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Full Length Article

Influence of patient position and other inherent factors on image quality in two different cone beam computed tomography (CBCT) devices

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ABSTRACT

Objectives: The aim of this *in vitro* study was to evaluate how a deviation from the horizontal plane, affects the image quality in two different CBCT-devices.
Methods: A phantom head SK150 (RANDO, The Phantom Laboratory, Salem, NY, USA) was examined in two CBCT-units: Accuitomo 80 and Veraviewepocs 3D R100 (J. Morita Mfg. Corp. Kyoto, Japan). The phantom head was placed with the hard palate parallel to the horizontal plane and tilted 20 ° backwards. Exposures were performed with different field of views (FOVs), voxel sizes, slice thicknesses and exposure settings. Effective dose was calculated using PCXMC 2.0 (STUK, Helsinki, Finland). Image quality was assessed using contrast-to-noise-ratio (CNR). Region of interest (ROI) was set at three different levels of the mandibular bone and soft tissue, uni- and bilaterally in small and large FOVs, respectively. CNR values were calculated by CT-value and standard deviation for each ROI. Factor analysis was used to analyze the material.
Results: Tilting the phantom head backwards rendered significantly higher mean CNR values regardless of FOV. The effective dose was lower in small than in large FOVs and varied to a larger extent between CBCT-devices in large FOVs.
Conclusions: Head position can affect the image quality. Tilting the head backward improved image quality in the mandibular region. However, if influenced by other variables *e.g.* motion artifacts in a clinical situation, remains to be further investigated.
Advances in knowledge: Image quality assessed using CNR values to investigate the influence of different patient positions and FOVs.

1. Introduction

Cone beam computed tomography (CBCT) is an imaging modality that since its introduction into the field of diagnostic radiology in the late 1990s [1] has gained a widespread use in various disciplines: endodontics [2], orthodontics [3], implantology [4], pediatric dentistry [5] and periodontology [6]. Due to its relatively high availability, low cost and small footprint the technique is often used to enhance the diagnostic capability of different pathological conditions in the dentomaxillofacial area, as well as an aid in digital treatment planning.

The number of CBCT devices has increased substantially since the introduction, and today there are a large number of CBCT devices from different manufacturers on the market [7]. However, even if the term CBCT often is addressed as a generic name for the technique, the devices may vary in several aspects such as patient positioning (sitting or lying down, standing up), X-ray spectrum (voltage peak, filtration), X-ray exposure (mA-value, number of projections, rotation angle), volume of the exposed field and voxel size [8]. Further, a majority of the devices today is equipped with different imaging protocols and thus, varying voxel sizes and acquisition/exposure time to adapt the image resolution to the specific diagnostic task and the cooperation of the patient. Due to these differences between CBCT devices the radiation dose to the patient reveals a large variation, 27–674 μSv [9] depending on region of interest (ROI) and different exposure settings used [10].

There are several publications including guideline statements on the use of CBCT in the head and neck region [11]. However, there is still a lack of specific instructions of how to optimize the radiographic examination on basis of the individual patient and region of interest. This may be due to the large number of different CBCT devices with their inherent differences.

A possibility to overcome these shortcomings, and investigate how different CBCT devices perform under certain conditions, is to use the

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Fig. 1. Illustrates the difference in the phantom head position.

contrast-to-noise-ratio (CNR) as an objective measure of image quality. In science and engineering, the signal-to-noise ratio (SNR) is a measure that compares the level of a desired signal to the level of background noise, CNR measure of image quality is based on image contrast rather than the raw signal. Using CNR instead of observers in image quality assessments may reduce the possibility of observer influence due to individual preferences. The difference in CNR values has been used in several articles to assess and compare image quality and optimization using different device settings [12–17].

However, until today there is, to our knowledge, no study that has investigated the influence of patient position on CNR value and thus, its effect on image quality in CBCTs for dental applications.

The head position of the patient may influence the amount of tissue volume that the cone shaped radiation field has to pass to get to the detector. Since the radiation field is rotating around the patient head during exposure this may influence the amount of photons that reach the detector and hence the image building process.

Therefore the aim of this *in vitro* study was to evaluate how a deviation of the hard palate from the horizontal plane, affects the image quality, using two different CBCT devices. Further, to investigate the influence of different exposure parameter settings and field of views (FOVs).

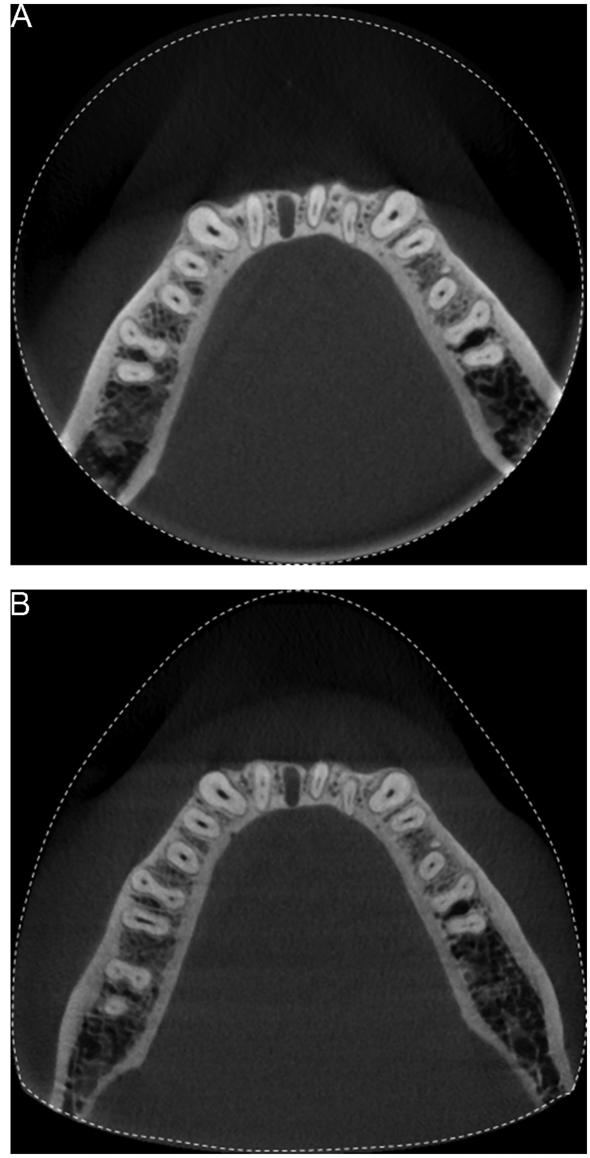

Fig. 2. Illustrates the difference between the areas of the large FOV in (A) Accuitomo and (B) Veraviewepocs. The Veraview has a rouleaux shape that is more adjusted the shape of the jaws.

2. Materials and methods

2.1. Test object

The Sectional Head Phantom, SK150 (RANDO, The Phantom Laboratory, Salem, NY, USA) a human skull embedded in acrylic material (*i.e.* polyurethane) to simulate soft tissue, was used. The phantom

Table 1
Specifications for the different image parameter settings for the different CBCT-devices.

Device	Voxel size (mm)	Slice thickness (mm)	No of axial slices in each scan	No of projections during scan	Exposure time (s)
Accuitomo[a] 40 mm × 40 mm	0.125	0.375	107	586	17.5
Veraview[b] 40 mm × 40 mm	0.125	0.375	115	342	9.4
Accuitomo[a] 80 mm × 80 mm	0.160	0.480	167	586	17.5
Veraview[b] 100 mm × 80 mm[c]	0.160	0.480	167	342	9.4

[a] Accuitomo F80.
[b] Veraviewepocs 3D R100.
[c] Reuleaux Full Arch is an area shaped like a convex triangle. By more closely matching the natural dental arch form, this FOV allows a more complete scan of the maxilla and mandible.