LETTER TO THE EDITOR

Effect of voxel size and partial volume effect on accuracy of tooth volumetric measurements with cone beam CT: Author response

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We truly appreciate the interest Ye et al showed with their letter¹ related to the recent article titled “Effect of voxel size on accuracy of 3D reconstructions with cone beam CT”,² and we welcome the opportunity to respond to the points of consideration raised.

We would like to comment as follows:

- (1) The general description of the partial volume effect (PVE) by Ye et al is accurate.¹ We respectfully disagree, however, with the notion that the PVE would typically lead to overestimation of the true object size. Firstly, in an artefact-free data set with a sufficiently high number of voxels compared with the size of the original object, the segmented volume should be reasonably close to the object size.²

In the case of real-life data sets that include artefacts, selecting a local adaptive threshold has benefits over an International Organization for Standardization (ISO)50 threshold. This procedure is implemented in so-called surface determination tools that use iterative computation methods, *e.g.* in software packages such as VG Studio (Volume-Graphics, Mannheim, Germany); this approach has been used to exactly determine root canal sizes.³

- (2) We would also respectfully disagree with the notion that using laser surface scans provides a better reference standard to test accuracy and precision of cone beam CT measurements.⁴ Laser scans will result in point-cloud data; such data also need to be segmented to achieve measurable volumes. This in turn may introduce a similar bias compared with segmentation of cone beam CT data.

Indeed, only using physical references such as objects of known or directly measurable dimensions renders true comparison data.^{5,6} Using such comparisons, linear⁵ and volumetric⁶ measurements from cone beam CT and micro-CT appear to be very close to true object sizes of dental hard tissues. These findings contrast sharply with the differentials reported recently⁴ by up to 43.9% and 41.6% for enamel and dentine, respectively, compared with laser surface scanning data.

In conclusion, it is our opinion that voxel sizes such as 200 μm and less permit reliable measurements of dentine and enamel object sizes. Utilizing more advanced computational methods will help to minimize observer- and artefact-induced errors in this field. Hopefully, this communication will contribute to discussions in this promising field of research and support advances in clinical practice.

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