Absorbed dose of radiation from dental and maxillofacial radiographic exposure in paediatric dentistry

While dental radiographs are common and it is argued that the radiation burden is negligible and consequently the risk of developing a fatal cancer from exposure to dental ionising radiation is non-existent, the effect of being exposed to ionising radiation are accumulative and young individuals run a higher risk.

Children younger than 10 years old run a risk three times higher than that of adults and children between 10 and 20 years old still run a risk twice as high as that of adults of developing a fatal cancer caused by ionising radiation. The non-threshold linear concept, derived from high-energy radiation exposure effects determined from unfortunate events such as those in Nagasaki, Hiroshima and Chernobyl, on which the stochastic effects of ionising radiation are based, has not shown that there are no effects; neither has it shown that there are. Nevertheless, until it has been proven that dental radiographs do not cause fatal cancers, we should consider them potentially harmful and we should act accordingly.

The estimated risk in adults of developing a fatal cancer from two ideally taken periapical radiographs (70 kV, 4 mA, 0.12 seconds exposure time, rectangular collimation) is 1 in 20 million, whereas the risk from a panoramic radiograph is 1 in 1,000,000.

CBCT is a great hype these days and has caused a tsunami in abundant and often unjustified use because it is marketed as being the ideal radiographic technique that provides the clinician with the ultimate 3-D images and as having such a low radiation dose that the clinician should not be too concerned. Unfortunately, the comparison is made with medical CT and not with conventional 2-D intra-oral radiography. Moreover, the huge variety of CBCT devices on the market makes these assumptions even more inaccurate. A CT scan of the skull equals about 2,000 periapical radiographs in radiation dose. A CBCT scan varies between 10 and 800 periapical radiographs in radiation dose, depending on the exposure settings (kV, mA and exposure time), field of view and resolution. Considering CBCT a low radiation dose radiographic technique is relative because this is determined by the dose of the radiographic technique with which it is being compared.

Estimating the potential risk of developing a fatal cancer induced by a CBCT scan is therefore not an easy task, but a conservative estimate is a risk of between 1 in 500,000 and 1 in 1,000,000. These figures are for adult patients and should be reassessed for children, as mentioned above. In order to put everything into perspective, the annual natural background radiation dose in Europe and the US equals about 2,500 and 5,600 periapical radiographs, respectively. Every (medical and dental) radiographic exposure has to be added to this figure.

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There are three basic principles in the internationally supported radiation protection principles in dentistry. Every radiograph should be justified (justification principle). If there are other ways of obtaining the same diagnostic information, or if a patient cannot cope with a procedure, one should refrain from taking that radiograph. Patients should never be exposed to ionising radiation for training purposes only.

Every radiograph should also be taken at the lowest radiation dose possible (ALARA limitation principle) and be of optimal diagnostic quality (optimisation principle). This may imply that the lowest radiation dose technique may not provide the best diagnostic image or that for a certain pathology the technique that will expose the patient to a higher radiation is really necessary. As long as the benefits outweigh the risks of exposing the patient to ionising radiation and the clinical examination indicated that a radiograph is necessary, the exposure is justifiable.

Translated into the dental practice, this means that CBCT is not justifiable for screening for dental decay. Bitewing radiographs are better suited for that purpose. However, if the patient is not able to tolerate intra-oral positioning of image receptors, alternatives such as oblique lateral radiographs or a panoramic radiograph may be a better solution. The latest hype is the panoramic bitewing radiograph, introduced by a major competitor on the radiology market. This technique is ideal in the above-mentioned patient case, but should not be regarded as the standard because the intra-oral technique to obtain bitewings is superior in image quality and diagnostic yield. Perhaps that may change in the future. CT may be indicated in a severe skull trauma case, where intracranial or submandibular haemorrhage has to be detected accurately for diagnostic purposes. CBCT would in that case be insufficient, but it could serve perfectly in a dentoalveolar trauma case. Each technique has its own advantages and disadvantages, but the proper knowledge of every technique will allow the clinician to make the correct and well-considered choice.
There is often confusion about absorbed dose of radiation, equivalent dose and effective dose, and these terms are often used ambiguously. The absorbed dose is a measure of the amount of energy absorbed from the radiation beam per unit mass of tissue. The official unit is the gray and used to be expressed as the rad (radiation absorbed dose; 1 Gy = 100 rad).

The equivalent dose is a measure that allows the different radiobiological effectiveness of different types of radiation to be taken into account. A radiation weighting factor (W) represents the biological effects of each type of radiation. For X-rays, this weighting factor equals 1, while for alpha particles it equals 20, meaning that the impact of being exposed to alpha particles is 20 times higher than the impact of being exposed to X-rays. The official unit of equivalent dose is the sievert and used to be the rem (roentgen equivalent man; 1 Sv = 100 rem).

The effective dose allows doses from different investigations of different parts of the body to be compared. The tissue weighting factor (Wt) has been introduced for radiosensitive organs and tissues. For example, the Wt for the thyroid gland is 0.05, whereas for the salivary glands it is 0.01.

What can dental care providers and clinicians practically speaking do to respect the rules of radiation protection? Besides justification assessment, one should try to keep the radiation as low as reasonably achievable. This can be accomplished with appropriate beam collimation and is supported by research and is mentioned in every radiology handbook on oral and maxillofacial radiology. It has been shown to be the most effective measure one can take to achieve the lowest radiation burden for the patient, while still obtaining the best-quality images possible.

Collimation indicates that the surface being irradiated is at least as small as the image receptor being used and it should only cover the area of interest. Therefore, using rectangular collimation for intra-oral radiography makes logical sense. Why should one use a circular collimator to direct X-rays at a rectangular image receptor? Using rectangular collimation, one can reduce the radiation burden to the patient by 50 per cent. The use of a proper image receptor holding device to enable aim of the X-rays perpendicular to the image receptor and the use of a rectangular collimator will also improve the image quality. The latter is because the radiation scatter, which will cause deterioration of the image, is proportional to the size of the area that has been exposed.

Lead shielding is meant to protect the patient’s tissue from accidental exposure to the primary radiation beam. The radiation that is scattered in the patient’s tissue cannot be trapped by a lead apron. In paediatric patients, it is, however, important to shield the thyroid gland, as this organ appears to be very sensitive to ionising radiation. The proper use of a lead thyroid collar or shield is also promoted in every radiology handbook and numerous scientific papers.

It is our duty as clinicians to stand guard over the safety of our patients and as long as research has not shown that dental radiographic exposure is without any risk, we should act as if it is.

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**Special needs patients: Rolling the dice**

Prof. Leda Mugayar

According to a 2005 definition by the Joint Interdisciplinary Committee for Special Care Dentistry in the UK, “individuals who have a physical, sensory, intellectual, mental, medical, emotional or social impairment or disability or, more often, a combination of those factors” are considered special needs or special care patients. It is evident from this that special care dentistry addresses the needs of a broad range of patients.

Many people with disabilities encounter medical conditions have difficulty accessing oral health services, and, consequently, achieving good oral health. The number of people with special needs living in the community and requiring oral health care has been significantly on the rise owing to improvements in medical care, the decreased need for institutional care, and changes in societal values.

Many of these individuals require additional assistance that extends beyond local anaesthesia in order to undergo dental treatment. The decision-making process regarding the selection of a method of treatment or a combination of methods that facilitate dental treatment for these individuals must be considered. The aim of such efforts is to assist oral health professionals and other parties in planning and administering oral health care to patients with special needs. Consideration must be given to planning treatment and alternative treatment modalities, as well as the implications of combinations, regarding the repeated or frequent use of these approaches.

The dental profession has developed and currently employs a number of methods to help individuals with special needs undergo dental treatment. These include general anaesthesia, sedation (ranging from minimal to deep sedation), and behavioural and physical support. The choice of one or more of the treatment modalities should only be made after careful consideration of the associated risks and benefits. It is important to consider the longevity of the treatment as part of a long-term plan for achieving and maintaining the oral health of the individual concerned. Also, improvement in terms of helping individuals receive dental care with less pharmacological, behavioural or physical support, and maintaining oral health immediately after the procedures must be addressed.

An intensive preventive programme should be introduced in order to maintain the patient’s oral health after dental procedures and to reduce the patient’s risk of developing new or recurring oral diseases in the future. In order to manage special care patients, preventive strategies combined with behavioural, psychological and, when possible, social support or intervention that lessens the need for pharmacological interventions or physical support.

Preventive interventions can therefore reduce the incidence of oral disease and consequently decrease the necessity of dental procedures. More importantly, prevention programmes do not have side-effects, unlike treatments that require the use of medication.

Finally, the pursuit of an ad hoc approach of telling the patient what to do and, instead, involving the care provider with the patient in order to understand the causative factors of the disease and to aid in selecting self-management goals to address the aetiological factors of the disease.

The ECC I results after 50 months demonstrated that children in the ECC disease management group experienced lower rates of new cavitated lesions, pain and referrals for restorative treatment under general anaesthesia in the operating room compared with baseline historical controls. An economic evaluation of the disease management model for ECC management conducted at the sites found that the additional costs of the ECC intervention were offset by the reduction in restorative and operating room care. In 2011, ECC Collaborative Phase II, also funded by the DentaQuest Institute, expanded the project to five other sites in the US over an 18-month period. The clinical outcomes were similar to those described for Phase I. At Boston Children’s Hospital, the disease management approach is now the standard of care. We have shorter waits for patients awaiting treatment in the operating room and greater flexiblity in scheduling operating room care for those patients who need it.

We conclude that a chronic disease management approach to addressing ECC utilising qualitative improvement strategies can be implemented in dental practices and has the potential to deliver better care, improve clinical outcomes and reduce costs. Further testing of the chronic disease management approach is needed in diverse settings. For a successful paradigm shift to risk-based disease prevention and management to occur, reimbursement is needed for paediatric Cardiorespiratory Arrest, non-surgical management of caries, more frequent risk-based disease management visits, education and counselling for some suitable patients. These activities are not presently reimbursable by insurance in the current US fee-for-service system.

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