Influence of object location in cone beam computed tomography (NewTom 5G and 3D Accuitomo 170) on gray value measurements at an implant site

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Received: 16 May 2013/Accepted: 6 September 2013/Published online: 10 October 2013
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Abstract
Objectives The aim of this study was to determine the gray value variation at an implant site with different object location within the selected field of view (FOV) in two cone beam computed tomography (CBCT) scanners.
Methods A 1-cm-thick section from the edentulous region of a dry human mandible was scanned by two CBCT scanners: 3D Accuitomo 170 (J. Morita, Kyoto, Japan) and NewTom 5G (QR Verona, Verona, Italy). Five FOVs were used with each CBCT scanner. Within each FOV, the specimen was located at different positions. The scans were converted to DICOM format. Data analysis was performed using 3Diagnoys (ver. 3.1, 3DIEMME, Cantu, Italy) and Geomagic software (Studio 2012, Morrisville, NC). On one of the scans, a probe designating the site for pre-operative implant placement was selected. The inserted virtual implant was transformed on the same region on each CBCT scan by a three-dimensional registration algorithm. The mean voxel gray value of the region around the probe was derived separately from all CBCT scans. The influence of object location within each FOV on variability of voxel gray values was assessed.
Results In both CBCT systems, object location had a significant influence on gray value measurements ($F_{4,15} = 3.71$, $p = 0.0255$ for Accuitomo and $F_{4,15} = 9.31$, $p = 0.0000$ for NewTom).
Conclusions Gray level values from CBCT images are influenced by object location within the FOV.

Keywords Cone-beam computed tomography · Bone density · Dental implants · Patient positioning

Introduction
Among the imaging modalities, computed tomography (CT) has gained popularity in assessing bone density at prospective implant sites. This concept was introduced by Schwartz et al. for the first time in 1987, and since then has been used more frequently [1, 2]. In multi-slice CT (MSCT), calibrated Hounsfield units (HU) are obtained that can be directly converted to bone density measurements. In the jaw, bone density measurements derived from HU are highly reliable [3, 4]. However, a high radiation dose associated with MSCT in preoperative dental implant planning has been demonstrated [5, 6].

Cone beam computed tomography (CBCT) has been considered a precision diagnostic imaging tool in dentistry since the late 1990s. CBCT offers some advantages over MSCT, such as increased accessibility by oral health specialists, lower cost, higher comfort for patients, and a more compact design. Although a lower radiation dose to the main organs of the head and neck region has been cited as