The Saudi Dental Journal (2012) 24, 127–134

King Saud University

The Saudi Dental Journal

www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Effect of exposure time on the accuracy and reliability of cone beam computed tomography in the assessment of dental implant site dimensions in dry skulls

Asmáa A. Al-Ekrish

Department of Oral Medicine and Diagnostic Sciences, College of Dentistry, King Saud University, P.O. Box 56810, Riyadh 11564, Saudi Arabia

Received 24 December 2011; revised 26 April 2012; accepted 14 May 2012
Available online 1 June 2012

KEYWORDS

CBCT;
Radiation dosage;
Reliability;
Dental implantation;
Dry skull

Abstract *Objectives:* To investigate the accuracy and reliability of implant site measurements, recorded from low-dose cone beam computed tomography (CBCT) images.

Methods: CBCT reformatted images of five skulls were obtained using 40, 20 and 7 s exposure protocols. From these protocols, edentulous ridge dimensions were recorded by two observers and compared with measurements recorded directly from the bone. The measurement errors and intra- and inter-examiner reliability were calculated for each exposure protocol and compared with each other.

Results: The mean absolute errors from the 40, 20 and 7 s protocols were 0.50, 0.46, and 0.51 mm, respectively. The intra-examiner reliability scores were 0.996, 0.995 and 0.998, respectively. The inter-examiner reliability scores were 0.993, 0.998 and 0.994, respectively. There was no significant difference in accuracy or reliability between the three protocols.

Conclusions: In imaging of dry skulls, lowering the CBCT exposure time from 40 s to 20 or 7 s does not affect the reliability or accuracy of implant site measurements.

1. Introduction

The use of cone beam computed tomography (CBCT) is rapidly spreading and becoming the imaging modality of choice for implant site assessment. However, the increasing use of CBCT has raised concerns of excessive exposure to ionizing radiation to the collective population (UNSCEAR, 2008) that necessitates the introduction of dose-saving strategies. The radiation dose imparted by a CBCT examination is variable because it depends on the CBCT machine, the field of view (FOV), number of basis images, mode of exposure (continuous or pulsed), and exposure parameters of milliampere (mA), kilovoltage peak (KvP), and duration of exposure. By using a variety of CBCT machines and varying the exposure parameters of identical machines, considerable reductions in radiation dose have been found (Ludlow et al., 2006; Ludlow and Ivanovic, 2008; Roberts et al., 2009).

E-mail addresses: asma.alekrish@gmail.com, aalekrish@ksu.edu.sa
Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

1013-9052
http://dx.doi.org/10.1016/j.sdentj.2012.05.001

Although reduction of the radiation dose is advantageous from a biological point of view, it may possibly lead to undersampling artifacts or quantum noise that could theoretically adversely affect the diagnostic quality of the images (Bushberg et al., 2002; Jaffray and Siewerdsen, 2000; Mozzo et al., 1998; Siewerdsen and Jaffray, 2001; van Daatselaar et al., 2004). Suomalainen et al. (2009) investigated image quality vs radiation exposure of dental CBCT machines and found that, for protocols utilizing the same exposure parameters and producing images with the same voxel size, a reduction of exposure time and scan volume led to a slight reduction of contrast-to-noise ratio (CNR) but a small increase in the 10% modulation transfer function (Suomalainen et al., 2009).

The effect of increased noise and streaking due to reduced exposure times for CBCT examinations may not degrade the image severely, but the diagnostic implications of such image degradation depend on the diagnostic task at hand. Implant site imaging is mainly concerned with hard tissues, and for depiction of such high-contrast structures, low mA settings are not thought to negatively influence the diagnostic quality (Mozzo et al., 1998). Comparing and contrasting the results from the currently published literature, however, we were unable to determine the individual effect of reduction of the number of basis images on the accuracy of CBCT images for implant site assessment. This is because different devices, methodology, and protocols are used; the effects of the various examination parameters are intertwined. Furthermore, different reconstruction filters also affect the accuracy of the resultant images. Therefore, to investigate the effect of one parameter, all the others must be factored out.

To our knowledge at the time of writing, no published data exist on the effect of reducing the exposure time of a CBCT examination on objective image quality for implant site assessment. Thus, this study aims to measure the reliability and accuracy of measurements of edentulous ridges for implant site assessment performed on images obtained by low-dose CBCT protocols and to compare and contrast the results from the various examination protocols. The results of such a study should aid in determining the optimum scan protocols, with the appropriate balance between dose and image quality, thus reducing the risk of adverse effects on patients.

2. Methods

2.1. Preparation of skulls

Five human dried skulls were used in this study. Because the study was an *in vitro* experimental study using dried human skulls, it did not require the approval of institution's ethics committee. However, since human skulls were used, they were obtained from the Anatomy Department of the King Saud University College of Medicine through official channels with the approval of both the chairman of the Department of Oral Medicine and Diagnostic Sciences (College of Dentistry) and the chairman of the anatomy department (College of Medicine).

All existing teeth within the skulls were removed, and the alveolar ridges were flattened to expose areas of bone that would facilitate physically sectioning the bone while maintaining the height and width of the ridge at the site of the sections. After grinding, the surface of one of the maxillae was found to be made up entirely of large, exposed marrow spaces, and it was therefore not used for measurement purposes. The corresponding mandible was used, though, and the entire skull was imaged to facilitate proper positioning of the mandible.

The edentulous areas to be measured were designated with radiopaque gutta-percha markers 1.4 mm in diameter. The markers delineating each sample site were placed at the crestal, buccal, and lingual sides of the jaws; a groove filled with softened gutta-percha was also placed along the inferior border of the acrylic resin surrounding the mandible. All were placed to delineate the position and plane of the transverse cross-sections as well as the proposed path of measurements, as outlined in Fig. 1.

The markers were obtained by cutting the black color-coded ends of size 80 gutta-percha cones with scissors and embedding them in a layer of clear acrylic resin separated from the bone by three layers of sheet wax (each layer 1.5 mm thick). The wax and acrylic resin surrounding the maxillae covered the entire ridge, tuberosity, and palate, and extended buccally superior to the floor of the nasal fossa and maxillary sinus. For the mandibles, the entire body of the mandible was surrounded by wax and acrylic resin. Distribution of the demarcated sample sites is listed in Table 1.

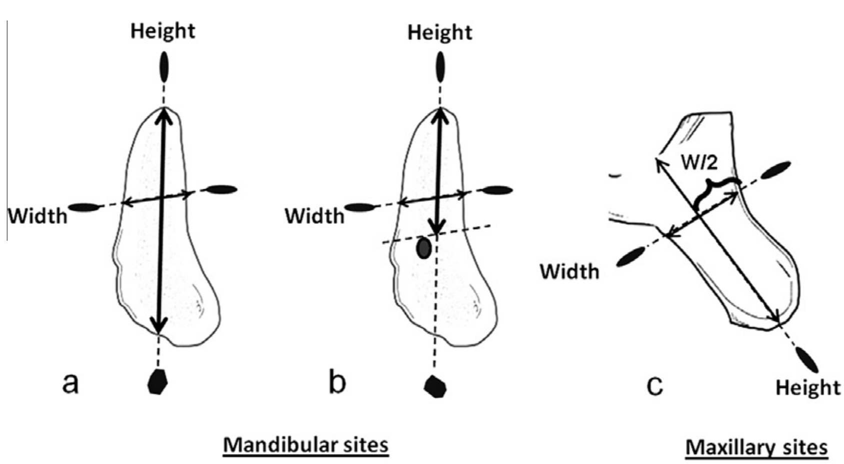

Figure 1 Diagram showing the direction of the height and width measurements on transverse cross-sections. (a) Mandibular section, anterior to the mental foramen. (b) Mandibular section, at and posterior to the mental foramen. (c) Maxillary section.