Review Article

Indian Journal of Dental Education
Volume 11 Number 1, January - March 2018
DOI: https://dx.doi.org/10.21088/ijde.0974.6099.11118.4

Considerations of Radiation in Endodontics: An Update

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Abstract

The use of radiation in dentistry is now pervasive and routine. From long time back, manual techniques and advancements have surpassed a huge leap based on radiation influenced diagnosis, treatment protocol and follow up. So, as essential tools across all branches and specialties of medicine.The inherent properties of ionizing radiation provide many benefits, but can also cause potential harm. Its use within medical practice thus involves an informed judgment regarding the risk/benefit ratio. This judgment requires not only medical knowledge, but also an understanding of radiation itself.This update provides a global perspective on radiation science, risks for endodontists and its safety strategies .

Keywords: Radiation; Endodontist; DNA; IOPA etc.

Radiation exposures of patients occur in diagnostic, interventional, and therapeutic procedures. Clinics provide facilities but the current regulation is not focused on patient safety.Physicians and staff must be aware of the radiation risks and benefits associated with medical exposure, and implement the principles of radiation protection for patients as well as for themselves.

Introduction

Radiation is potentially harmful. Unfortunately, the manifestation of this harm may not be realized for upto 10 to 20 years. For many diagnostic dilemmas encountered in the practice of dentistry, periapical, bitewing, or panoramic radiography may be appropriate and sufficient. In other cases, higher and advanced radiographic techniques may be advised based on clinical need and maximizing diagnostic benefit. Even though radiographs are an indispensable diagnostic aid in endodontics, but it is important for dentists to have a basic understanding of xray radiation so that their patients, and in particular children and adolescents, are not placed in unnecessary risk. The optimum search strategy was combined with the above-mentioned terms and used to search MEDLINE from 1983 to 2015. A similar search was undertaken on Embase (1988–2013) and HealthSTAR.

Two reviewers scanned all titles and abstracts where available, and decided whether or not they were related to radiation in any way. Manual searches of reference lists of the relevant articles were also completed to identify additional publications. In addition, limited gray literature searches were conducted along with Google Scholar to identify any relevant publications that may have been missed by the electronic database searches.

Physiology of Radiation

In humans, x- ray radiation interacts primarily with water molecules, and the result of these interactions is the generation of molecular intermediaries called free radicals [1]. Free radicals are relatively unstable atoms or molecules that contain at least one unpaired electron.

Their production can initiate a cascade of events throughout the cell,damaging cellular macromolecules including DNA, proteins and enzymes, lipid, and carbohydrate molecules. Damage to DNA in the form of double strand may be more

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Received on 13.03.2018, **Accepted on** 17.04.2018

difficult to repair. In some instances, DNA can be misrepaired, and this may result in point mutations and chromosomal aberrations, both of which have been linked to the development of cancer in cells, laboratory animals and humans [2].

Radiation Sciences

Radiation risk depends on radiation dosimetry. Human exposure is directly dependent on such doses. So, a basic knowledge about different units for measurements of radiation needs to be known. They are as follows:

1. *Absorbed dose* is the concentration of energy deposited in tissue as a result of an exposure to ionizing radiation. Note: In this case, it means the energy absorbed by human tissue.
2. *Equivalent dose* is an amount that takes the damaging properties of different types of radiation into account.
3. Effective dose is a calculated value, measured in mSv, that takes three factors into account:

- The absorbed dose to all organs of the body,
- The relative harm level of the radiation, and
- The sensitivities of each organ to radiation.

Considerations for Xray Equipments

1. *Film:* use the fastest speed available – currently F-speed. Film should be processed according to the manufacturers instructions. A proper safe light should be used.
2. *Digital:* charged Couple Device (CCD), Complementary metal-oxide semiconductor (CMOS) and storage phosphor receptors are acceptable when x-ray film can be replaced.
3. *Beam Collimation:* for intraoral radiographs limit beam diameter to 6 or 7 cm or smaller at the patient's face and preferably with rectangular collimation. The rectangular restriction has been reported to decrease patient radiation absorbed dose by a factor of between 4 to 5 times without an impacting image quality [4].
4. *Lead Aprons and Thyroid Collars:* these may cover the entire front of the body, the front and back of the body to the pelvis, or only to the chest, and may incorporate different thicknesses of lead [5]. They are used to protect the gonadal tissues against scattered radiation that could potentially affect genetic material contained there [6]. So, incorporating 0.25 mm of lead is mandatory for shielding against scattered radiation.
5. *Receptor Holders*: they are beneficial and should be used to optimize alignment and minimize repeat exposures.
6. *Operator Protection*: operators should stand out of the primary beam, at least 2m away from the source, and behind a protective barrier whenever possible.
7. *Hand-Held Units*: where permitted, hand-held units should be stored in a locked facility when not in use and should always be used with a shielding ring and held close to the patient's face.
8. *Conch shell Design*: the operatory that contains the x ray unit should be made in such a way that it is protective in nature.
9. *Film Badge*: it keeps track of occupational exposure.
10. *CBCT:* when indicated and when lower-dose techniques are not sufficient, use the smallest field of view sufficient to answer the clinical question and dose minimizing procedures such as half-cycle exposures when appropriate. Imaging data sets may need to be interpreted by an oral and maxillofacial radiologist.

Results

X ray's are a part of dentistry and so is contemporary endodontics. For any given treatment, a minimum of 4 IOPA's are required which includes preoperative view, IOPA to determine working length, IOPA to visualise master cone, post obturation IOPA. With optimised calibrated equipments, the radiation exposure from a single IOPAR film is 0.0095 mSv and from a single digital IOPAR is 0.0031 mSv [7-9]. So, as per protocol, if a single endodontic treatment is performed daily, it will amount to 20 exposures per day. If any practitioner is working 300 days per year, so it will equal to 6000 exposures. For film based, it will be 57 mSv and for digital radiography it will be 18.6 mSv per year.

In endodontics, after examination of the preoperative film, usually available in the patient file, an apex locator (Root ZX) can be used to measure the working length. After complete chemomechanical debridement and master cone evaluation by a digital imaging system (RadioVisio Graphy (RVG), obturation can be performed when measurements of the electronic device and RVG are comparable. In this way radiation exposure to both the practitioner and patient can be minimised. CBCT may be considered for periapical assessment, in selected cases, when conventional radiographs give a negative finding and when there are contradictory positive clinical signs and symptoms [10].

Discussion

Adverse effects of ionizing radiation can be divided into deterministic and stochastic effects.

Deterministic effects have a threshold level below which no damage will occur and their severity increases with dose. It has been suggested that a cataract is a typical deterministic effect on the eye and may be caused by lower doses than previously considered.

Stochastic effects, including carcinogenesis, result from DNA damage [11]. Recent analyses suggest that the cancer risk to a patient from a dental radiographic examination is of the order of one in a million; the genetic risk is substantially less, about one in a billion. The risks appear to be essentially equal for full-mouth intraoral and for panoramic examinations [12,13]. Detrimental effects of radiation depends on *maximum permissible dose* which is the largest amount of ionizing radiation that one may safely receive within a specified period according to recommended limits in current radiation protection guides. It is the dose that produces very little genetic or somatic injury [14]. These estimates are numerically quite small, but the effects are severe. Thus, these risks cannot be ignored. It is important to follow ALARA principle during regular dental treatment [15]. The short term effects of radiation are primarily determined by the sensitivity of parenchymal tissues. Highly differentiated tissues such as bone marrow, oral mucosa undergo apoptosis when exposed to moderate dose of radiation.

Radiation may affect different organs at different rate during routine dental x ray. Skin cancer may develop if excess of 5 complete mouth radiographic series is taken in no time. Eyes may suffer from cataract if the dose exceeds more than 2 Gy. The thyroid gland is found to be radiosensitive and care should be taken that the dose doesn't exceed by 0.05 Gy. The x ray dose associated with leukaemia is about 50 mGy. However, the dose to reproductive cells is extremely low in dental x-ray, approx 0.005 mGy for males and 0.003 mGy for females.

Conclusion

Radiography is not a diagnostic test that should be performed routinely. Rather, it should be ordered only after completing a clinical examination, and when a historical finding, or a clinical sign or symptom suggests the presence of an abnormality that requires further investigation. Decision-making practices should yield a benefit to the patient and ultimately influence their management.

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