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The Consistent Image – How to Improve the Quality of Dental Radiographs: 2. The Image Receptor, Processing and Darkroom/Film Handling

Abstract: The two papers in this series aim to discuss quality assurance as applied to dental radiography. 'The Ionising Radiation Regulations'[1,2] emphasize the need for quality assurance programmes wherever radiography is being undertaken. A written quality assurance programme is good practice. This second paper deals with the image receptor, processing and darkroom/film handling.
Clinical Relevance: Utilization of digital imaging will eliminate processing and darkroom errors but may introduce new categories of error.
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Image receptors

Until recently, images were only recorded on radiographic film, however, digital radiography is becoming increasingly popular as dental practices obtain computer-based practice management systems. Digital receptors are available which include phosphor storage plates or those with a 'flex' such as CCDs and CMOs.

Intra-oral radiography

Obviously, with any system it is important not to damage the receptor. Intra-oral film should be stored away from the x-ray source.

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Panoramic radiography

Screen film should be stored away from any x-ray or light source. It is important that it is stored upright, thus avoiding pressure effects. It should also be stored in a dry environment. Cassettes should be checked for light tightness and screen/film contact. This can be done with a test object or graph paper inserted into the cassette. A low exposure is made and the resultant film processed. The graph paper should be seen evenly throughout the entire image and there should be no dark areas which might suggest a faulty cassette.

Digital radiography

The phosphor plates can be quite delicate and prone to scratches. In addition, they need to be cleared of the previous image prior to further use. This means that they may be stored on top of a light viewing box.

Processing

Processing errors are a major source of non-diagnostic films. As more practices obtain automatic processors, then processing errors should reduce, as quality control is far easier to manage compared with manual processing.[3] However, marks from some automatic processors can become obtrusive. This can be reduced by regular cleaning of the roller mechanism following the manufacturer's recommendations as to frequency. Obviously, the use of digital imaging will eliminate this category. Each morning it is useful to put a cleaner film through the system to pick up chemical residues of the transport mechanism. Depending on the processor, regular checks on temperature, chemical levels, etc should be carried out. A common error is a pale film due to underprocessing, often as a result of exhausted developer (Figure 1). However, it is impossible to tell from a pale film

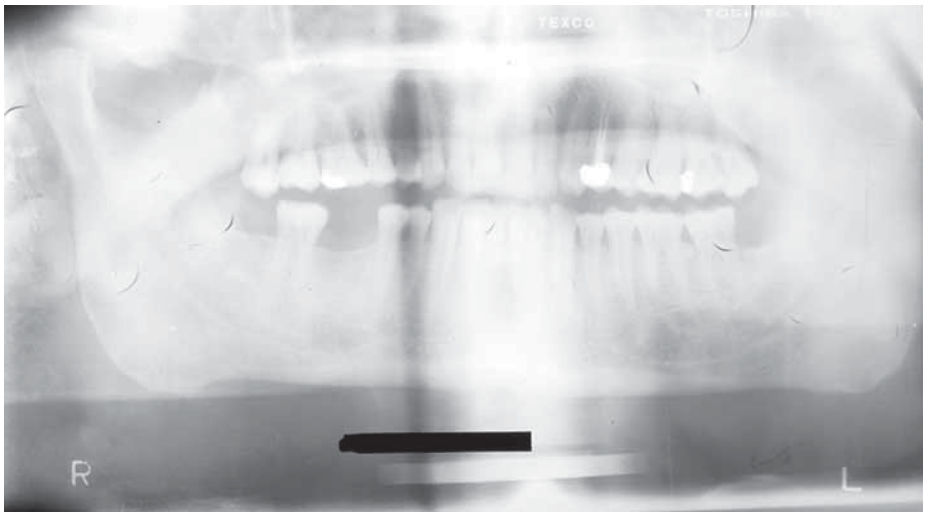

Figure 1. Pale film caused by underexposure or underprocessing. In addition there are multiple nail/crimp marks and the patient has been incorrectly positioned (chin up).

Figure 2. Home-made step wedge (test object) used for monitoring processing.

Figure 3. Appearances of radiograph of step wedge. Image on right would be the reference film and that on the left the possible image obtained if the developer was exhausted.

whether this is a result of underexposure or underprocessing. It is for this reason that processing should be monitored. Exposure factors should only be increased for repeats when the operator is sure that processing is optimal and therefore not the cause of the fault. How often the chemicals need replacing depends on the throughput of films and the type of processor, although with most processors, chemicals should be changed at least every 3 weeks. In an American study, 30.6% of dental practitioners asked, admitted to changing the chemicals only once a month, and 13.4%, only when needed.[4] Manufacturers' guidelines should be followed, including the timing of the service. Sensitometric strips are available to allow monitoring of processing. An alternative is to use a test object of some sort. The best test object is a step wedge. This can be purchased, but a home-made step wedge is readily constructed (Figure 2). A series of layers of lead foil from an intra-oral film sellotaped to the film giving 0–5 layers works well as a test object. If this is exposed at a standard distance and time and then processed using fresh chemicals, it can be used as a reference film. Thereafter the test object can be exposed, processed and the subsequent films compared with the reference film (Figure 3). This can be done daily or weekly. If carried out weekly, it is worthwhile increasing the timing of the test in the 2–3 days up to the expected expiry date.

The National Radiological Protection Board (NRPB) supplies a QA pack that is designed to last 3 years and has a ready-made test object (Figures 4 and 5). They will supply the reference film, which should be exposed on the dentist's own X-ray set and which is then processed, under ideal conditions, by the NRPB.

Darkroom/film handling

Errors may result from poor darkroom technique or film handling, such as crimp marks, bends in the film, fingerprints, chemical splashes, fogging and static (Figures 1 and 6). If using a dark room, light tightness should be checked and the coin test carried out at regular intervals.[5] A coin test can also be used to test daylight automatic processing hoods for light tightness. A piece of extra-oral film should be 'flash exposed' to x-rays. Lay coins along the film, cover with light-proof card and then uncover a coin every 15–30 seconds with the safelight on. Once developed, if the outline of any coins of those uncovered for less than a minute is seen, then the safelight is not safe.[5,6]

Film should be stored as recommended by the manufacturers. This should be in a dry, cool environment and the film supplies should be monitored in case the expiry date has been reached. Stock rotation is important to ensure the newest film is used after older film. Screens should be regularly cleaned with a proprietary cleaner using a lint-free cloth.

Chemical disposal is an important environmental issue. Silver traps should be used to collect silver from fixer and companies offer a service for disposal of waste chemicals.

Information regarding films, storage, stock control, etc. should be kept in the Radiation Protection File, which is described in the Guidance Notes.

Other factors

Valuable diagnostic information can be retrieved from an overexposed film by the use of correct viewing conditions. Viewing boxes should also be considered in a QA programme, particularly if adjacent bulbs of different illumination are used. Other equipment factors should also be included, such as checking cassettes for

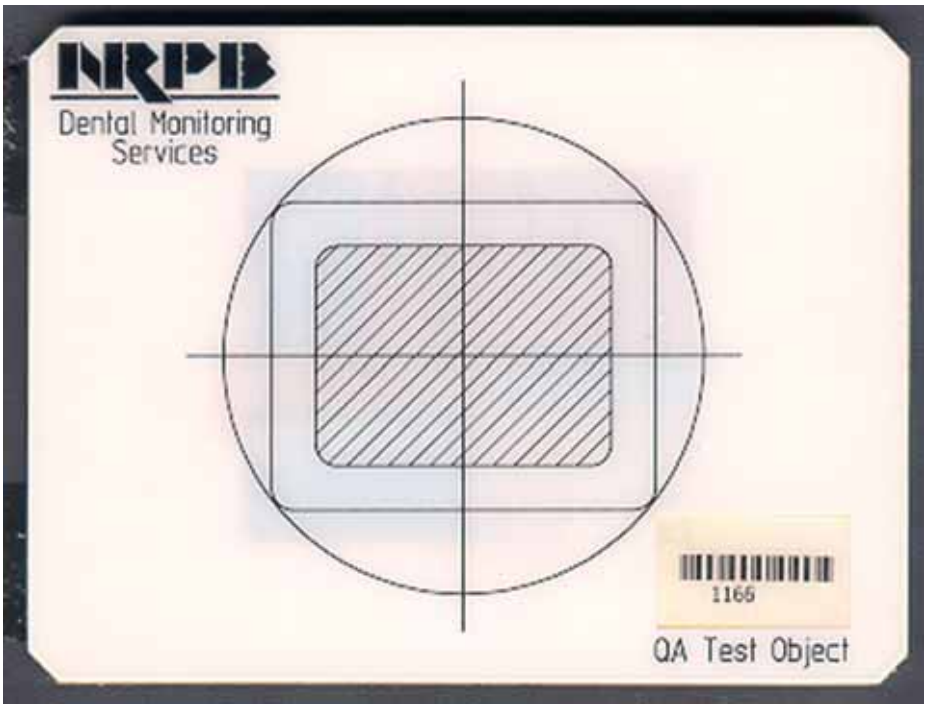

Figure 4. Test object supplied by NRPB.

Figure 5. Radiograph of NRPB test object.

Figure 6. Periapical radiograph which has been exposed to light prior to development (apart from where a finger has been holding it), ie fogging.

light tightness and screen/film contact. Film/screen contact can be tested by inserting a piece of graph paper into the cassette with an unexposed film. By covering the exit port with a thin sheet of lead (eg lead foil from film packet) and giving the lowest exposure available, the image of the graph paper should be seen. The lines should be crisp and regular. Any blurring suggests poor screen/film contact.

The light tightness of the cassette can be tested by leaving a loaded cassette in a light place for about an hour and then processing it. If any dark areas are seen once the film is developed this may indicate a faulty cassette.[6]

For intra-oral radiographs, once an excellent image has been obtained, it is important to mount these properly. They should be correctly labelled as to patient identity and date. Practices often do not have the luxury of a laminator but proprietary film mounts are available.

Radiation protection file

This should include all information pertaining to ionizing radiation, including The Local Rules, training, stock control, etc. It can be overwhelming for one individual to carry out all that is required for a QA programme. Most of the tasks can be delegated to different staff members, but one individual should have overall responsibility. Too often, QA is forgotten until a non-diagnostic film has been produced, which necessitates a retake. It is better to be proactive rather than reactive. It is also worthwhile to keep an excellent quality check film on the viewing box as a quick reminder of what all films should look like.

Conclusion

The errors arising from processing and the darkroom or film handling are very important. Processing should be monitored using a test object. Also, to reiterate from the previous paper, image quality should be continually assessed, but a formal assessment of image quality (film reject analysis) should be carried out at least every 6 months.[7] Film holders with beam aligning devices should be used for intra-oral radiographs.

Light beam diaphragms and other positioning aids should be used for panoramic radiography. Exposure times should be optimized and a list of exposure factors should be kept beside each X-ray set.

References

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