Journal of Applied Dental and Medical Sciences
NLM ID: 101671413 ISSN:2454-2288
Volume 2 Issue 2 April - June 2016

Original Article

CBCT: The Wave Of Future In Imaging Cleft Palate Patients – An Observational Study

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ARTICLE INFO

Keywords:
Volumetric Analysis, CBCT, Cleft Palate, Alveolar Bone Grafting

ABSTRACT

Aim: The purpose of this observational study was to determine the use of Cone Beam computed Tomographic imaging in assessing the volume of alveolar clefts. **Materials and Methods**: Preoperative CBCT scans of four patients with cleft palate were analyzed. Using anatomical landmarks, the volumetric analysis and bucco-palatal length were evaluated. The nasal cavity morphology and dentition adjacent to the cleft were also observed. **Results**: This observational study revealed the average facial width which ranged from 6.03±1.02mm -15.6±2.04mm,facial height ranging from 1-12.9±2.33mm, and facial length ranging from 1-9.1±1.81mm, the average volume determined was ranging from 6.3±1-1831.2±24 mm^3. 3-D relationship between the bone bridge and the roots of the cleft adjacent teeth,and nasal morphology were also observed. **Conclusion**: CBCT imaging can be a reliable method to calculate the height, width and length of the clefts. These data can be useful to the operating oral and maxillofacial surgeons to assess the amount of alveolar bone grafting needed and determining the time orthodontic treatment of the cleft-adjacent teeth.

Introduction

The incidence of cleft palate in India is reported as 1:700[1]. Clefts of the lip and palate lead to many problems in speech, mastication, deglutition, occlusion and aesthetics. Repair of alveolar clefts establishes a continuity of dental arch, bony support of the upper lip and base of the nose and resolutions of the problems that arise from the defect. As such it is important for surgeons participating in the care of these patients to have a thorough understanding of the size and anatomy of the methods to repair the defects [1]. In individuals with cleft palate, the main goal of the alveolar bone grafting surgery is to provide bone tissue for the cleft site and consequently unite the maxillary segments, allowing further development of normal occlusion[2]. Standard imaging methods for assessment of the preoperative and postoperative condition include dental, occlusal, and panoramic radiography. Conventional radiographs enables clinicians to

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Table: 01: Demographical data of the cases.

± **CASE NO.**	± **AGE**	± **SEX**	± **SIDE**
± A	± 15 years	± M	± Right
± B	± 6 years	± F	± Right
± C	± 5 years	± F	± Right
± D	± 8 years	± F	± Left

Table: 02: Determining the volume of the cleft

± **CASE NO.**	± **DEFECT DIMENSIONS**			
±	± FL(mm)	± FW(mm)	± FH (mm)	± Volume ± (mm^3)
± A	± 8.3±1.7	± 11.33±4.75	± 8.6±1.81	± 808.7±9.4
± B	± 9.1±1.81	± 15.6±2.04	± 12.9±2.33	± 1831.2±24
± C	± 7.1±1.5	± 6.03±1.004	± 6.45±1.4	± 276.14±5.44
± D	± 1	± 6.13±1.02	± 1	± 6.3±1

FH:FL: Facial length, FL: Facial length, Facial height.

Table: 03: Observation of dentition of cleft palate patients.

± **CASE NO.**	± **DENTAL ANOMALY**
± A	± Displacement of central incisor.
± B	± Displacement of 21, presence of supernumerary tooth, congenitally missing 22
± C	± Fusion of dentition (lateral & supernumerary tooth)
± D	± Displaced tooth.

Table: 04: Observation of alterations of nasal morphology in cleft palate patients.

± **CASE.NO**	± **Nasal morphology**
± A	± Concha Bullosa, nasal deviation
± B	± Nasal spur, deviated nasal septum, deficient bone in the floor of the nose.
± C	± Nasal spur, deviated nasal septum, deficient bone in the floor of the nose.
± D	± Deviation of the nasal septum.

Figure: 01: Size of the cleft (width)

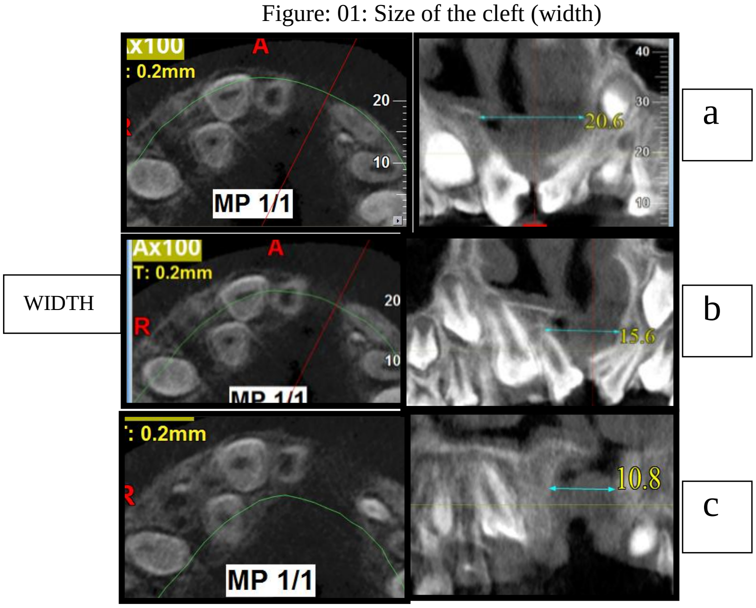
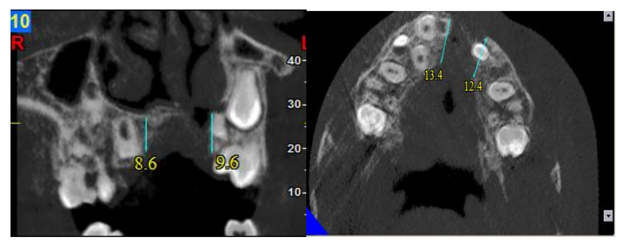
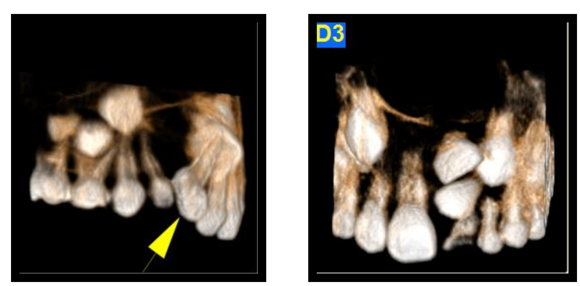


Figure:01Width of the cleft at the level of labial cortical plate (a), mid-alveolus (b), palatal cortical plate (c).



a, Height b, Length

Figure: 02 Size of the cleft, Determining the Height of the cleft (a) and Length of the cleft (b).

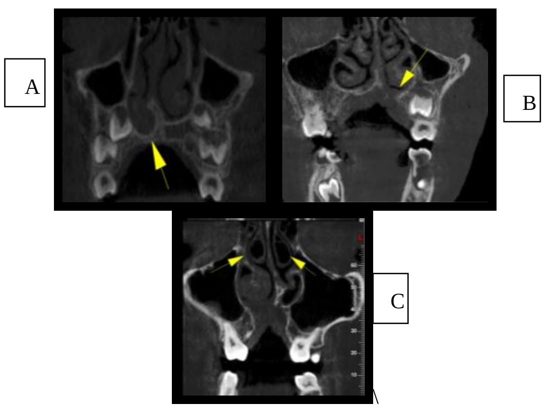


Fusion Dentition

Figure 03:Dental anomalies

approximate the vertical bone height of the bone bridge but have many drawbacks, such as image enlargement and distortion, structure overlap, limited identifiable landmarks, and positioning problems, that can adversely affect image quality[3].Conversely, evidences suggest that cone beam computed tomography (CBCT) is the imaging method of choice for evaluating surgical outcomes because it providesimages with high resolution while using low doses of radiation. CBCT also allows the visualization of various cross-sections and the assessment of depth and volume of bone in order to

Panoramic radiograph



a) Deviated nasal septum, altered level of floor of nose
b) Deficient bone in the floor of the nose.
c) Concha bullosa&nasal spur.

Figure 04: Alterations in the nasal morphology

decide the type and size of graft needed. This observational study was performed to evaluate various anatomical malformations in the maxillary alveolus caused by cleft.

MATERIALS AND METHODS:

An observational study was performed of 4 randomly selected patients with clefts who underwent preoperative CBCT imaging. All scans were performed *with NewTomGiano CBCT machine, 11’’×5’’ FOV & 0.2mm slices were obtained for analysis*. Using anatomical landmarks, measurements were collected from the CBCT image for each patient: vertical height and bucco-palatal width of the bone bridge (Figure 1, 2a and b). Although the magnification of CBCT images can be freely set according to the film size, the millimeter ruler to verify life size is always displayed on the top of the film. The ruler was used for exact 3D measurement of the bone bridge from the CBCT images.

RESULTS:

The patients demographic characteristics are described in Table 1, with their age ranging from 5 years-15years. The volume of the defect is as given in Table 2a and b, with a maximum of cleft volume seen with patient ‘B’ 1831.2±24mm^3, and minimum cleft volume was seen in patient ‘D’ with 6.3±1mm^3,which states that more the volume more is the defect. Multiple dental anomalies (Table3 and Figure3) and alterations in nasal morphologies (Table4 and Figure4) were also observed.

DISCUSSION:

The most important clinical use of imaging of alveolar bone grafting is to evaluate whether the bone bridge can support prosthetic treatment with dental implants, orthodontic treatment of the cleft-adjacent teeth, or subsequent eruption of the canine or incisor. CBCT images of cross sections of the dental arch clearly showed 3D morphology and bony architecture of the bone bridge. These images can be used for exact measurement before installation of dental implants[3].

The present study was undertaken to determine the preoperative CBCT measurements of the cleft volume which would provide reliable estimates to the amount of required graft material.

Two-dimensional radiographic appearance of this cleft is a well defined vertical radiolucent defect in the alveolar bone as well as numerous dental anomalies. These may include the absence of the maxillary lateral incisor and the presence of supernumerary teeth in this region. Often the involved teeth are malformed and poorly positioned. In patients with cleft palate a mild delay in the development of maxillary andmandibular teeth may occur. Affected children of both genders also have an increased incidence of hypodontia in both arches [4]. In our study displacement of tooth, congenitally missing tooth and fusion of dentition was seen.

Lee et al. (1995) found that the dental radiograph significantly overestimated the total number of bone-grafted alveolar clefts that could be managed orthodontically by up to 17%. Furthermore, they argued that dental radiography alone is inadequate for orthodontic treatment decisions for the following reasons: (1) It failed to provide detailed information about the depth and volume of bone deposited in the cleft, (2) It was inconsistent and often late in showing graft trabeculation, and (3) It failed to show the buccal-lingual position of adjacent or erupting teeth relative to the bone graft.

These problems of plain dental radiography could be resolved with 3D measurements taken from CT images. In fact, Van der Meij et al. (2001) successfully used CT scan for assessing whether a sufficient amount of bone, especially in the buccopalatal direction, was present to facilitate eruption of the permanent canine into the bone bridge. In particular, radiation dose for CT examination of the maxillofacial region is excessively high for younger patients; therefore CT is not recommended[3]. CBCT for patients with cleft palate is useful for both preoperative and therapeutic evaluations. The real-time creation of images in several planes and parasagittal sections through the imaging volume has broad applications in the assessment of cleft palate cases. Three-dimensional reconstructions of images in association with 3D navigation systems allow preoperative evaluations of the cleft palate regarding the volume of the bone defect, the location of the bone defect, the presence of supernumerary teeth, and an appraisal of permanent teeth and alveolar bone morphology.

In a study by Albuquerque et al. (2011), CBCT was found to be equivalent to multi-slice CT in both the volumetric assessment of bone defects in alveolar and palatal regions and in establishing donor area and the volume of the bone graft to be used in the rehabilitation of cleft patients[5,7].

For alveolar defect repair, autogenous bone can be harvested from intraoral sites (limited to the amount of bone available), such as the mandibular symphysis, retromolar pad, mandibular ramus, tuberosity and zygomatic buttress, and from extraoral sites, such as the tibia, and iliac crest. Although the iliac crest can provide an abundant bone amount for grafting, the preoperative computer simulation and assessment of the 3D alveolar cleft volume using CBCT images can avoid the inadequate harvest of bone as well as reducing the postoperative morbidity of the donor region. This can prevent some of the possible surgical complications such as excessive blood loss, delayed wound healing, pain and hypoesthesia. Thus, it is essential to assess the cleft dimensions to select the adequate donor site and harvest the needed amount of bone for the alveolar graft[6].In our study, Case No. ‘B’ would need abundant bone amount for grafting (volume- $1831.2\pm24mm^3$) as compared to Case No. ‘D’ requiring minimum grafted bone. This can be conveniently harvested from any intra-oral sites.

The ability to use 3-Dimenasional CBCT imaging to assess the volume of defects is not only useful for alveolar clefts but can also be applied for reconstruction after trauma, pathologic resections and other congenital malformations. This may be of greater significance in cases considering the grafts from the posterior iliac crest where patient positioning must be changed intraoperatively.

CONCLUSION:

In conclusion, CBCT imaging can be used to reliably calculate the cleft height and bucco-palatal width of the cleft. This can be of great benefit to reconstructive surgeon. Its use in preoperative assessment and planning to quantitatively assess the cleft volume and thus predict the amount of bone necessary to repair the void can lead to decreased surgical time. Although the Dental CBCT imaging system has a few drawbacks, we consider it to be useful for clinical assessment of alveolar bone grafting. Especially beneficial for both patients and clinics are the significantly lower cost and radiation exposure to obtain 3D radiographic information, compared with conventional spiral CT. CBCT has eventually replaced plain radiography and spiral CT as a clinically applicable modality for routine imaging of alveolar bone grafting.

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Source of support: Nil Conflict of Interest: None

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