Digital Imaging–Think i-CAT™

Cone Beam 3-D Dental Imaging System

BODY LOGIC RESOURCES

DIAGNOSTIC AND EDUCATIONAL PRODUCTS

i-CAT™ technology provides you with a full range of diagnostic services, as well as full compatibity with all implant and orthodontic volumetric software without having to send your patients for a medical CT, for in-office, three-dimensional imaging that is safe, quick, easy, and cost effective.

With a typical scan time of 20 seconds or less, the patient is subject to significant less radiation than traditional CT scans of the oral and maxillofacial region. The i-CAT™ delivers safe, quick and easy image acquisition. Its small footprint and economic design allow practices to extend their service offerings and enhance the overall delivery of care from diagnosis to treatment.

- 3-D volumetric images
- True anatomic measurements
- Scan Dimensions:17cm (w) x 13cm (h)
- 12 BIT Gray Scale
- OPG-sized Footprint
- Fast Scan Time
- Low Radiation
- Higher resolution for all views (amorphous silicon flat panel image sensor)
- Dicom 3 Compatible
- Easy to Operate
- Priced Affordably

The i-CAT™ ~ a Compact Machine at a Compact Price

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Cone Beam Imaging

THIS REPORT IS A BRIEF COMPARISON BETWEEN MEDICAL/CONVENTIONAL COMPUTED TOMOGRAPHY (CT) AND THE CONE-BEAM I-CAT, WITH RESPECT TO DESIGN OF MACHINE, SIZE OF MACHINE, RADIATION EXPOSURE, SCAN TIME, TRAINING AND EASE OF USE. EACH HAS BEEN OUTLINED AND A SUMMARY OF THE POINTS HAS BEEN TABULATED IN TABLE I.

Comparison between Conventional CT and i-CAT (Cone Beam CT)

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1) Conventional CT makes use of an x-ray tube with an array of detectors that rotates continuously in one direction whilst the table on which the patient is lying is mechanically moved through the x-ray beam.

Conventional CT uses a fan beam and the transmitted radiation thus takes the form of a helix or spiral. Instead of acquiring data one slice at a time, information is acquired as a continuous helix which is then interpolated or re-binned by the scanner into a set of contiguous slices making up a volume. This allows large anatomical regions of the body to be imaged during a single breath hold, thereby reducing the possibility of artefacts caused by patient movement.

The new dental CT scanners referred to as Cone Beam Computed Tomography (CBCT) or Dental Volume Tomography (DVT) scanners (such as the i-CAT) utilise a cone beam, which radiates from the x-ray source in a cone shape, thus encompassing a large volume with a single rotation about the patient. The images are then reconstructed using algorithms to produce 3-dimensional images at high resolution. Cone Beam acquisition is very efficient and requires a lower radiation dose than a fan beam radiation source passing about the patient multiple times.

2) Conventional CT makes use of a lie-down machine with a large gantry, the maintenance of which is very costly. Furthermore, when patients lie down, the soft tissues tend to collapse. Whilst this may not be a problem for diagnostic uses, for accurate dental or surgical treatment planning a precise assessment of the soft tissues is very important and incorrect measurements may result if the patient is not scanned in the same position they will be during treatment (typically, sitting up). This is of particular importance to orthodontists when predicting the tissue changes likely to result from specific tooth movements.

Because the i-CAT is a sitting-up machine, it offers more accurate information for dental practitioners. The radiation dose from a conventional CT also does not justify taking a CT scan of, for example, a child in order to make soft tissue measurements.

3) The size of a conventional CT scanning machine precludes its installation and usage in a dental surgery. A conventional CT scanner has to be large (and utilizes heavy duty engineering) because the gantry rotates at a very high speed. The i-CAT gantry, by contrast, rotates once in approximately 20 seconds – so there is no comparison in terms of size, weight and safety requirements. The i-CAT is approximately the same size as a DPT/OPG machine which makes it compact and easy to install (Height = 183cm, Width = 127cm, Depth = 112cm taking into account the space required for rotation of the gantry). Because it rotates at about the same speed the patient safety requirements are very similar to a conventional DPT/OPG.

4) The greatest advantage that the i-CAT has over conventional CT is its lower radiation dose. The radiation exposure to a patient from a conventional CT is approximately 100-300 microsieverts (μSv) for the maxilla and 200-500 μSv for the mandible[1]. The

i-CAT

radiation exposure (for both mandible and maxilla) from the i-CAT is between 34-102 microsieverts[2] (μSv) depending on the time and resolution of the scan.

5) Scan time on the i-CAT is set at 10, 20, 40 seconds. This is comparable to conventional CT scans.

6) The i-CAT has the following advantages over the conventional CT

- Convenience of having the machine in your practice which will lead to
- Time-saving and
- Long-term cost effectiveness
- Isotropic resolution at 0.2–0.4mm cubic voxel size (as opposed to 0.25mm x 0.25mm x 1 mm non-isotropic voxels on conventional CT).
- Artefacts arising from metallic restorations are less severe.

7) The i-CAT is simple to use and training is provided by a qualified i-CAT engineer. The training required by an i-CAT operator is very similar to that required to operate a DPT or OPG. Provided adequate shielding and safe work practices are employed, the radiation dose to the operator should be negligible (certainly less than 0.3 μSv per year).

The regulations with regard to ionising radiation (National Standard for limiting occupational exposure to ionising radiation NOHSC:1013 [1995] republished March 2002; Regulation 3.3;) state that

> *"Employers are responsible for providing induction and training to all employees who may be exposed to ionizing radiation at work. The type and level of training and its method of presentation should be consistent with the characteristics of the employees to whom it is directed and with the radiation risks associated with the workplace, and should take into account appropriate consultation with the workforce. Training and induction programs should be documented and may require approval by the appropriate authority. Employee participation in training programs should be recorded and the records retained by the employer."*
> *(http://www.nohsc.gov.au/PDF/Standards/GuidanceNotes/RPS1.pdf)*

Since adequate training by way of image capturing and data interpretation is provided to any and all members of staff, there is no reason why a dentist and his staff will not be able to operate the i-CAT safely and effectively.

The i-CAT undergoes stringent critical examination by an independent Radiation Protection Agency post-installation and prior to use to ensure that all measures have been taken to control occupational, medical and public exposure. This ensures compliance with the above-mentioned and other relevant regulations.

In terms of patient positioning, conventional CT require the patient's head to be manually tilted to create images suitable for the dentist's needs (e.g. parallel to the occlusal plane, the hard palate, or the lower border of the mandible). When positioning to the lower border of the mandible, the patient's jaw is tilted quite far upward with strain to the neck, which patients find uncomfortable. An important feature of the i-CAT is that patient positioning is standard for every case. The patient's lower jaw is positioned in the chin cup and the forehead stabilised using Velcro straps if necessary. The scan is taken and the images can be re-positioned if necessary using the software.

Because the artefacts that arise from metallic restorations are less severe with cone beam reconstruction, it is less imperative to scan parallel to the occlusal plane to eliminate artefact when using the i-CAT. The patient can be positioned in a manner that is most comfortable for them.

Protocol selection (e.g., slice thickness) is often problematic with conventional CT. Occasionally, the technical scanner settings are not correct and not enough information can be gathered from the scan. This means that the patient may need to be exposed a second time using conventional CT. The options on the i-CAT allow for easy selection of either the mandible, maxilla or both with no need to select the slice thickness or how many slices are necessary thus decreasing the likelihood of re-exposing the patient. ◆

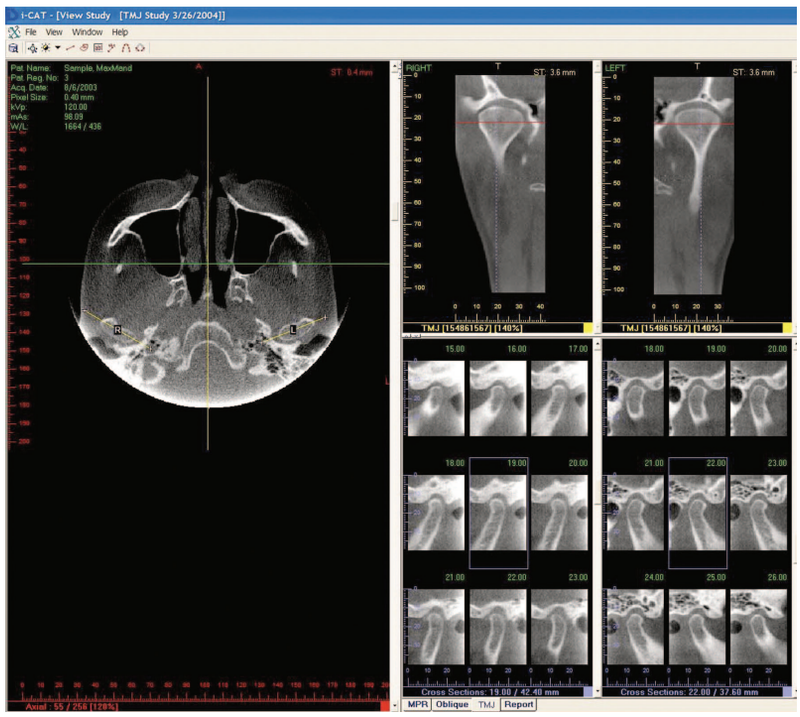

Table I:

	Conventional CT	Cone-beam CT
Design of machine	Lie-down	Sit-up
Size	Large for dental surgery	Adequate for dental surgery
Radiation Dose (maxilla and mandible)	300–800mSv	34–102mSv
Scan time	5 seconds–2 minutes	10,20,40 seconds
Training	More involved, patient positioning more difficult	Simple to use, patient positioning easy, less time-consuming

References:

1. Dula K, Mini R et al. Hypothetical mortality risk associated with spiral computed tomography of the maxilla and mandible. *Eur J Oral Sci* 1996; 104: 503-10
2. Brooks SL. Effective dose of two cone-beam CT scanners: i-CAT and NewTom 3G. Quarterly Publication of the American Association of Dental Maxillofacial Radiographic Technicians, Winter 2005