 DOI: 10.18231/2455-6750.2017.0012

Radiation Protection in Dental Office-A Review

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Introduction

The discovery of X rays by Sir Wilhelm Conrad Roentgen 1895 in Wurzburg, was the beginning of a revolutionary change in our understanding of the physical world. Health physics is concerned with protecting people from the harmful effects of ionizing radiation while allowing its beneficial use in medicine. Radiography as an has become an inseparable part of medical health care. This tool uses ionizing radiation which can harm both human and environment. It is used for both diagnostic as well as therapeutic purposes. As a diagnostic tool it has to be used with caution and ethics. Dental fraternity uses radiographs more alarmingly when compared to other medical specialist to diagnose and to know the treatment outcome. The more commonly used radiographs are intraoral periapical radiographs.

In olden times soon after the discovery of x-rays, its side effects were not much known or studied. And also the side effects were much simpler like skin rashes and ulcers rather than delayed ones. The use of x rays were initially limited to diagnostic areas rather than using them for any other purpose in medical field.

The use of x rays can harm both the humans as well as the environment. Different studies done in animals showed that x rays can damage normal cells, can mutate genes leading to development of cancer. As the time passed more and more delayed effects were observed by the scholars, scientist and other radiographic workers which led them to think of developing an ethical guidelines or system. As part of this, several bodies were set up like International Atomic Energy agency (IAE), World Health Organization (WHO), International Labour Organization (ILO).

Several international guidelines and regulations have been published by different bodies. One among them is published by International Commission on Radiation Protection (ICRP**)** named "1990 recommendations of the International commission on Radiological Protection publication 60."

A similar body was set by the Indian Government named as Atomic Energy Regulatory Board (AERB). The first code by this body was issued in 1986, further it was revised and amended and published 2012 November.

The primary goal in radiography is to produce diagnostic images which contributes to the treatment outcome. Therefore the image quality should be maintained.

All the organizations theoretically stick onto a principle called ALARA, coined initially by ICRP. Dental fraternity must adhere to this ALARA principle, a phrase coined 1973 by International Commission on Radiologic protection that stands for 'As Low as Reasonably Achievable'. Recently, a new concept of ALADA "as low as diagnostically acceptable" which is a modification of ALARA is being considered.(1)

There are four main concerns when dealing with radiation hazard. First, patients should not be subjected to unnecessary radiographs. Second, patient should be protected from unnecessary exposures. Third, the personnel in dental offices should be protected from unnecessary exposures in course of their work. Finally public requires adequate protection.

Adverse Effects of Ionizing Radiation

Adverse effects of ionising radiation can be of two types. Deterministic effects have threshold below which no damage occur and their severity increases with dose. For example skin erythema, hairloss, sterility. Stochastic effects results from DNA damage, including genetic hereditary and carcinogens.(2)

Effective dose: Effective dose is the tissue weighted sum of the equivalent doses in all specified tissues and organs of human body and represents the stochastic health risk to the whole body which is the probability of cancer induction and genetic effects of low levels of ionising radiation.

The effective dose for common dental imaging varies widely from 1.5micro Sieverts for intraoral radiograph to 2 .7-2.4 micro sieverts for panoramic radiograph.(3) Effective dose for CBCT ranges from 11-1073 micro Sievert.(3)

Radiation Exposures in Dentistry

Effective radiation dose for dental radiographic examination are:(4,5)

Type of exposure Effective dose {adults} in msv
Effective dose {adults} in microsieverts
Full mouth series 18 images
With PSP storage or F speed film and rectangular collimation.
With PSP storage or F speed film and round collimation. 0.035 msv
0.171msv 34.9 µsv
170.7µsv

Bitewing (4 images) with PSP storage/ F speed film and rectangular collimation.
0.005msv
5.0µsv
Cone Beam computed tomography
Dentoalveolar CBCT and medium field view.
Maxillofacial CBCT with large field of view.
0.011 – 0.674 msv
0.030 – 1.073 msv 11- 674 µsv
30 – 1073µsv
msv-milli Sievert µsv-micro sievert

Adverse Effects of Ionisation Radiation
Selected Organ Doses Corresponding to Oral and Maxillofacial Radiology Examination.[6,7]

Bone marrow Thyroid gland Salivary gland
Full mouth series (ANSI F speed film / PSP with round collimation)
134 µsv
550µsv
4110 µsv
4 bitewing radiographs (ANSI F speed / PSP with round collimation)
4 µsv
0µsv
156µsv
Panoramic radiograph (assorted CCD based systems)
Upto 20 µsv
Upto 67µsv
Upto 761µsv
Lateral cephalometric skull radiograph with a PSP sensor
5 µsv
45µsv
80 µsv
PA cephalometric skull radiograph with a PSP sensors
71 µsv
30 µsv
55 µsv
CBCT (large field)
82 – 1542µsv
183 – 10042µsv
956-11833 µsv
PSP-phosphor storage plate CBCT-cone beam computed tomography

Radiation Protection Methods

1. **Effective use of Radiographic Examination:** Guidelines for selecting patients for dental radiographic examinations have been developed to serve as an adjunct to dentists professional judgement of how to best use diagnostic imaging for patients. The concept of radiographic justification and effective use of X ray in dental practice are described in European guidelines[8] and American Dental association guideline.[9] These guidelines suggests that all X ray examinations must be justified on individual patient basis by demonstrating that the benefits to patients outweigh potential detriment. When referring a patient for radiographic examination dentist should supply sufficient clinical information to allow practitioner taking clinical responsibility for X ray exposure to perform the justification process.
2. **Equipment Factors**

Image receptors: In conventional intraoral radiography the fastest available films should be used.[8] Intraoral films of ISO speed groups E or F are recommended because they significantly reduce patient dose by more than 50%. Regarding conventional extra oral radiography the fastest available rare earth intensifying screen /film combination should be used.

Collimation: Reducing size of X ray beam to the minimum size needed to image the object of interest is an obvious means of limiting dose to patients[8] and improves image quality.[10] by reducing scatter radiation. A circular collimation of 6cm of diameter indicate considerable scope for further collimation.[11] As rectangular collimation decreases radiation dose by up to 5 fold as compared to short circular one. Radiographic equipment should be equipped with rectangular collimation for periapical and bitewing radiographs.[12] Use of rectangular long collimation results in 29% reduction to lens of eye and 38-45% reduction in thyroid exposure.[13]

Tube Voltage and Filtration: Use of 60-70kvp for intraoral radiography is considered to be a reasonable choice of limiting dose.[8]

Lead shielding: Thyroid gland is one of the most radiosensitive organs in head and neck region is frequently exposed to scattered radiation and occasionally to primary beam during dental radiography.[14] Thyroid skin exposure can be reduced by 33-84% in adults and 63-92% in children using thyroid shield.[15]

3. **Protection of Dental Professional:** Operator protection measures include implementation of a radiation protection program, recommendations for personal dosimeters and use of barrier shielding.
4. **Protection of Personnel:** Operator of radiographic equipment should use barrier protection, barriers should contain a leaded glass windows to view patient during exposure .Operator should stand atleast 6 feet from patient at an angle of 90-135 to central ray of X ray .Operators should never hold films. Film holding instruments should be used .Neither the patient nor operator hold radiographic tube housing during exposure. Suspension arm should be maintained to prevent housing movement and drift.

Means for Dental Office to Minimize Radiation Exposure:[16]

Exposure fluctuation: The exposure should yield diagnostic information that will influence patient care.

Image receptors Film: use fastest speed available – currently F speed Film should be processed according to manufactures instructions. A proper safelight used.
Digital: charged couple device, complementary metal oxide, semiconductor and storage phosphor receptors are acceptable.
Receptor holders: Use to optimise alignment and minimize repeat exposures.

Kvp, Ma and exposure time. For intraoral radiographs preferably use 60-70 kvp to optimize contrast and reduce depth dose. Reduce exposure time. Use machine with automatic exposure controls when available. If not use technique charts or other appropriate means to minimize over/ under exposures.
Operator protection: Operator should stand out of primary beam atleast 2 m away from the source and behind protective barrier whenever possible.
Patient shielding: Use leaded aprons, thyroidcollors.
Beam collimation: For intraoral radiographs reduce the beam with rectangular collimation. For all other radiographs collimate beam to area under investigation.
CBCT: When indicated and when lower dose techniques are not sufficient use the smallest field of view sufficient to answer clinical question and dose imaging procedures such as half cycle exposures when appropriate.

Cone Beam Computed Tomography: CBCT is one of the most recently used radiographic technique. CBCT technology was first described in 1998, employs a cone shaped X ray beam and a planar digital sensor.(6) There are two general classes of CBCT systems, one employs small field of view with dimensions of 8cm or less and large field of view with dimensions greater than 8cm. For small field systems, effective radiation doses ranges from 5.3 to 38.3 micro sieverts and for large field system ranges from 68 millisieverts to 1073 microsieverts.(6,7)

Implementing the concept of ALADA require strict regulation of guidelines on CBCT referrals followed by an evidence based assessment of image quality for specific diagnostic tasks with exposure and doses associated with a given level of image quality.

Conclusion

Dentist should implement radiation protection programs in their offices and should remain informed on safety updates and the availability of new equipment, supplies and techniques that will further improve the diagnostic ability of radiographs and reduced exposure. A dentist should try to keep theirs as well as the patient’s radiation exposure to the minimum as possible in order to protect from the harmful effects of radiation exposure.

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