

LETTER TO THE EDITOR

Effect of voxel size and partial volume effect on accuracy of tooth volumetric measurements with cone beam CT*Dentomaxillofacial Radiology* (2013) **42**, 20130070. doi: [10.1259/dmfr.20130070](https://doi.org/10.1259/dmfr.20130070)**Cite this article as:** Ye N, Jian F, Lai W. Effect of voxel size and partial volume effect on accuracy of tooth volumetric measurements with cone beam CT. *Dentomaxillofac Radiol* 2013; **42**: 20130070.

With interest, we read the article on analysing the effect of voxel size on accuracy of three-dimensional reconstructions with cone beam CT (CBCT) in the December 2012 issue of *Dentomaxillofacial Radiology*.¹ The authors found that the tooth volumes were underestimated by CBCT 200 μm and 300 μm voxel sizes compared with CBCT 76 μm voxel size or micro-CT 41 μm voxel size groups. The cause was inferred as the partial volume effect (PVE). However, our studies showed that, with increase in scanning voxel size, the *in vitro* volume measurements of teeth tended to be overestimated.² We consider that it is more reasonable using the PVE theory to explain the overestimation of the object volume. The concerns about this study are as follows.

(1) In the theory of PVE, a voxel that represents the density value of a point in three-dimensional space can show only one kind of density. If a voxel lies completely within an object, it would reflect that object's density. However, if a voxel is at the junction of two objects of different densities (*e.g.* tooth and air), the voxel reflects an average value somewhere between the true values for enamel and air.^{3,4} Accordingly, the voxels at the margin of a crown reflect the average density of enamel and surrounding tissues, which bring artefacts to the tooth volume reconstruction. These PVE artefacts would lead to volume overestimation rather than underestimation. In our opinion, the underestimation of teeth volumetric measurements in this study might be caused by the segmentation. Owing to the jaw bones surrounding the tooth germs, it is very difficult to separate the tooth contour from the bone

completely in the low resolutions (200 μm and 300 μm voxel sizes). To obtain the tooth contour as clear as possible, a high threshold value will usually be chosen during the segmentation procedure, which creates a smaller volume.³

(2) Micro-CT used as the reference standard in this study can cause artefacts (PVE and scatter) in high-density tissues (*e.g.* enamel). Enamel artefacts have a significant negative impact on the volume measurement accuracy. In addition, the micro-CT reconstruction parameters can also affect the accuracy of the models. Setting the threshold value too high would underestimate the volume of the teeth, and vice versa.⁵ In our opinion, we recommend laser scanning as the reference, which can provide the accuracy of 20 μm and would not be affected by the enamel artefacts.

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