

Radiography and Radiation Protection- Core Subject **Radiation Dose and Legislation**

Aims:

To provide an overview of dental radiography dosage and dose limitation for patients and staff.

Objectives: On completion of this verifiable CPD article the participant will be able to demonstrate, through completion of a questionnaire, the ability to:

- Identify the doses of certain types of x-rays and be able to compare this with dental radiography.
- Identify the current UK legislation relating to radiography.
- Identify some of the current guidelines relating to dental radiography.
- Know the difference between classified and non classified workers.
- Identify methods of dose reduction.

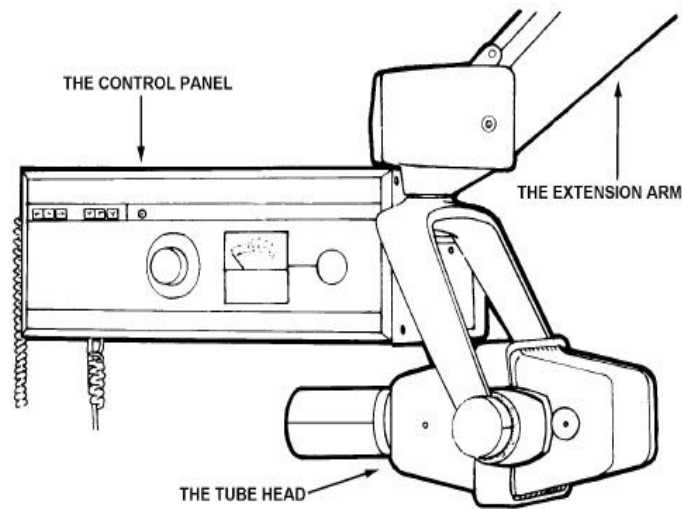
Introduction

In the dental surgery Xradiation is used to produce an image of various parts of the head or jaw. Some form of radiographic examination is necessary on the majority of our patients and as a result of this radiographs are often referred to as the clinicians' main diagnostic aid.

Dental nurses are able to complete additional training in order to take dental radiographs under the prescription of a dentist. Even if the dental nurse does not physically take the radiographs, they are still likely to be involved in the process through the processing and storing of the radiographs or through the daily care of the equipment and materials. The General Dental Council Recommend that DCPs undertake five hours of verifiable CPD on dental radiography over a five year cycle.

An estimated 20-25 million intraoral and extraoral radiographs are taken each year in the UK alone and there are an estimated 10 fatal malignancies a year from dental radiography.¹ This article will discuss the dose of various types of dental radiographs and compare this other medical radiographs. Annual dose limits to staff and the public will be advised and methods of dose reduction will be discussed.

The X-ray Machine



An x-ray tube head is a glass tube with a positive and negative terminal. This is sealed in oil and steel and then shielded in lead to control stray x-rays. X-rays only pass through a thin window down the tube head. The x-rays are only emitted when the exposure button is pressed.

Radiation Dose

A dose of 1 SV is a very large dose and enough to cause radiation injuries. However, during routine dental radiography, doses to employees and patients are measured in thousandths and millionths of a Sievert.² The table below denotes the fractions of a Sievert that are used to measure doses in radiography.

Fraction	Prefix	Abbreviation
1/1000th	Milli	m
1/1000 000th	Micro	u
1/1000 000 000	Nano	n

From the table below, if the ionising radiation dose received from types of medical radiographs are compared with that received from dental radiography, it can be seen that the dose received from dental radiography is comparatively small.

X-Ray Examination ¹	Effective Dose (mSv)
CT Chest	8.0
CT Head	2.0
Lumbar Spine	0.7
Bitewing/periapical	0.001-0.008
Upper standard occlusal	0.008
Panoramic	0.004-0.03
Lateral cephalometric	0.002-0.003
CT mandible	0.36-1.2
CT maxilla	0.1-3.3

When comparing radiation dosage it is also important to be aware that every day, we are exposed to natural background radiation. The table below highlights some natural sources of radiation that an individual receives each year from background radiation.

Radiation Source	Average Annual Dose (uSv)
Cosmic rays	300
External exposure from the earth's crust	400
Internal radiation from certain foodstuffs	370
Exposure to radon and its decay products	700

In mSv these annual amounts of radiation are equal to approximately 2.7 mSv. If this is compared to the ionising radiation that is received from a dental bitewing (0.001-0.008 mSv), it can be seen that the radiation dose received from a dental x-ray is comparatively small when compared to the natural background radiation each individual receives on a daily basis.

The dose received depends on several factors such as the equipment used and the speed of the dental film. However, to quantify this dose, if a patient asks how much

ionising radiation they will receive from a dental x-ray, we can tell them that a set of bitewings is approximately equivalent to:

- The additional radiation received on a return flight to Spain
- One days natural background radiation

Health Risks

As far as the risks to health are concerned, the probability of developing cancer from ionising radiation is derived from studies of populations that have received known and usually significant radiation doses. These include:

- The survivors of the nuclear disaster at Chernobyl.
- Radiation workers.
- Person's exposed during certain medical procedures.^{1,2}

The radiation exposures for these populations have been relatively high, with doses received mainly from acute exposures. Thus knowledge of the risk of these high levels does exist, but our knowledge of the risks at low exposure is more limited. However, it is estimated to follow a roughly linear line (figure 1) and no dosage of radiation, no matter how small, is without risk. This is called the 'no threshold theory' and we need to realise that every radiograph that is taken adds to the total amount of ionising radiation that the patient has received.¹

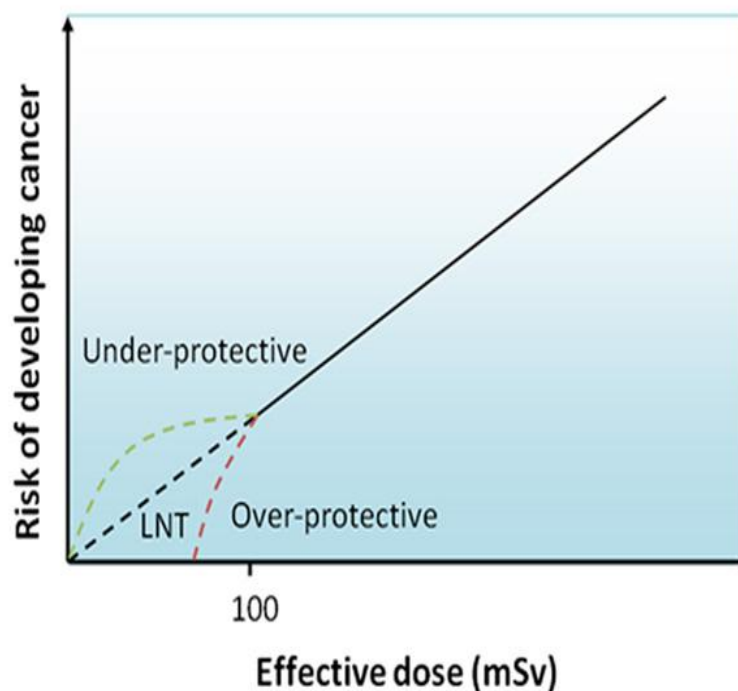


Figure 1 The Risk of Developing Cancer from Ionising Radiation

Legislation

There are two sets of regulations in the UK governing the use of ionising radiation. These are:

- The Ionising Radiation Regulations 1999 (IRR99) which are which primarily concerned with the radiographic equipment, the workers and the public.³
- The Ionising Radiation (Medical Exposure) Regulations 2000 (IR(ME)R2000) which are primarily concerned with the protection of the patient.⁴

These both form part of the Health and Safety at Work Act 1974.

Guidelines

There are also sets of guidelines. These are:

- Guidelines on Radiological Standards in Primary Dental Care.
- Selection Criteria for Dental Radiography 2nd Edn.⁵
- Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment.⁶

Dose Limitation

The international commission on radiological protection cover all aspects of radiological protection. The recommended system of dose limitation is summarised into three basic components. That is that there should be:

- Justification of practice.
- Optimisation of radiation protection.
- Dose limits for individuals at work and for members of the public.⁷

The primary concern is to keep exposures at the lowest practicable level. In English law this is known by the acronym ALARP which is keeping exposures:

As
Low
As
Reasonably
Practicable

This requirement is specifically included in the Ionising Radiations Regulations 1999 and employers deemed not to be keeping exposures as low as they reasonably can, could be at risk of prosecution.

Dose Monitoring

When work is carried out in a controlled area under written arrangements, the employer must demonstrate that doses are being restricted. The most reliable way to achieve this is for those who work in the controlled area to wear a personal dosimeter provided by an approved dosimetry service which is approved by the Health and Safety Executive.²

Individuals who work with ionising radiation are divided into two subgroups depending on the level of occupational exposure. These are:

1) Classified workers

These are individuals who receive high levels of exposure to radiation at work. An upper annual effective dose limit of **20mSv** is set for classified workers. These individuals require compulsory personal monitoring and annual health checks. If local rules are observed this is highly unlikely in dental practice.

2) Non classified workers

These individuals receive low levels of exposure to radiation at work. If local rules are observed, all dental staff should receive an annual effective dose of considerably less than the non-classified limit of **6mSv**. For this reason, regulations suggest setting dose constraints which should represent the upper level of individual dose that should not be exceeded. In a well managed dental practice and for dental radiography the following recommendations are made:

Operators- **1mSv**

Employees not directly involved with radiography and for members of the general public- **0.3mSv⁸**

Personal monitoring is not compulsory, although it is recommended if the risk assessment indicates that individual doses could exceed 1 mSv per year. The 2001 Guidance notes state that in practice this should be considered for those staff whose weekly work load exceeds 100 intra oral or 50 panoramic films per week, or a pro-rata combination of each type of examination.¹

Reducing the Dose

There are some simple methods that can be employed to reduce the dose of ionising radiation when taking dental radiographs.

- A faster film can be used. Using an E speed film can reduce the amount of ionising radiation by 50% and using an F speed film gives an additional 20% benefit.
- A rectangular collimator offers a 40% reduction.
- Digital x-rays can dramatically reduce the dose.
- Film holders and beam aiming devices can reduce the dose by reducing the amount of retakes that may be required.

Personal Protective Equipment



With regards to PPE, a lead apron is only usually required by the operator carrying out an exposure and only then if it is necessary to assist the patient or hold the film during an exposure.

There is usually no justification to routinely provide the patient with a lead apron which has been shown not to shield the internal scatter of radiation within the body. However, the exception to this is in the case of a patient who is, or may be, pregnant.²

Justification

An IRMER practitioner is the person who takes responsibility for an individual's medical exposure. This would be the dentist or DCP that is qualified to take a dental radiograph. "No exposure can take place unless it is justified by the IRMER practitioner."² For an exposure to be justified the benefit to the patient from the diagnostic information should outweigh the detriment of the exposure.

When justifying an exposure the IRMER practitioner should take into account many factors such as:

- "The specific objectives and the characteristics of the individual involved.
- The total potential diagnostic benefit to the patient.
- The individual detriment that the exposure may cause.
- Alternative available techniques.
- The information supplied by the referrer, including information available from previous radiographs."²

So basically the justification for the taking of a dental radiograph should be made on an individual basis. It is also important to ensure that the radiographs are not only justified but that their justification is recorded when the notes are taken. It isn't enough to write "2 bitewings and 1 OPG". It is important to write why the radiographs were taken. For example "two bitewings were taken to assess for interproximal caries". The findings then need to be recorded.

The frequency that radiographs may be taken depends on factors such as caries risk. The following table gives the recommended frequency that radiographs may be taken depending on the selection criteria⁶.

Selection Criteria	Adult
New patients to assess dental diseases and growth and development	Patient specific bitewings and selected periapicals (PA)
Growth and development	One-off PA or panoramic
High caries risk	Bitewings 6 months
Moderate caries risk	Bitewings annually
Low caries risk	Bitewings at 2 year intervals
Periodontal disease or history of periodontal disease	Patient specific radiographic examination

The justification for the frequency that radiographs are taken must be clearly marked in the patient's notes.

Quality Assurance

Both the IRR(99) and IR(ME)R 2000 place clear, but different responsibilities on the legal person to establish and maintain quality assurance programmes in respect of dental radiography. The WHO define quality assurance as “An organised effort by the staff operating a facility to ensure that the diagnostic images produced by the facility are sufficiently high quality so that they consistently provide adequate diagnostic information at the lowest possible cost and with the least possible exposure to radiation.”⁸

The aims of a quality assurance programme in dental radiography are:

- To produce radiographs that are of a consistently high standard.
- Reduce the number of repeat radiographs.
- To highlight sources of error so that they can be rectified.
- Reduce costs.
- Increase efficiency.
- To ensure that radiation doses to patients (and staff) are kept as low as reasonably practicable. (ALARP).¹

The essential procedures relate to:

- Image Quality

- Patient dose and x-ray equipment
- Darkroom, films and processing
- Training
- Audits

A dental radiography audit has already been examined in a previous CPD4dentalnurses CPD article, and quality assurance programmes within dental radiography will be discussed in more detail in a future article.

Conclusion

Dental Care Professionals are advised to carry out 5 hours of verifiable CPD on the subject of radiography. This article has discussed the dosages of ionising radiation in dental radiography and compared this with ionising radiation produced by other types of medical x-ray and that received through natural background radiation. Dose limits to patients and members of staff have been discussed and methods of dose reduction have been touched upon.

More information on dental radiography and the IRR and IRMER regulations can be found through the non-verifiable CPD section of the website. Don't forget to update your non-verifiable CPD logs.

References

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8. WHO (1994) Quality Assurance in Dental Radiography. Available at: <http://whqlibdoc.who.int/publications/1982/9241541644.pdf> (accessed 23rd March 2012)