of surgery. The Chelsea scale can be used in the mixed

From Bauru Dental School, University of São Paulo, Bauru, São Paulo, Brazil.
[a]Department of Orthodontics.
[b]Department of Community Health.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Based on research submitted by the second author in partial fulfillment of the requirements for the specialty degree in orthodontics at the Hospital of Rehabilitation of Craniofacial Anomalies, University of São Paulo, Bauru, São Paulo, Brazil.
Address correspondence to: Daniela Garib, Department of Orthodontics, Bauru Dental School, University of São Paulo, Alameda Octávio Pinheiro Brisolla 9-75, Bauru, SP 17012-901, Brazil; e-mail, dgarib@usp.br.
Submitted, February 2016; revised and accepted, November 2016.
0889-5406/$36.00

http://dx.doi.org/10.1016/j.ajodo.2016.11.019

dentition, and it classifies the projection of the bone bridge in the tooth adjacent to the cleft into 6 groups.[16] More recently, the Standardized Way of Assessing Graft has been developed to score (0-6) the prognosis of the ABG according to the filled cleft site and bone position at 3 vertical thirds (apical, middle, and coronal).[17,18]

With the advent of tomographic assessment, new studies have evaluated the quality of the newly formed bone septum and the periodontal morphology of teeth adjacent to the cleft.[19-25] Cone-beam computed tomography (CBCT) images have been used to assess the volume of the cleft defects[26] and measure small maxillary structures,[27] allowing measurement of the bone septum height, and to identify possible resorption areas in different depths.[20,23,28] A previous CBCT study with unilateral cleft lip and palate patients submitted to orthodontic movement through the grafted alveolar cleft showed different buccal and lingual periodontal morphology compared with the noncleft side. Both sides showed acceptable bone morphology, and severe buccal and lingual bone dehiscences were detected in only 1 and 2 patients, respectively.[21] Suomalainen et al[23] evaluated the vertical height and labiopalatal thickness of the alveolar bone at the grafted region 6 months after secondary alveolar bone grafting using CBCT. The authors stated that the 3-dimensional (3D) method allows assessment of the alveolar bone and location of bone defects after secondary alveolar bone grafting.

CBCT images allow detailed evaluation of the alveolar bone morphology. Although some studies have 3-dimensionally registered the quality of ABG, this seems to be the first study to propose a CBCT scale for evaluating ABG after orthodontic rehabilitation. Previous studies have evaluated ABG in the long term after comprehensive orthodontic treatment,[5,21,29] and additional studies were suggested to evaluate the ABG surgery outcomes after comprehensive orthodontic treatment with an adequate sample size and follow-up time.[29] Moreover, 1 strategy suggested by the World Health Organization was that "a follow-up of a series of patients to provide an overview of the outcome of care" should be performed.[30] Therefore, the purposes of this study were to evaluate the grafted alveolar cleft after comprehensive orthodontic treatment using a CBCT scale and to assess the reproducibility of the proposed CBCT method. The null hypothesis was that teeth on the cleft and noncleft sides have similar mesial and distal alveolar bone morphologies.

MATERIAL AND METHODS

This study was approved by the ethical committee of the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo, Brazil (process number 463.500). A secondary data analysis of a sample collected from August 2011 to January 2012 comprised postretention CBCT images of 30 patients with unilateral cleft lip and alveolus (n = 8) or complete unilateral cleft lip and palate (n = 22) from 1 center.[21] The inclusion criteria were secondary ABG surgery, presence of both maxillary lateral incisor and canine on the noncleft side, agenesis of the lateral incisor at the cleft side, and comprehensive orthodontic treatment with posterior mesialization of the canine into the grafted area. All interdental spaces between the maxillary canines and central incisors were clinically closed, with the mesial surface of the canine touching the distal surface of the central incisor. The sample comprised 14 female and 16 male subjects with a mean age of 20.5 years. All patients were treated by orthodontists from 1 center, and the retention protocol was a maxillary Hawley plate and canine-to-canine mandibular bonded retainers. The CBCT images were taken at least 6 months after debonding, with a mean time of 1.8 years after appliance removal. Table I gives further information about the sample.

The maxillary permanent canines from the noncleft side were used as controls in a split-mouth study design. Three surgeons, using the same technique and bone from the iliac crest, performed the ABG surgeries. All surgeons used the surgical technique described by Boyne and Sands,[31] with success rates varying from 80% to 90% in the long term for unilateral cleft lip and palate.[12] At the bone graft surgery, 36% of the patients had their permanent canine partially erupted on the cleft side. In 58% of the patients, the maxillary canine spontaneously erupted, and in 7%, canine traction was performed.

CBCT examinations were performed using the 3D i-CAT cone-beam system (Imaging Sciences International, Hatfield, Pa) with the technical parameters of 120 kV, 23.87 mA, field of view of 16 × 6 cm, and voxel size of 0.25 mm. The images were digitally analyzed using Nemoscan Software (Nemotec, Madrid, Spain).

The head image was reoriented with the maxillary canine positioned perpendicularly to the horizontal plane in both the sagittal and coronal views. Axial sections 3, 6, and 9 mm apically from the maxillary canine cementoenamel junction were used to represent the cervical, middle, and apical root thirds, respectively. The scores illustrated in Figure 1 were given to each axial section from the experimental and control groups to the mesial and distal bone septa of the maxillary canines. Four of the 30 patients had dental implants in the canine region, and the distal septum was not evaluated in them.

Statistical analysis

The images (score classification) were evaluated twice with an interval of 30 days by 2 independent