A SOFTWARE TOOL USED IN 3D EVALUATION OF THE ALVEOLAR BONE DEFECT IN BILATERAL CLEFT LIP AND PALATE PATIENTS

Yllka Deçolli¹, A. Nemţoi¹, Sidonia Susanu⁴, Danisia Haba², Ana Petcu³
University of Medicine and Pharmacy “Grigore T. Popa”-Iaşi
Faculty of Dental Medicine
1. Ph.D. student
2. Department of Oral and Maxillofacial Surgery
3. Department of Pedodontics
   Faculty of Medicine
4. Department of Ophthalmology

A SOFTWARE TOOL USED IN 3D EVALUATION OF THE ALVEOLAR BONE DEFECT IN BILATERAL CLEFT LIP AND PALATE PATIENTS (Abstract): Evaluation of the cleft size and the assessment of an estimative volume required for bone grafting provide useful information to the surgeon performing secondary alveolar bone grafting. **Aim:** To use a software tool to evaluate the estimative volume of the bone defect in the alveolar cleft area, based on cone beam computed tomography (CBCT) data. **Material and methods:** Three patients with bilateral cleft lip and palate (BCLP) were randomly selected in the order of referral to treatment at “Saint Mary” Emergency Hospital for Children. CBCT examinations were performed prior to secondary alveolar bone grafting procedure. The preoperative estimative volume (PEV) of the alveolar bone defect was evaluated by three observers with different areas of expertise (a dentomaxillofacial radiologist, a maxillofacial surgeon, and a Ph.D. radiology student), using Romexis 3.0.1 software program. The inter-observer fidelity was assessed using the Interclass Correlation Coefficient (ICC), with an optimal value of 0.837 for all observers. **Results:** The mean PEV for all BCLP patients was 1.84 ± 0.16 cm³. **Conclusions:** The results suggest that measuring the preoperative estimative volume of the alveolar bone defect in CLP patients using Romexis 3.0.1 software program, with CBCT scan data is beneficial. A proper protocol should be established, in order to provide useful information for the surgeon performing the secondary alveolar bone grafting. **Keywords:** BILATERAL CLEFT LIP AND PALATE, CONE BEAM COMPUTED TOMOGRAPHY, PREOPERATIVE, ALVEOLAR BONE DEFECT, SOFTWARE

Cleft lip and palate (CLP) consist in a heterogeneous group of pathologies that are among the most common malformations in the head and neck region and may determine various functional, aesthetic and social disorders (1). Previous European and US studies suggest that unilateral CLP is more frequent, and within CLP, only 20% are bilateral (2).

With the advancement of maxillofacial imaging, cone-beam computed tomography (CBCT) has become the procedure of choice when 3D imaging is necessary during CLP management, offering a lower dosage of radiation exposure compared to the classic CT (3-5), thus respecting the
ALARA (As Low As Reasonably Achievable) principle (6,7). CBCT examination brings essential information in the preoperative assessment, as well as in the outcome evaluation during different stages of the CLP surgical and orthodontic treatment, allowing accurate linear and three-dimensional measurements of the bone defect areas (8-10).

Evaluation of the cleft size and the assessment of an estimative volume required for bone grafting provide useful information to the surgeon performing secondary alveolar bone grafting, influencing the choice of an optimal donor site. The aim of this study was to use a software tool to calculate the estimative volume of the bone defect in the alveolar cleft area, based on the CBCT data collected from three patients presenting bilateral cleft lip and palate (BCLP), prior to secondary alveolar bone grafting.

**MATERIAL AND METHODS**

From all the CLP patients presented to pursue surgical treatment at “Saint Mary” Emergency Hospital for Children, between 1 January 2014 and 30 June 2014, three BCLP patients were randomly selected in the order of referral to treatment.

Neither of the selected patients had undergone secondary alveolar bone grafting, or followed any orthodontic treatment. Patients presenting other congenital malformations or syndromes were excluded from the study. An informed consent for research, approved by the Ethics Committee, was obtained from all patients’ parents/tutors.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>Patients’ characteristics and protocol used during CBCT data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>Cleft type</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>C.A-E.</td>
<td>BCLP**</td>
</tr>
<tr>
<td>C.I.</td>
<td>BCLP**</td>
</tr>
<tr>
<td>G.M.M.</td>
<td>BCLP**</td>
</tr>
</tbody>
</table>

* Dose-Area-Product

** Bilateral Cleft Lip and Palate

CBCT examinations were performed prior to secondary alveolar bone grafting procedure, in a private radiology clinic. A Planmeca Promax 3D MID (Planmeca Oy, Helsinki, Finland) unit was used to collect CBCT data, with the patient in upright sitting position, Frankfort horizontal plane being parallel to the floor. Technical parameters for obtaining CBCT data were selected based on the patient’s age and body structure (tab. I).

The scans were reconstructed using three - dimensional imaging software Romexis 3.0.1 (Planmeca OY, Helsinki, Finland) (fig.1). In order to achieve coronal, sagittal and axial views, sections were established with a thickness of 1 mm and at a distance of 1 mm.

All CBCT scans were screened independently by three observers with different
A software tool used in 3d evaluation of the alveolar bone defect in bilateral cleft lip and palate patients

areas of expertise (a dentomaxillofacial radiologist, a maxillofacial surgeon, and a Ph.D. radiology student). Prior to the assessment of the alveolar bone defect volume, all observers agreed on defining the following limits of the region of interest: the superior limit was set to be the nasal floor plane, defined as the plane parallel to the Frankfort horizontal plane that passed through the anterior and posterior nasal spine; the inferior limit was considered to be the inferior margin of the alveolar bone adjacent to the cleft; the lateral boundaries were represented by the limits of the alveolar bone surrounding the teeth adjacent to the cleft (fig. 2).

![Image](image1.png)

**Fig. 1.** Images of BCLP patient (C.I.), achieved using Romexis 3.0.1 software, after measurements performed by the first observer. The alveolar bone defect is colored differently for each area of the bilateral cleft (right and left).

The alveolar bone defect was traced by selecting Volume rendering option in the Tools panel, then by using the elliptical cursor to establish the limits of the cleft area, in both sides separately (fig. 2). The established limits were evaluated by every observer separately, in all CBCT sections in coronal, sagittal and axial planes.

Statistical analysis was performed using SPSS version 20.0 (*SPSS Inc, Chicago, IL*). The Intraclass Correlation Coefficient (ICC) was used to evaluate the inter-observer reliability in the assessment of the alveolar bone defect volume using Romexis 3.0.1 software program. The results showed no significant difference between the inter-
observer measurements, with a ICC value of 0.837 for all three observers. The ICC value for average measures was calculated with a 95% confidence interval. The resulting value indicates an optimal interobserver reliability.

**Fig. 2.** Assessment of alveolar bone defect in BCLP patient (C.A-E.); A – coronal view; B – sagittal view; C – axial view; D – three-dimensional view, soft and hard tissues.

**RESULTS**
The results of the measurements performed by all three observers are presented in Table II. The mean value for the right and the left area of each cleft region resulted from the values obtained by all the observers. The combined average volume for both sides of the bilateral clefts resulted in the overall preoperative estimated volume (PEV) for each BCLP patient (tab. II). The mean PEV for all BCLP patients was 1.84 ± 0.16 cm³.
A software tool used in 3d evaluation of the alveolar bone defect in bilateral cleft lip and palate patients

TABLE II
Estimative bone defect volume in the alveolar cleft area, calculated by all observers

<table>
<thead>
<tr>
<th>Patient</th>
<th>Cleft area</th>
<th>Measurements</th>
<th>Measurements</th>
<th>Measurements</th>
<th>Mean value</th>
<th>Overall PEV****</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>O1* (cm³)</td>
<td>O2** (cm³)</td>
<td>O3*** (cm³)</td>
<td>(cm³)</td>
<td>(cm³)</td>
</tr>
<tr>
<td>C. A-E.</td>
<td>Right</td>
<td>0.727</td>
<td>0.714</td>
<td>0.688</td>
<td>0.710</td>
<td>1.992</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>1.136</td>
<td>1.474</td>
<td>1.236</td>
<td>1.282</td>
<td></td>
</tr>
<tr>
<td>C.I.</td>
<td>Right</td>
<td>1.272</td>
<td>0.740</td>
<td>0.963</td>
<td>0.991</td>
<td>1.860</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>0.909</td>
<td>0.790</td>
<td>0.908</td>
<td>0.869</td>
<td></td>
</tr>
<tr>
<td>G.M.M.</td>
<td>Right</td>
<td>0.663</td>
<td>0.884</td>
<td>0.709</td>
<td>0.752</td>
<td>1.668</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>0.904</td>
<td>0.932</td>
<td>0.911</td>
<td>0.916</td>
<td></td>
</tr>
</tbody>
</table>

*O1: Observer 1 (maxillofacial surgeon); **O2: Observer 2 (dentomaxillofacial radiologist); ***O3: Observer 3 (Ph.D. radiology student); ****PEV: Preoperative estimative volume

DISCUSSION

The preoperative volumetric assessment of the alveolar bone defect provides useful information for the secondary alveolar bone grafting, which is considered the gold standard in the surgical reconstruction of the cleft region (4, 10-12). The accurate evaluation of the alveolar bone defect helps determining the quantity of bone necessary to the bone grafting procedure, thus influencing the choice of the optimal donor site and avoiding inadequate bone harvesting (11, 12).

Previous studies have reported a significant correlation between the size of the alveolar bone defect in the cleft area and the success of the secondary alveolar bone grafting procedure (13-15).

Most studies evaluating PEV of the alveolar bone defect have been conducted on unilateral CLP (UCLP) patients. A possible explanation may be the lower prevalence of BCLP compared to UCLP (2).

The PEV values reported by previous studies conducted among BCLP patients vary widely. Choi et al. reported findings slightly lower than ours (1.4±0.4cm³) (16).

Oberoi et al. reported even lower values: 0.82cm³ (4). Shirota et al. study included only two BCLP patients and declared higher findings compared to ours: 3cm³ and, respectively, 3.8cm³ (14).

There may be various explanations for the differences found among these studies. Different software programs were used to assess the PEV of the alveolar bone defect in CLP patients. Meanwhile, the absence of a specialized multidisciplinary center for the treatment of CLP patients in Romania, along with the unavailability of an adequate protocol for the CLP management, leads to an incomplete CLP management for many patients. All the patients involved in this study had not undergone orthodontic treatment, which must begin prior to secondary alveolar bone grafting (2). The absence of maxillary expansion may explain our findings being higher than those reported by other studies.

CONCLUSIONS

The results suggest that measuring the preoperative estimative volume of the alveolar bone defect in CLP patients using
Romexis 3.0.1 software program, with CBCT scan data is beneficial. A proper protocol should be established, in order to provide useful information for the surgeon performing the secondary alveolar bone grafting.

REFERENCES