Basic Dental Radiology

Radiographic examination forms an important part in the diagnosis and treatment of dental pathology. Nearly every dental clinic is licensed to install one or more x-ray equipment. Teeth and jaw bones are hard tissues which show up particularly well on radiographs. Traditional setup consists of a dental x-ray tube, analog intra-oral films and processing chemicals. This is the smallest and simplest x-ray diagnostic system used in a clinic. Although simple, this setup can produce reasonable intra-oral dental radiographs with good image contrast and relatively high resolution. Pathology like dental caries and periapical infection are readily detected. Anatomical restrictions in the dentomaxillofacial region limit the projection angle to certain pre-defined planes making multiple projections at different angles difficult. Accurate dimensional measurement of the jaw bones is not possible.

Rapid advances in diagnostic imaging and computer technology have major impact in dental radiology and dental practices as a whole. More and more dental clinics are equipped with digital imaging system and panoramic machines. This equipment enhances the radiological diagnostic ability and starts to overcome the anatomical restraints. Simple linear tomography is available in most panoramic machines but inferior image quality and complicated procedure had prevented it to become a popular projection. Until quite recently, 3 dimensional and sectional imaging are not possible in a dental practice.

Computed Tomography

Computed tomography (CT) has been available in Hong Kong since early 1980's. It was used to be an expensive and sophisticated machine which would only justify to be installed in large general hospitals. Years of development has seen this technology channels down stream and becomes much more user-friendly. At present, over 10 dental practices have equipped themselves with their own in-house CT scanners and the number is growing. Contrary to helical CT, these scanners utilise cone beam technology with flat panel detector. Often referred to as cone-beam CT (CBCT) or volumetric CT (VCT), these scanners are characterised by small footprint, ultra high resolution, low radiation dose, and relatively inexpensive.

Flat panel detector of CBCT consists of amorphous silicon and it captures radiographic image of the patient in high resolution. The imaging characteristics of the detector make CBCT particularly suited for hard tissue imaging. A routine scan in the jaws can be completed with one scanner rotation, which takes 10 to 20 seconds. Conventional axial, coronal and sagittal planes do not provide the best viewing projections in the dentomaxillofacial complex. Special computer software is available to view these CT images in a curve tomographic plane that follows the dental arch. This produces more realistic and practical images that facilitate interpretation.

The typical spatial resolution in hard tissues is from 0.1 to 0.4mm. This is more than enough in most clinical situations. The radiation dose is only about 10% that of a comparable helical CT. The much reduced radiation dose and much enhanced radiological performance of CBCT have modified the selection criteria of CT. Minor clinical conditions which in the past do not justify CT because of cost and radiation dose have to be reconsidered in the light of this new development. The whole setup of CBCT has been customised to suit almost all common dental radiological diagnostic needs.

Computer Aided Treatment Planning

After CT scanning, there are a large amount of patient data in the computer. The patient’s anatomical information is stored as a 3 dimensional matrix but most viewing methods are only 2 dimensional. In order to fully utilise the patient data, clinicians have to learn to use special viewing software to produce the required diagnostic images. Apart from basic adjustment of window width and level (contrast and brightness), most viewing software allow clinicians to manipulate the images in 3D or in any origination plane. This gives clinicians a realistic perception of the patient anatomy in real time. Clinicians are now much more involved and in control in advanced imaging.
Some clinicians still prefer CT images to be printed on films for easier viewing, but numerous studies have shown there is increased distortion and loss of clinical information with printed CT images. There is significant loss in the transfer of data from scanning computer to printed films. Films, once printed, cannot be altered to suit clinicians’ preference. Digital images are best viewed digitally, i.e. by computer monitor. Similar things can be said with digital camera and printed photo.

A further development in viewing software is computer aided treatment planning. There is several planning software available in the market. They help clinicians in diagnosis and treatment planning for dental implants, orthodontics and maxillofacial surgery. Surgical template can be fabricated according to the computer planning. The template guides the surgical procedure to much higher precision. The 3 dimensional presentation of the planning is also a good communication tool to show patients the expected treatment outcome. High quality 3D images showing pre- and post-operative conditions eliminate any possible misunderstanding from patients.

The Way Forward

The development of advanced imaging in recent years is breathtaking. Just a few years ago, 3D and sectional imaging were limited to conventional helical CT. 3D reconstruction and multiplanar reformatting can only be done with CT workstations. All images have to be printed on films and viewed using light box in clinic. Today, CT scans are considered essential for multiple dental implant placements. Quite a few dental surgeons installed their own in-house CBCT largely because of high demand for dental implants. Many clinics are equipped with special software for implant planning and orthodontics.

The further development of CT in dentistry will certainly be higher infiltration of CBCT machines into dental clinics and broadening its application to almost all dental treatment. The ultra high resolution nature of CBCT makes it perfect in detecting root fracture, accessory root canals or lateral perforation. Periapical changes can be detected much earlier than conventional periapical radiograph. There is huge potential in endodontic treatment. Dentistry, as a whole, still needs some time to adapt to this rapid development in imaging. With the vastly improved diagnostic ability from CBCT, the treatment outcome becomes highly predictable. The quality of all dental patient care will be enhanced by it. One thing is sure: the change has just begun.
MCHK CME Programme Self-assessment Questions

Please read the article entitled "Computed Tomography in Dentistry" by Dr. Thomas Ka-lun Li and complete the following self-assessment questions. Participants in the MCHK CME Programme will be awarded 1 CME credit under the Programme for returning completed answer sheets via fax (2865 0345) or by mail to the Federation Secretariat on or before 30 November 2008. Answers to questions will be provided in the next issue of The Hong Kong Medical Diary.

Questions 1-10: Please answer T (true) or F (false)

1. Dental x-ray machine and intra-oral film can produce good diagnostic radiographs.
2. Periapical radiograph cannot detect early periapical changes.
3. Dimension of jaw bones can be measured accurately with analog films.
4. Cone beam CT is a form of helical CT.
5. The radiation dose for cone beam CT is 10% of helical CT.
6. Typical imaging resolution for cone beam CT is about 1mm.
7. CT images are best viewed with films and good light box.
8. The increase in demand for 3D and advanced imaging is largely contributed by the demand for dental implants.
9. Apart from dental implants, cone beam CT is not very useful in other dental treatment such as endodontics.
10. With better diagnostic imaging, the success rate of treatment will be enhanced.

Please return the completed answer sheet to the Federation Secretariat on or before 30 November 2008 for documentation. 1 CME point will be awarded for answering the MCHK CME programme (for non-specialists) self-assessment questions.

Answer Sheet for November 2008

Please return the completed answer sheet to the Federation Secretariat on or before 30 November 2008 for documentation. 1 CME point will be awarded for answering the MCHK CME programme (for non-specialists) self-assessment questions.

Computed Tomography in Dentistry

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Answers to October 2008 issue

Update on Lupus Erythematosus, Dermatomyositis & Systemic Sclerosis