Utility of Cone Beam CT in Maxillo-Facial Radiology

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Introduction
DVT or Cone beam Computed Tomography (CBCT) is an advancement in Computed Tomography imaging that has begun to emerge as a potentially low-dose cross-sectional technique for visualizing bony structures in the head and neck. CBCT was first adapted for potential clinical use in 1982 at the Mayo Clinic Biodynamics, Research Laboratory. Exploration of CBCT technologies for use in radiation therapy guidance began in 1992, followed by integration of the first CBCT imaging system into the gantry of a linear accelerator in 1999. [1]

Successful dental treatment is always based on thorough planning and this usually necessitates the use of images. The need to assess the spatial relationships of anatomical structures and measurements and the evaluation of tissue density has all increased the prescription of three-dimensional (3D) and cross-sectional images in recent times. [2] Three-dimensional image capture and analysis had been absent in dentistry until its introduction in 1998 by Mozzo et al. [3, 4] Three-dimensional imaging techniques such as CT or Magnetic Resonance Imaging (MRI) have become increasingly important in diagnostic imaging in the head and neck. CT involves, however, a considerably higher radiation dose than conventional radiography as well as higher operating costs and a significant investment in equipment. [5, 6] The characteristics of Cone beam CT equipment are low entrance dose and higher resolution. The doses from CBCT are significantly lower than conventional CT, yet are higher than doses from the conventional views used in dentistry. As radiation dose is said to be significantly lower in comparison with CT, DVT has been recommended for general use in Dentomaxillofacial radiology for 3 dimensional imaging instead of panoramic radiography. [7, 8, 9]

Plain radiographs are the foundation for simple trauma, but for complex facial trauma, they may be complemented by other modalities such as CT. Advanced cross-sectional imaging techniques such as CT are used in dentomaxillofacial imaging to solve complex diagnostic and treatment-planning problems, such as those encountered in craniofacial fractures, endosseous dental-implant planning, and orthodontics, among others. CT with primary coronal section and multislice system with secondary reconstruction now are the accepted protocols for pre-operative planning of Zygomatico maxillary complex fractures. The advantages of CT imaging are that it provides images of thin slices of facial skeleton, overcoming the problem of superimposition of structures that inevitably occurs on plane radiograph. [11] In view of radiation exposure, CT can currently be considered as the gold standard in three-dimensional (3D) maxillofacial diagnosis. [9] It offers spatially accurate visualization of soft and hard tissue structures, wide contrast range, direct volumetric reconstructions and easy data transformation for use in 3D analyses but on the other hand, CT equipment is complex and expensive, and requires a dedicated environment and maintenance that is difficult to provide in maxillofacial surgery or a dental practice.

The first CBCT system became commercially available for Dentomaxillofacial imaging in 2001 (New Tom QR DVT 9000; Quantitative Radiology, Verona, Italy). [1, 2, 10] With the advent of CBCT technology, cross-sectional imaging that had previously been outsourced to medical CT scanners has begun to take place in dental offices. A relatively low patient dose for dedicated dentomaxillofacial scans is a potentially attractive feature of CBCT imaging. [1, 9]

Despite CBCT doses being in order of magnitude to or much below to doses for conventional CT, they are still significantly higher than those from conventional dental radiography. The potential benefits of CBCT in dentistry are undisputed; however, it is imperative that their use be fully justified over conventional techniques before they are carried out. [15] An effective dose in the broad range of 13–498 µSv can be expected, with most scans falling between 30 and 80Sv, depending on exposure parameters and the selected field of view size. In comparison, standard panoramic radiography delivers ~13.3 µSv and multi-detector CT with a similar Field of view (FOV) delivers ~860 µSv. [1]
Conclusion

This cutting edge technology is thus an ideal imaging technique not only for maxillofacial trauma but also for other practices like cleft palate, implant, periodontal surgery, temporomandibular joint and orthodontic examination. With the continued decreasing cost of CBCT technology, it is only a matter of time until CBCT finds its way into the average oral and maxillofacial radiology practice. The increased diagnostic capability combined with the lower radiation dose also will help bring this technology into the mainstream. We are now capable of obtaining significantly more data to characterize a patient’s condition. The next step is to establish how best to use these additional data in the most effective manner. The development and rapid commercialization of CBCT technology dedicated for use in the maxillofacial region will undoubtedly increase both general and specialist practitioner access to this imaging modality. CBCT is capable of providing accurate, sub-millimeter resolution images in formats enabling 3D visualization of the complexity of the maxillofacial region. Increasing availability of this technology provides the practitioner with a modality that is extending maxillofacial imaging from diagnosis to image guidance of operative and surgical procedures.

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