Radiography: Digital Radiography, Legislation and Statutory Requirements

Aims: To develop an understanding of the history of digital radiography, the different types of digital x-rays and the advantages and disadvantages of digital dental radiography, the different types of digital radiographs and to outline the legislation and statutory requirements relating to ionising radiation in dental practice.

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

- Have knowledge of the difference between direct and indirect digital radiography.
- Identify the two types of corded sensors used in digital radiography.
- Identify the advantages and disadvantages of digital radiography.
- Identify some of the different types of digital radiographs.
- Be able to explain some of the requirements of the IRR17 and IR(ME)R2017 regulations.

Introduction

Radiography is an invaluable tool for the dental team, providing information that is impossible to obtain by clinical examination alone.[1] Digital radiography is now a common technique which is used in dentistry. It is a reliable and versatile technology that expands the diagnostic and image-sharing possibilities of radiography in dentistry.[2]

Even if a dental practice is only using digital images, the conventional x-ray equipment is still used (x-ray tube), and this means that the same regulations still apply. A dental practice that is only using digital radiography still needs to adhere to the regulations.

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

- The Ionising Radiation Regulations 2017(IRR17) which are which primarily concerned with the radiographic equipment, the workers and the public and are enforced by the Health and Safety Executive.[3]

- The Ionising Radiation (Medical Exposure) Regulations 2017 (IR(ME)R17), which are primarily concerned with the protection of the patient. These are enforced in the UK by: The Care Quality Commission (CQC) in England; the

Healthcare Inspectorate Wales (HIW) in Wales; the Scottish Executive (SE) in Scotland; and, the Regulation and Quality Improvement Authority (RQIA) in Northern Ireland.[4]

These both form part of the Health and Safety at Work Act 1974. The regulations in Northern Ireland have also been updated to IRR(NI)2017 and IRMER(NI)2018.

Additionally, dental professionals must adhere to the guidance provided by the Health and Safety Executive (HSE) and the Faculty of General Dentistry (FGDP) (College of General Dentistry).

When a digital system is introduced to a dental practice, the necessary computer hardware and software needs to be installed, and staff need to undergo appropriate training in the use of the software and computer maintenance of the images. When adopting this system, risk assessment and auditing should still be completed by the dental practice.

History of Radiography

X-rays were discovered in 1895 by the German physicist Wilhelm Conrad Roentgen and the first dental radiograph was taken two weeks later by Otto Walkoff, a German dentist who placed small photographic plates wrapped in a rubber dam in his own mouth and exposed them for 25 minutes.[5] The first digital x-ray sensors were introduced in the 1980's by Francis Mouyen.[6] The first digital system only acquired the image but it could not be stored. Per Nelvig and his colleagues soon developed a more comprehensive system, and this was quickly improved upon by more manufacturers'.[5]

Initially, most systems used an 8-bit contrast resolution but, with the development of computers and computer software, this has improved, and sensor systems now capture images at 12-16 bit depth. This higher bit depth improves the image quality.[6]

In recent years, three-dimensional reconstruction and rendering of radiographic image data has been introduced in the form of cone beam computed tomography (CT) and local CT which offer a higher resolution with much lower doses of radiation to the patient.[7]

Digital radiography is now a reliable and versatile technique which can be used in dental practice to improve the diagnostic and sharing possibilities of radiographs in dentistry.

Direct and Indirect Digital Radiography

Digital x-rays can either be captured using a direct or indirect method.

Indirect images are captured by using a digital camera or scanning and digitalising a film captured image.[8] This method is time consuming and it is still necessary to take and process a conventional film. It does not increase the information available from the original radiograph, it simply turns the image into one that can be read and analysed by a computer.[9]

However, once the image has been digitalised, possibilities exist for it to be contrast enhanced and it can be shared electronically with ease.

Direct images are divided into two types, Real time or corded and Photostimulable Phosphor Storage Plate or cordless.[10] Both types are available to use with intra-oral systems and extra-oral systems.

Real time or Corded

These systems use conventional film generating equipment but the film is replaced by a solid-state sensor which is built around a special electronic chip consisting of an array of x-ray sensitive elements called pixels.[11] The solid-state systems are called Charge Coupled Device (CCD) or Complementary Metal Oxide Silicon sensors (CMOS), depending on the technology used to create the chip. [12]

These systems work because the pixels are sensitive to x-ray photons and to light photons and this makes it possible to add a layer of luminescent crystals on top of the pixels which produce light when hit by x-ray photons. The sensor is connected to the computer by a cable and the electronic information produced by the pixels is transferred through the cable to the computer.[13]

Fig. 1 Corded Digital Radiograph Sensors[14]

Photostimulable Phosphor Storage Plate or cordless

These sensors are based on a different technology. A thin plate of synthetic material is coated with a layer of phosphor crystals and some of the energy of the x-ray photons is stored into the phosphor layer during radiographic exposure. A scanner is required to read the image information from the plate. It does this by scanning the plate with a laser beam of near-red wavelengths which releases the energy from the phosphor layer and converts it into a digital image which is then stored on the computer.[15]

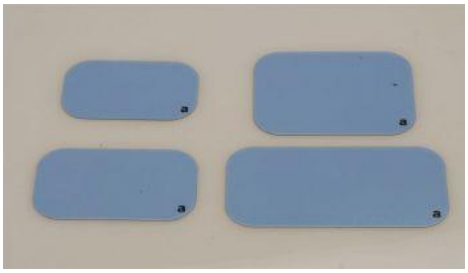


Fig. 2 Cordless Digital Radiograph film[16]

Advantages of Digital Radiography

1. Dose Reduction –

This is considered to be one of the major advantages of using digital radiography in comparison to conventional films. Although the dose per radiograph for digital sensors is lower than the dose required for a conventional film, it is sometimes necessary to take more radiographs to gain the same amount of diagnostic information. This is due to the size of the digital intra oral detectors which are sometimes smaller than conventional films, therefore more radiographs may need to be taken. Positioning of the digital detectors can sometimes prove more difficult which can also result in more retakes.[17]

2. Processing –

There is no need for conventional processing and therefore this avoids the processing faults which can sometimes occur with conventional film processing. This also eliminates any risks involved with handling, storage and disposal of processing chemicals making it more environmentally friendly.[18]

3. Storage –

It is easy to store digital x-rays as they are archived directly into the patient's records and computer software often prevents the deletion of an image from the patient's record once it has been committed to the file. This reduces the risk of misplacing x-rays.[19]

4. Sharing Images –

The radiographs can easily be shared to other surgeries in the practice or to other dental professionals by electronic transfer.[20]

5. Image Quality/Manipulation –

Contrast and density can be altered with computer software to improve the quality of a digital image. Some software programs also allow the user to perform on screen measurements which can be very accurate. It is possible to magnify a digital image.[21]

Disadvantages of Digital Radiography

1. Data Security –

The computer system needs to be backed up so that the images remain secure. Explicit consent must be gained before taking radiographs. [22]

2. Expense –

The initial cost of providing this type of system and software can be expensive.

3. Viewing the image –

It is necessary to have a computer monitor in a suitable position within the surgery to enable the operator to view the image on the screen. Reflection of bright lights on the screen need to be avoided as this will affect the quality of the image the operator is viewing.[23] If the image is printed onto photographic paper it can compromise the quality of the image.[24] However, as the quality of printers and software is advancing rapidly this is becoming less of a disadvantage.

4. Placement of corded sensors –

Placement of corded sensors can be difficult due to the cord attached.

5. Tampering of images –

Clinical imaging software should always store a copy of the original image before it is enhanced in any way, however third-party software does exist which could allow images to be tampered with. Software programmes can be installed that contain audit trails to track down and recover original images.[25]

Types of Radiographic Images

Bitewing Radiographs:

These show the upper and lower teeth in a focused area of the mouth, usually for detecting cavities, interproximally, overhangs, checking the fit of a crown or bridge and detecting bone loss from periodontal disease. The beam is aimed at a slight downward angle to the horizontal plane.[26,27]

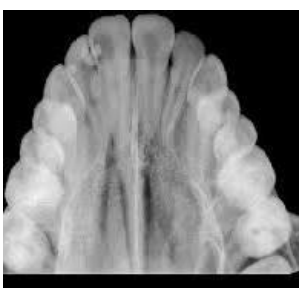
Periapical Radiographs:

Captures the entire tooth from the crown to the root, including surrounding bone. They are useful for diagnosing issues with the root, abscesses, or bone structure. The beam should meet the film/tooth at right angles. [26,27]

Panoramic Radiographs (Panorex):

A broad, two-dimensional image that captures the entire mouth in a single image, including the teeth, upper and lower jaws, sinuses, and jaw joints. It's used for detecting impacted teeth, jaw fractures, tumours, and growth abnormalities. They can be used to establish baseline records for new patients. The X-ray tube head and the image receptor (usually a film or sensor) move in an arc around the patient's head. The beam should be centered properly to ensure the full dental arch is captured in a single image. [26,27]

Occlusal Radiographs:



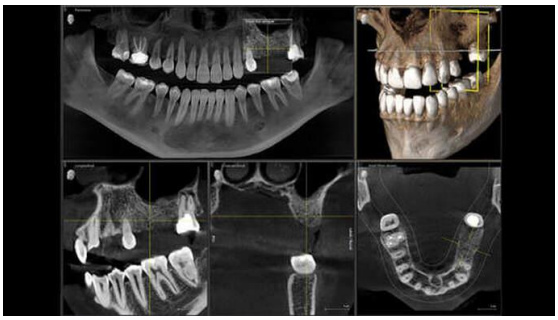
Larger radiographs that display the full arch of the teeth in either the upper or lower jaw. These are often used to locate extra teeth, jaw fractures, or growths. The tube is aimed at a steep upward or downward angle. [26,27]

Cephalometric Radiographs:

A side-view X-ray of the entire head, mainly used in orthodontics to examine the relationships between the teeth, jaw, and skull. In younger patients, cephalograms help predict how the face and jaws are expected to grow, aiding in planning, the timing and type of orthodontic treatment.

Flat panel detectors are used to capture the planar image. They can be stand-alone units or some CBCT machines can generate 2D cephalometric images from the 3D data they collect, offering an integrated solution where both 2D cephalometric views and 3D CBCT scans are captured in one session. [26,27]

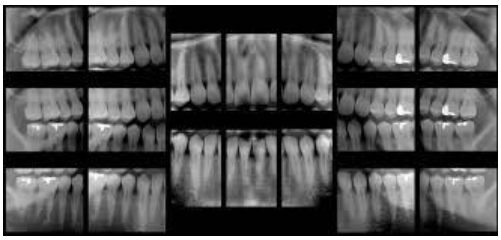
Cone Beam Computed Tomography (CBCT):



A 3D imaging method used to visualize the teeth, soft tissues, nerve pathways, and bone in a three-dimensional perspective. It is particularly useful for complex dental procedures like implant placement, orthodontics, endodontics and TMJ disorders.

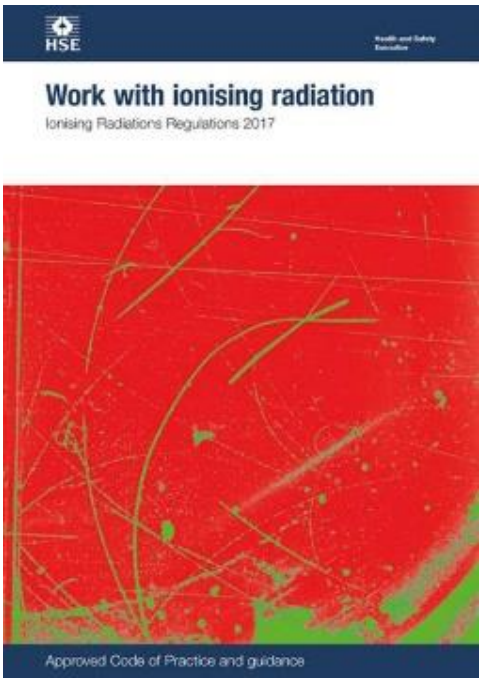
The machine emits a cone-shaped X-ray beam that rotates around the patient's head, capturing multiple images from various angles. The captured images are combined by specialized software to create a 3D representation of the area being examined. [26,27]

Full Mouth Series:



A comprehensive set of intraoral X-rays that include both bitewings and periapicals. This provides a complete picture of a patient's oral health. [26,27]

The Ionising Radiation Regulations 2017 (IRR17)[3]



IRR17 is made under the provisions of the Health and Safety at Work Act 1974 and came into force on January 1st, 2018. The Approved Code of Practice and guidance will help employers comply with their duties under the IRR17.[28]

The IRR17 are primarily concerned with the radiographic equipment, the workers and the public and are enforced by the Health and Safety Executive. The legislation covers:

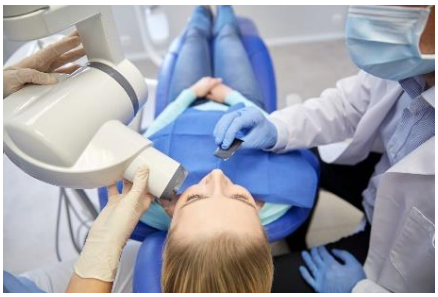
- Registration with the HSE.
- Equipment, including critical examinations.
- The appointment of a Radiation Protection Advisor (RPA) and Radiation Protection Supervisor (RPS).
- Dose limits for occupational exposure. Radiation doses to staff and other persons must be kept as low as possible and must not exceed the specified dose limits. Dose assessments must be carried out and recorded.
- Design of dental and radiography facilities including safety and warning signs and contingency plans. The employer must prepare a contingency plan designed to ensure, as reasonably practicable, the restriction of exposure to ionising radiation and the health and safety of people who may be affected by a radiation accident. These should arise from the risk assessment and should be included in the Local Rules
- The designated controlled area.
- Radiation risk assessment.
- Personal Protective Equipment.
- Information, instruction, and training.
- Local rules.
- Training.[28,29]

The legal person and employee must:

- not knowingly expose themselves or any other person to x-rays to an extent greater than is reasonably necessary for the purposes of their work.
- exercise reasonable care when working on any aspect of dental radiology.
- Immediately report to the legal person whenever they have reasonable cause to believe that an incident or accident has occurred with the x-ray equipment and they or some other person has received an overexposure.

The full IRR17 regulations can be downloaded from the end of this article in the further reading section, as can the Approved Code of Practice and Guidance.

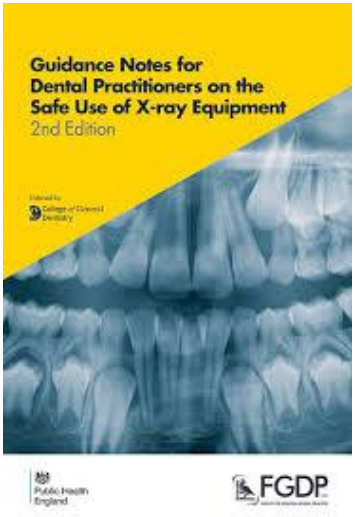
The Ionising Radiation (Medical Exposure) Regulations 2017 (IR(ME)R17)[4]



IR(ME)R17 is primarily concerned with safeguarding the patient and other exposed people, including comforters and carers. These are enforced in the UK by: The Care Quality Commission (CQC) in England; the Healthcare Inspectorate Wales (HIW) in Wales; the Scottish Executive (SE) in Scotland; and the Regulation and Quality Improvement Authority (RQIA) in Northern Ireland. It involves ensuring that every exposure of ionising radiation to the patient is justified, that positions of responsibility are defined, and that there is quality assurance programme.

The full IR(ME)R17 regulations can be downloaded from the end of this article in the further reading section.

Guidelines



The Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment 2nd edition were published in 2020. They set the standards for the safe use of x-ray equipment within dental practice in line with IRR17 and IR(ME)R17.

Other guidance documents include:

- Guidelines on Radiological Standards in Primary Dental Care.
- Selection Criteria for Dental Radiography 3rd edn (2018).

Registration with the Health and Safety Executive

Dental practices must inform the Health and Safety Executive (HSE) that they work with ionising radiation. Employers must apply to the HSE for certain work they do with ionising radiation, and it is an offence to work with x-ray generators without doing so. The HSE has developed a graded approach to registration perceived on the risk associated with using ionising radiation.

Depending on the level of risk of the ionising radiation work, the employer may need to apply to:

- Notify
- Register
- Get consent

Dental x-ray equipment has been put in the middle grade, requiring registration. Registrations in England, Scotland and Wales all require an application to be submitted to HSE via a dedicated website at https://services.hse.gov.uk/bssd/, along with the registration fee.

In Northern Ireland, the application for a registration must be submitted to the Health and Safety Executive for Northern Ireland via this address https://www.hseni.gov.uk/services/apply-registration-or-consent-hseni .

The Employer

In the IRR17 and IR(ME)R17, the term ‘employer’ typically refers to the individual or organisation responsible for ensuring compliance with the regulations and health and safety issues in the workplace where ionising radiation is used. All employers must have written procedures in place covering all aspects of radiography and radiation

protection in the workplace, and the staff involved. This will include "providing a framework of written procedures, protocols and QA programmes within which the various duty holders undertake their functions."[29]

Radiation Protection Supervisor

The Radiation Protection Supervisor (RPS) is responsible for overseeing the safe use of radiation in dental procedures, ensuring compliance with regulations, and implementing safety protocols to minimise radiation exposure to both patients and staff. In particular, they supervise the arrangements set out in the local rules. The legal responsibility for supervision, however, lies with the employer. Ideally, the person appointed as the RPS will be an employee who works closely with dental radiography.

Radiation Protection Advisor

Under IRR regulation 14, a Radiation Protection Advisor (RPA) must be appointed who has the required knowledge and experience for the employer's type of work. This is an individual who provides expert advice and guidance on radiation safety practices. RPAs assist dental practices in implementing and maintaining effective radiation safety programmes, ensuring compliance with regulations, conducting risk assessments, and advising on equipment selection to minimise radiation exposure to patients and staff. The Guidance Notes state that the advice given by RPAs should cover the following:

- Prior assessment of installation plans.
- Acceptance into service of engineering controls, design features, safety and warning devices in relation to new or modified radiation sources.
- Drafting and review of risk assessment, local rules, and contingency plans.
- Designation of controlled and supervised areas and subsequent requirements.
- Working arrangements for pregnant employees.
- Calibration of radiation monitoring equipment and checks on its condition.
- Personal protective equipment.
- Designation of classified persons and personal dosimetry.
- Training programmes.
- Prevention, investigation, and analysis of accidents.
- Quality assurance.
- Periodic testing of engineering controls, design feature, safety and warning devise and regular checking of systems of work.

Consultation with an RPA for any advice on any of the matters indicated in bold is specifically required under section 14. An RPA or RPA body must have current certificates to demonstrate knowledge of the HSE's current criteria of core of competence.[29]

A list of individuals and RPA bodies holding current certificates can be found at:
http://www.rpa2000.org.uk/list-of-certificate-holders/ and
https://www.hse.gov.uk/radiation/rpnews/

Dose Limitation

Radiation doses are discussed in the CPD article, “The Basic Concepts of X-Radiation, Radiation Doses in Dental Radiography and the Potential Risks of Exposure to Ionising Radiation”, and is available on the website.

The International Commission on Radiological Protection[5] 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

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 2017 and employers deemed not to be keeping exposures as low as they reasonably, could be at risk of prosecution.

Roles and Functions Defined Under IR(ME)R17

IR(ME)R17 identifies the following 4 duty holders and each of these have clearly identified responsibilities under the regulations:

1) **The Employer** (as previously discussed).

2) Referrer - a referrer is a registered practitioner, “who is entitled in accordance with the employers’ procedures to refer individuals to an IRMER practitioner for medical (or

non-medical) exposure. The referrer is responsible for ensuring that sufficient clinical information is provided to enable the IRMER practitioner to decide whether the exposure can be justified."[29] In the dental practice it is likely that the referrer and practitioner will be the same person.

3) Operator - These are individuals who are entitled in accordance with the employer's procedures, to carry out all or part of the practical aspects that are associated with radiography. This could include any of the following:

- Patient identification.
- Positioning of the image receptor, the patient, and the x-ray tube head.
- Setting exposure parameters.
- Pressing the exposure button.
- Processing radiographs.
- Interpreting and reporting of radiographs or dental CBCT images.
- Exposing test objects as part of the quality assurance programme.

4) Practitioner- 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. For an exposure to be justified, the benefit to the patient from the diagnostic information should outweigh the detriment of the exposure. The IRMER practitioner should also consider exposures to "comforters and carers" when justifying the exposure to ionising radiation. A carer and comforter are individuals who help support the person undergoing the exposure.

Justification of exposure is covered in the article Radiography: Irmer and IRR – Radiation and Statutory Requirements in Dental Practice, and is available on the website.

Medical Physics Expert

Under regulation 14 of IR(ME)R17, a Medical Physics Expert (MPE) must be appointed. The MPE plays a crucial role in ensuring compliance with radiation safety regulations, including IRMER. They provide expertise in the safe and effective use of radiation in medical procedures, advise on equipment selection and calibration, conduct quality assurance testing, advise on optimisation of doses to patients and contribute to staff straining and radiation protection measures. The RPA and MPE may be the same person as long as they have the RPA2000 certification and are also listed as an MPE by RPA2000.[3] A list of certificate holders can be found on the following website https://www.rpa2000.org.uk/list-of-certificate-holders/ .

Local Rules

Local rules must be provided for every controlled area. Local rules are a set of key working instructions for restricting exposure and include procedures for normal work as well as contingency plans for accidents and incidents and must be drafted with the RPA.

The Approved Code of Practice and Guidance gives the following information for content that should be included in the local rules:

Essential contents:

- The dose investigation level specified for the purposes of regulation 9 of IRR17.
- Identification or summary of any contingency arrangements indicating the reasonably foreseeable accidents to which they relate (regulation 13).
- Name(s) of the appointed RPS(s) (regulation 18(5)).
- Identification and description of the area covered, with details of its designation (regulation 19(1)).
- A summary of the working instructions appropriate to the radiological risk associated with the source and operations involved, including the written arrangements relating to non-classified persons entering or working in controlled areas (regulation 19(3)).[28]

Optional Contents

Employers may also find it useful to include a brief summary or reference to the general arrangements in that area for:

- Testing and maintenance of engineering controls and design features, safety features and warning devices;
- Radiation and contamination monitoring;
- Examination and testing of radiation monitoring equipment;
- Personal dosimetry;
- Arrangements for pregnant and breastfeeding staff;
- Details of significant findings of the risk assessment, or where it can be found;
- A programme for reviewing whether doses are being kept as low as reasonably practicable and local rules remain effective;
- Procedures for initiating investigations etc;
- Procedures for contacting and consulting the appointed RPA;
- Details of the management and supervision of the work; and,
- Procedures for ensuring staff have received sufficient information, instruction and training.[28]

Training on the employer's local rules can be provided by in staff training.

Conclusion

Several studies have compared the diagnostic performance of conventional film and digital systems and in general digital systems are as reliable as traditional radiographs. All members of the dental team need to be trained when using conventional

radiography or digital radiography. Staff that carry out duties related to radiography such as processing should be trained sufficient to their role and safety. All of the regulations still apply when using digital radiography and risk assessment and auditing should still be completed by the dental practice.

Digital radiography is a reliable and versatile technique which can improve the diagnostic possibilities of radiography in dentistry.

The essential legal requirements of IRR(17) and IR(ME)R17 regulations still need to be adhered to, even if a dental practice is only using digital radiography.

Personal Development Plan and Reflective Learning

This CPD is linked to the following GDC Enhanced CPD Development Outcome:

C. Maintenance and development of knowledge and skill within your field of practice.

Reflective learning is now a requirement of the GDC Enhanced Professional Development Scheme. As such, you will now be given the opportunity to answer some reflective learning questions, before your certificate is generated. This can be updated at any time but, f you take a few moments to write your reflection on completion, you will have fulfilled the Enhanced CPD requirements.

The full IRR(17) and IR(ME)R(17) regulations can be reached by clicking on the links

below:

IRR(17)
IR(ME)R17
IRR(17) Northern Ireland
IR(ME)R18

Further Reading

Health and Safety Executive (2017) Work with Ionising Radiation Ionising Radiations Regulations 2017 Approved Code of Practice and Guidance
Public Health England (2020) Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment 2nd Edition

References

1.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
2.Van Der Stelt, P.(2005) Filmless imaging The uses of digital radiography in dental practice. *Journal American Dental Association*. 136 pp.1379-1387.
3. Health and Safety Executive (2017) Work with Ionising Radiation Ionising Radiations Regulations 2017 Approved Code of Practice and Guidance. Available at: https://www.hse.gov.uk/pubns/priced/l121.pdf (accessed 20/09/2024)
4. The Ionising Radiation (Medical Exposure) Regulations (2017) Available at: https://www.legislation.gov.uk/uksi/2017/1075/pdfs/uksi_20171075_en.pdf (accessed 20/09/3024)
5.Van Der Stelt, P.(2005) Filmless imaging The uses of digital radiography in dental practice. *Journal American Dental Association*. 136 pp.1379-1387.
6.Versteeg, C., Sanderink, G. and Van Der Stelt, P. (1997) Efficacy of digital intra-oral radiography in clinical dentistry. *Journal of Dentistry*. 25 pp.215-224.
7.Van Der Stelt, P.(2005) Filmless imaging The uses of digital radiography in dental practice. *Journal American Dental Association*. 136 pp.1379-1387.
8.Whaites, E. (2002) Essentials of Dental Radiography and Radiology. 3rd Edn. London: Churchill Livingstone.
9.Versteeg, C., Sanderink, G. and Van Der Stelt, P. (1997) Efficacy of digital intra-oral radiography in clinical dentistry. *Journal of Dentistry*. 25 pp.215-224.
10.Whaites, E. (2002) *Essentials of Dental Radiography and Radiology*. 3rd Edn. London: Churchill Livingstone.
11.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
12.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
13.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
14.Slide Player (2019) Available from: https://slideplayer.com/slide/6634297/ (accessed 20/09/2024).
15.Van Der Stelt, P.(2005) Filmless imaging The uses of digital radiography in dental practice. *Journal American Dental Associatio*n. 136 pp.1379-1387.
16.RDH (2019) Available from: https://www.rdhmag.com/patient-care/radiology/article/16407716/best-practices-and-patient-comfort-with-digital-intraoral-radiography (accessed 20/09/2024)
17.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
18.Whaites, E. (2002) *Essentials of Dental Radiography and Radiology*. 3rd Edn. London: Churchill Livingstone.
19.Whaites, E. (2002) *Essentials of Dental Radiography and Radiology*. 3rd Edn. London: Churchill Livingstone.
20.Van Der Stelt, P.(2005) Filmless imaging The uses of digital radiography in dental practice. *Journal American Dental Association*. 136 pp.1379-1387.
21.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
22.Versteeg, C., Sanderink, G. and Van Der Stelt, P. (1997) Efficacy of digital intra-oral radiography in clinical dentistry. *Journal of Dentistry*. 25 pp.215-224.
23. Whaites, E. (2002) *Essentials of Dental Radiography and Radiology*. 3rd Edn. London: Churchill Livingstone.
24.Whaites, E. (2002) *Essentials of Dental Radiography and Radiology*. 3rd Edn. London: Churchill Livingstone.
25.Faculty of General Dental Practitioners UK (2004) *Selection Criteria for Dental Radiography*. 2nd Edn. London. Faculty of General Dental Practitioners UK.
26.Colgate (2024) Available at: https://www.colgate.com/en-us/oral-health/x-rays/types-of-x-rays (accessed 21/09/2024)
27.IHS.Gov (2024) Available at: https://www.ihs.gov/dentalcde/documents/Chapter%203%20-%20Radiographic%20technique.pdf (accessed 21/09/2024)
28.Health and Safety Executive (2017) Work with Ionising Radiation Ionising Radiations Regulations 2017 Approved Code of Practice and Guidance. Available at: https://www.hse.gov.uk/pubns/priced/l121.pdf (accessed 20/09/2024)
29.Public Health England (2020) Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment 2nd Edition. Available at: https://www.rqia.org.uk/RQIA/files/44/449bdd1c-ccb0-4322-b0df-616a0de88fe4.pdf (accessed 20/09/2024)