The anticipation of three-dimensional imaging for orthodontics is at last here – and has already proven to be a most practical alternative to conventional 2D Cephalometrics. A single Volumetric CT scan can now replace the conventional Cephalogram, Panoramic radiograph, PA skull and tomograms of the TMJs and paranasal sinuses in one 20-second scan. The advent of Volumetric CT has overtaken conventional CT in both its reduction of radiation, significant increase in detail and at a lower cost to both the clinician and patient. This new technology is already redefining Cephalometrics.

CT was invented in 1972 by British engineer Sir. Godfrey N. Hounsfield of EMI Laboratories, England. The first patent on "CAT-Scans" was granted to Robert S. Ledley on November 25, 1975. Most conventional CT’s utilize a fan shaped beam (Figure 1) whereas the newer systems employ one of a cone shape. (Figure 2)

With conventional CT, a fan shaped beam of x-ray is produced as the gantry rotates the x-ray tube and detector around the patient (Figure 3) producing an image or ‘slice’ with each 360 degree rotation. In a cone-beam CT (CBCT) geometry, the entire subject is exposed from a single point source using a hydrogenated amorphous silicon (aSi:H) flat-panel sensor as its detector.
In conventional CT, 3D Volumetric Image reconstruction is then achieved by scanning the series of cross-sections and then stacking these slices. In CBCT imaging, the single rotation results in a volumetric scan of the entire subject with innate rapid volumetric data acquisition.

The new Imaging Systems' i-CAT™ utilizes CBCT technology in a high quality and relatively affordable system (Figure 4).

With a single 20 second CBCT scan, one has the full 3D volume of the head and neck from C4 to Nasion including the TMJ's, pharyngeal airway, paramusal and maxillary sinuses, etc. - automatically whether you want it or not. 3D rendering such as the MIP (maximum intensity projection) in Figure 5 will undoubtedly demand new cephalometric landmarks and analyses (Figure 6).
Such 3D data can now only enhance our existing knowledge with:

1. an accurate assessment of bone quality and density, (Hounsfield units)
2. the ability to measure before and after treatment arch widths, (Figure 7)
3. actual impacted dentition orientation in 3D, (Figure 8)
4. upper airway evaluation, (Figure 9)
5. TMJ morphology and condylar position, (Figure 10)

We no longer have to rely on two dimensional plain films to estimate relative positioning of the impacted canine but can now visualize it through its entire volume.

CONCLUSIONS

CBCT is responsible for a significant reduction in radiation as compared to conventional CT (68 uSv vs. 1200-3300 uSv). One 20 second scan is equivalent to approximately five plain film panoramic radiographs: CBCT images can be saved and viewed as native Dicom, PDF and JPEG compressed files and imported into most 3rd party patient management software programs. As a result of this evolution there are now numerous free Dicom 3D multi-view readers available. Notably is OsiriXTM (available in both PC and Mac platforms), CBCT has been responsible for making CT technology affordable while opening up paths for future research and innovation, particularly in Orthodontics/Orthopedics.

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