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# Accuracy of reconstructed images from cone-beam computed tomography scans

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**Introduction:** The aim of this study was to determine whether 2-dimensional (2D) images produced from cone-beam computed tomography (CBCT) images taken with an iCAT scanner (Imaging Sciences International, Hatfield, Pa) can substitute for traditional cephalograms.

**Methods:** Lateral and frontal cephalograms were taken of a radiographic phantom with known dimensions. Landmarks on the 2D images were traced and measured manually by 2 examiners and then digitally in Dolphin 10 (Dolphin Imaging Sciences, Chatsworth, Calif) by the same examiners. A CBCT scan was taken of the phantom, and orthogonal and perspective projections were created from the scans. Frontal and lateral cephalograms were created by using the 3-dimensional function in Dolphin 10, digitized into Dolphin, and traced by the same 2 examiners. Linear measurements were compared to assess the accuracy of the generated images from the CBCT scans.

**Results:** Measurements on the orthogonal projections were not significantly different from the actual dimensions of the phantom, and measurements on the perspective projections were highly correlated with those taken on standard 2D films.

**Conclusions:** By constructing a perspective lateral cephalogram from a CBCT scan, one can replicate the inherent magnification of a conventional 2D lateral cephalogram with high accuracy.

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## EDITOR'S SUMMARY

Two-dimensional (2D) imaging has been the accepted cephalometric tool for the past 75 years. Technological advances in 3-dimensional (3D) imaging in the form of cone-beam volumetric or computed tomography (CBCT) appear to offer significant advantages in both quality and quantity of data representing true anatomy. The most recent studies involving CBCT scans have shown not only that 3D measurements are much more accurate than 2D measurements, but also that they are close to reality. The difficulty of identifying some anatomic landmarks on lateral cephalograms is the inherent challenge of cephalograms in orthodontics. This might remain a significant challenge in cephalograms generated from CBCT images. The specific aim of this study was to determine whether a constructed image from the i-CAT scanner was equivalent to that of a conventional cephalogram. To do this, the authors compared linear distances between radiographic markers on 3 images to the actual dimensions of a phantom. The 2D function of Dolphin 10 was used to reconstruct the lateral and frontal cephalograms. Because of its timeliness, this study will be of interest to many readers of the *AJO-DO*. This information could prove to be useful for diagnosis and treatment planning. It is also a methodological study that can give birth to important clinical results.

By constructing a perspective lateral image from an i-CAT CBCT scan, one can replicate the inherent magnification of a conventional 2D lateral cephalogram with high accuracy. This image can then be used in place of a 2D lateral cephalogram for comparison with other normative data. The eventual standardization of the CBCT as an initial record will allow the clinician to gather significantly more accurate and comprehensive information about the patient while maintaining useful diagnostic tools commonly used by orthodontists.

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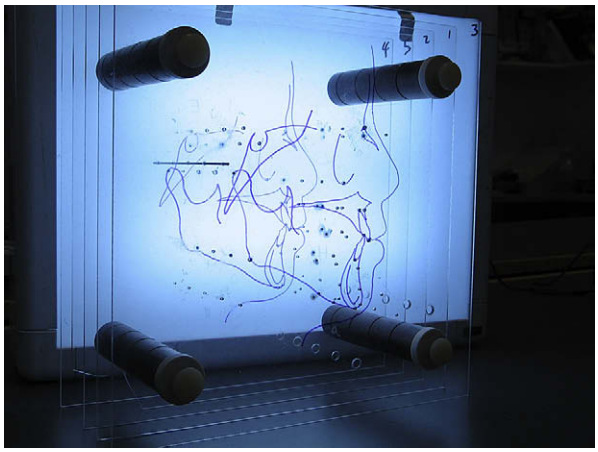

**Fig.** The radiographic phantom with known dimensions was constructed of 5 acrylic sheets with steel bearings at the corners and at anatomic landmarks.

**Q & A**

**Editor:** Are you now considering using both 3D and 2D images to follow the progress of active treatment in the clinic at Tufts?

**Will:** Yes, if the information can easily be obtained on a 2D cephalogram (or panoramic film), we will use that for our progress film instead of another CBCT scan. If we need to take a CBCT for a progress record, the cephalogram can then be generated for progress measurements.

**Editor:** Do you currently take a CBCT image of every patient entering your clinic for comprehensive care?

**Will:** No, for a variety of reasons. We take a CBCT scan routinely as a part of initial records for several categories of patients: those planned for orthognathic surgery, with clefts or craniofacial anomalies, with multidisciplinary needs, and with asymmetries, impacted teeth, or temporomandibular joint dysfunction. Our rationale for these patients was based on the information we can currently obtain from the scans. When a comprehensive dentofacial analysis is available, we might extend this to other groups, but we thought that these categories were most appropriate.

**Editor:** Are you concerned with the potential downside of this apparent increase in cost and radiographic exposure to the patient?

**Will:** At Tufts, we have been fortunate to be able to take CBCT scans as necessary without increasing the cost to the patient, but I realize that this might be impossible elsewhere. In general, however, if you can justify taking the scan based on the information you receive and how it will improve the patient's care, the cost increases are justifiable.

Regarding radiation exposure, this concern is the primary reason for limiting who receives the scan. The radiation dose is greater than a routine ceph, but, when the exposure from all films taken in training programs is totaled, the difference is minimal. As we know, there is no safe limit for radiation exposure, so these scans should only be taken to obtain useful information that cannot be obtained elsewhere. Because of its 3D nature, the CBCT scan contains more information than the sum of its 2D parts, so I believe that CBCT scans are justifiable in certain patients.