

Comparison Of Hounsfield Unit Of CT With Grey Scale Value Of CBCT For Hypo And Hyperdense Structure

Dr. Abhijeet Sande¹, Dr. Praveenkumar Ramdurg²

¹Senior lecturer, Department of Oral Medicine and Radiology, School of Dental Sciences, KIMSDU, Karad, Maharashtra, India;

²Associate professor, Department of Oral Medicine and Radiology, PNMNDental College and Hospital, Bagalkot, Karnataka, India

¹E-mail: praveenod@gmail.com

ABSTRACT: Background: The present study compared hounsfield unit of CT with grey scale value of CBCT for hypo and hyperdense structure.

Materials & Methods: 15 human dry skulls were subjected to MSCT and CBCT and hyperdense areas of enamel, cortical, and cancellous bones and hypodense areas of mental foramen, inferior alveolar canal and extraction socket within the mandible were assessed.

Results: For extraction socket CT had -860.5 HU and CBCT had -740.5 grey scale, for mandibular canal CT had -560.2 HU and CBCT had -726.4 grey scale, mental foramen had CT of -432.6 HU and CBCT had -458.6 grey scale, cancellous bone had CT had 346.2 HU and CBCT had 416.2 grey scale and cortical bone had CT 1880.4 HU and CBCT had 1652.8 grey scale. The difference was significant ($P < 0.05$).

Conclusion: The gray value for hypodense structures in large volume CBCT scan was more reliable and analogous to HU value in MSCT.

Key words: Hypodense, CT, CBCT

1. INTRODUCTION

Imaging is the key investigative tool for many diseases in diagnostic medicine. The development of three-dimensional (3D) imaging has revolutionized diagnosis in Radiology.¹ The emergence of multi-slice computed tomography (MSCT) has pronounced clinical impact, as it captures images rapidly and simultaneously. MSCT is an established system in dento-maxillofacial diagnosis and in assessment of bone density.² The evaluation of bone quality is critical for successful treatment plan. Hounsfield units (HU) or CT number provides a quantitative assessment of bone density. HU is the ability to attenuate an X-ray beam and it considered as a standard scheme for scaling the reconstructed attenuation coefficients of CT. However, CT cannot be used in routine diagnosis due to its limitations.³

Computed tomography (CT) images are used for the evaluation of soft and hard tissues and the diagnosis of pathologic and traumatic lesions in the head and neck region. CT has a standard design to measure beam attenuation by the body issues, which is referred to as Hounsfield Unit (HU). HU is used to evaluate the quality of bone at implant placement area, to control grafts and to diagnose lesions, anatomic structures, etc.⁴

cone-beam computed tomography (CBCT) in maxillofacial imaging is increasingly replacing MSCT for evaluating mineralized structures as CBCT images are of adequate quality with lower radiation dose.⁵ In addition, CBCT has reduced cost and limited volume scanning of structures. This may be because of scattered radiation and enhancing noise in reconstructed images. CBCT does not have a standard system for scaling the gray levels representing the reconstructed value.⁶The present study compared hounsfield unit of CT with grey scale value of CBCT for hypo and hyperdense structure.

2. MATERIALS & METHODS

The present study was conducted on 15 human dry skulls. Approval for the study was taken from institutional ethical committee.

Gutta-percha cones as radio opaque marker were placed in the molar region running from buccal to lingual side on each mandible. The hyperdense areas of cortical and cancellous bones and hypodense areas of mental foramen, inferior alveolar canal and extraction socket within the mandible were assessed. The mandibles were mounted and CT scan was taken with MSCT scanner (Toshiba, Japan) at an exposure of 120 kV, 100 mA and 0.5 seconds. The MSCT images were assessed using NNT DICOM software.

CBCT scans were outsourced using Planmeca CBCT unit. 3D imaging data were acquired at 100 kV, 10 mA and 9.6 seconds for a 360° rotation. Results were tabulated and subjected to statistical analysis. P value less than 0.05 was considered significant.

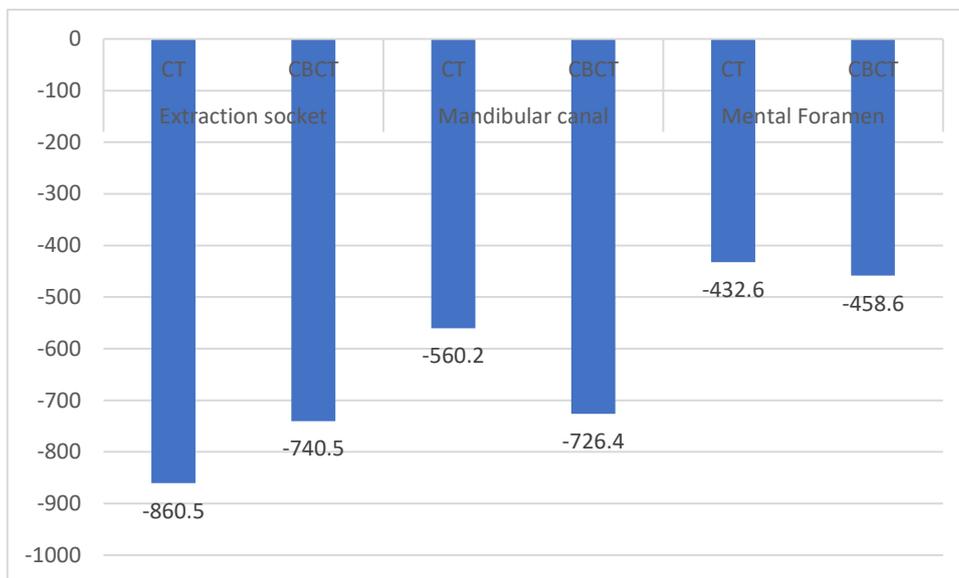
3. RESULTS

Table I Comparison between gray values of cone beam computed tomography with Hounsfield unit of multislice computed tomography

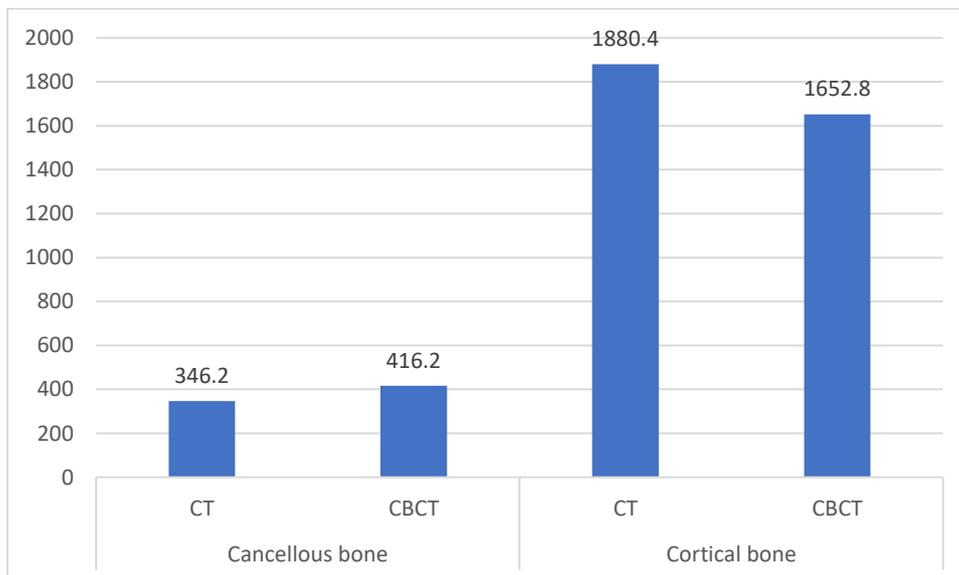
Structure	Images	Mean	Difference	P value
Extraction socket	CT	-860.5	-120	0.05
	CBCT	-740.5		
Mandibular canal	CT	-560.2	166.2	0.02
	CBCT	-726.4		
Mental Foramen	CT	-432.6	26	0.17
	CBCT	-458.6		
Cancellous bone	CT	346.2	-70	0.04
	CBCT	416.2		
Cortical bone	CT	1880.4	227.6	0.01
	CBCT	1652.8		

Table I. graph I, II shows that for extraction socket CT had -860.5 HU and CBCT had -740.5 grey scale, for mandibular canal CT had -560.2 HU and CBCT had -726.4 grey scale, mental foramen had CT of -432.6 HU and CBCT had -458.6 grey scale, cancellous bone had CT had 346.2 HU and CBCT had 416.2 grey scale and cortical bone had CT 1880.4 HU and CBCT had 1652.8 grey scale. The difference was significant ($P < 0.05$).

Graph I Gray values of CBCT with Hounsfield unit of multislice CT



Graph II Gray values of CBCT with Hounsfield unit of multislice CT



4. DISCUSSION

Some studies have shown that the CBCT technique cannot accurately show HU, which might be attributed to its high scattered radiation dose, artifacts and the noise resulting from the use of a cone-shaped beam in the CBCT, making the CBCT unreliable for estimating the density of bone.^{7,8} In contrast, some studies have shown a strong linear relationship between HU in CT and gray level in CBCT. Katsumata et al⁹, the gray level of bone had a wide range from -

1500 to +3000, limiting the ability to evaluate the quality of bone. Mahet al¹⁰ introduced a technique in which HU could be derived from the gray level. They compared the HU derived from a linear correlation coefficient with that derived from the gray level and reported minor differences in the majority of cases. The present study compared hounsfield unit of CT with grey scale value of CBCT for hypo and hyperdense structure.

In present study, we found that for extraction socket CT had -860.5 HU and CBCT had -740.5 grey scale, for mandibular canal CT had -560.2 HU and CBCT had -726.4 grey scale, mental foramen had CT of -432.6 HU and CBCT had -458.6 grey scale, cancellous bone had CT had 346.2 HU and CBCT had 416.2 grey scale and cortical bone had CT 1880.4 HU and CBCT had 1652.8 grey scale.

Raziet al¹¹ compared the Hounsfield Unit (HU) in computed tomography (CT) with the gray level in CBCT in human tissues. In this study, 25 different soft and hard tissues were evaluated in 21 patients. CBCT images were taken with NewtomVGI machine (Verona, Italy) and CT images were prepared with Somatom Sensation unit (Siemens, Germany). The HU values of soft and hard tissues were compared with the gray level values of CBCT images. There was a strong correlation between the HU in CT and the gray level in CBCT in soft tissues and hard tissues and in general. A high degree of agreement was seen between HU in CT and gray level in CBCT in both hard and soft tissues. Since the gray level in CBCT was similar to HU in CT and can be used as a parameter determine bone density in implant treatment and also to determine the bone type, the CBCT technique is recommended in such cases due to its low radiation dose, short time and low cost compared to CT.

Patrick et al¹² determined and compare the gray value and HU value of hypodense and hyperdense structures on CBCT and MSCT, respectively. The study also evaluated and compared the gray values in different field of views within CBCT on dry mandibles. The gray value for hypodense structures in large volume CBCT scans resembled the HU value. The study showed statistically significant difference ($P < 0.001$) in gray values for all the hyperdense structures in CBCT when compared to HU values of MSCT scans.

The shortcoming of the study is small sample size.

5. CONCLUSION

Authors found that the gray value for hypodense structures in large volume CBCT scan was more reliable and analogous to HU value in MSCT.

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