Reliability of Voxel Gray Values in Cone Beam Computed Tomography for Preoperative Implant Planning Assessment

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Purpose: To assess the reliability of cone beam computed tomography (CBCT) voxel gray value measurements using Hounsfield units (HU) derived from multislice computed tomography (MSCT) as a clinical reference (gold standard).

Materials and Methods: Ten partially edentulous human mandibular cadavers were scanned by two types of computed tomography (CT) modalities: multislice CT and cone beam CT. On MSCT scans, eight regions of interest (ROIs) designating the site for preoperative implant placement were selected in each mandible. The datasets from both CT systems were matched using a three-dimensional (3D) registration algorithm. The mean voxel gray values of the region around the implant sites were compared between MSCT and CBCT.

Results: Significant differences between the mean gray values obtained by CBCT and HU by MSCT were found. In all the selected ROIs, CBCT showed higher mean values than MSCT. A strong correlation (R = 0.968) between mean voxel gray values of CBCT and mean HU of MSCT was determined.

Conclusions: Voxel gray values from CBCT deviated from actual HU units. However, a strong linear correlation exists, which may permit deriving actual HU units from CBCT using linear regression models. Int J Oral Maxillofac Implants 2012;27:1438–1442.

Key words: accuracy, CBCT, cone beam computed tomography, Hounsfield unit

Bone density is one of the most important characteristics of bone quality. Assessing bone density prior to implant placement aids the practitioner in choosing a suitable implant site. Several imaging modalities have been used to assess bone density, including dual energy x-ray absorptiometry (DEXA), digital image analysis of microradiographs, quantitative ultrasound (QUS), and computed tomography (CT). Of these imaging techniques, CT gained popularity in assessing bone density at the prospective implant site. The concept was first introduced by Schwartz et al\textsuperscript{7} and has been used more frequently ever since. In multislice CT (MSCT), calibrated Hounsfield units (HU) are obtained, which can be directly converted to bone density measurements. In the arch, bone density measurements derived from HU are highly reliable.\textsuperscript{7} However, numerous studies demonstrated higher radiation exposure risk for MSCT in comparison with other imaging modalities.\textsuperscript{8–12}

Cone beam computed tomography (CBCT), which emits a cone-shaped x-ray beam, was introduced in the last decade in clinical dentistry. In comparison, CBCT has several advantages over MSCT in terms of increased accessibility to oral health specialists, more compact equipment, small footprint for the clinic, and relatively reduced scan costs. Additionally, lower radiation dose levels to the main organs of the head and neck region have been cited as one of the most important advantages of CBCT over MSCT.\textsuperscript{13–15} However, it has become recently well known that the effective dose from any CBCT device largely depends on the type of the machine and scan settings, including field of view (FOV), number of basis projections, and scan modes among other factors.\textsuperscript{16} Moreover, the latest generations of