Case Report

A note on digital dental radiography in forensic odontology

Sher-Lin Chiam
Specialist Forensic Odontology, General Dental Practitioner, Australia

Abstract

Digital dental radiography, intraoral and extraoral, is becoming more popular in dental practice. It offers convenience, such as lower exposure to radiation, ease of storing of images, and elimination of chemical processing. However, it also has disadvantages and drawbacks. One of these is the potential for confusion of the orientation of the image. This paper outlines one example of this, namely, the lateral inversion of the image. This source of confusion is partly inherent in the older model of phosphor storage plates (PSPs), as they allow both sides to be exposed without clue to the fact that the image is acquired on the wrong side. The native software allows digital manipulation of the X-ray image, permitting both rotation and inversion. Attempts to orientate the X-ray according to the indicator incorporated on the plate can then sometimes lead to inadvertent lateral inversion of the image. This article discusses the implications of such mistakes in dental digital radiography to forensic odontology and general dental practice.

Key words: Forensic odontology, identification, dental, digital radiography

Address for correspondence:
Dr.Sher-Lin Chiam,
Unit 2., 51Jenke Circuit,
Kambah, ACT, Australia 2902

Introduction

Radiographs are an integral part of dental practice. In clinical dentistry, intraoral and extraoral radiographs are integral part of diagnosis of dental disease and treatment planning.

While in forensic odontology, radiographs are an implicit part of practice used mainly in identification and age estimation. Radiographs allow shapes of restorations and anatomical structures otherwise not visible at clinical examination.[1,2]

The tenet of identification by dental means is the comparison of antemortem records with postmortem records. Records include dental charts, written records, and dental radiographs. Radiographs are important when comparing consolidated antemortem with postmortem information.[3-5] Radiographs are nonabstract and observable when antemortem and postmortem data are presented to the end users of forensic odontological reports.[3] Indeed, "A picture is worth a thousand words", attributed to French leader Napoleon Bonaparte is an apt allegory here.

Access this article online	
Website: www.jfds.org	Quick Response Code
DOI: 10.4103/0975-1475.137072	

However, radiographs are obtained through a multi-step procedure, and as outlined later in the text, operator error can be introduced at different stages.[6,7] The main errors that will be presented and discussed are those that lead to difficulties or mistakes in orientation of the radiographs and the possible ramifications arising from that.

Focus of this paper is as follows:

- The inversion of the right and left marker orthopantomographs (OPG), causing the image to be laterally inverted
- The reverse placement of phosphor storage plate (PSP) receptor for intraoral dental radiograph resulting in confusion of the right and left.

Both of these errors can result in potential problems in practice as illustrated by the case examples presented here.

Case Report

- An adult male was referred for an extraction of lower left erupted carious third molar under local anesthetic. It was noted that on OPG, when placed in the correct orientation for viewing according to the indicator, the carious tooth to be extracted was the right lower third molar. Consultation before the procedure and confirmation with previously obtained periapical radiographs confirmed that OPG was laterally inversed [Figures 1 and 2]
- As illustrated above, the indicator in the digital intraoral radiograph can help with orientating an X-ray. This is the case provided that the correct side of the receptor has been placed toward the X-ray tube. This is illustrated with an example [Figures 3-5].

Discussion

There are several different types of radiograph of interest to dentistry.

They can be categorized by the purpose and views required. Bitewings or periapical radiographs are used for intraoral views, and OPG are used for extraoral views. They can also be classified by method of acquisition into either digital or analog radiographs.

Regardless of the method of acquisition, radiographs are obtained by exposure of ionizing radiation to a receptor.

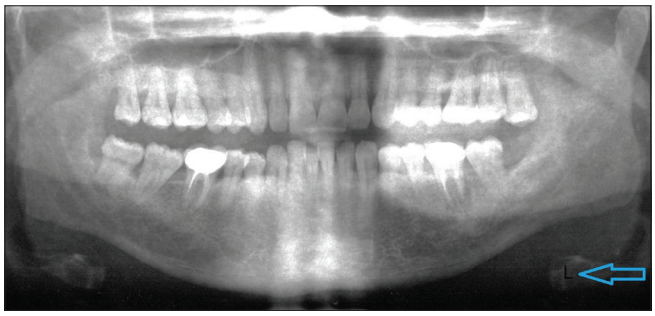

Figure 1: Laterally inverted OPG. The "L" indicated by the arrow means left. OPG = Orthopantomographs

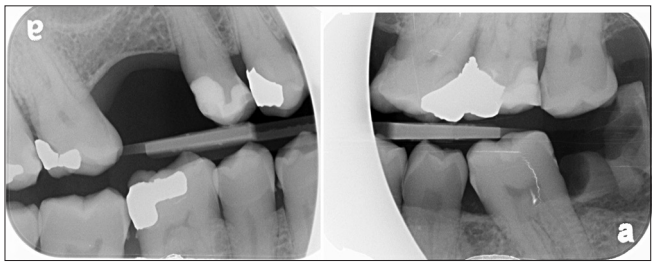

Figure 3: The above is a set of bitewings taken with the correct side facing the tube and the indicator in the correct orientation. In the right bitewing, the indicator is on the top distal corner while in the left bitewing, the indicator is the left distal corner. (Note: the common operator error – cone cutting)

The receptors can be analog radiographic films or digital charge-couple devices (CCD) plates and PSPs. The exposed receptor containing the latent image is then processed to produce the final visible image. Analog dental radiographic films require a chemical process to develop the latent image, whereas digital receptors require a computer to process the stored information into a visual image on a computer monitor. All of these receptors, analog and digital, have only one recommended surface of exposure toward the source of radiation.[8] To help with film placement, the analog dental intraoral radiograph has an embossed dot on the film that serves as an indicator for the surface for exposure. As for digital and film OPG, "R" for right or "L" for left is indicated on the receptor and these are transferred to the final radiographic image.

Figure 2: Periapical radiograph of the same patient showing tooth 38. Note "a" in the corner, when the PSP is used with the correct side facing the X-ray source, and if placed with the indicator to the distal, a lower left radiograph should have the "a" positioned such as in this model of phosphor plate intraoral radiograph receptor. PSP = Phosphor storage plate

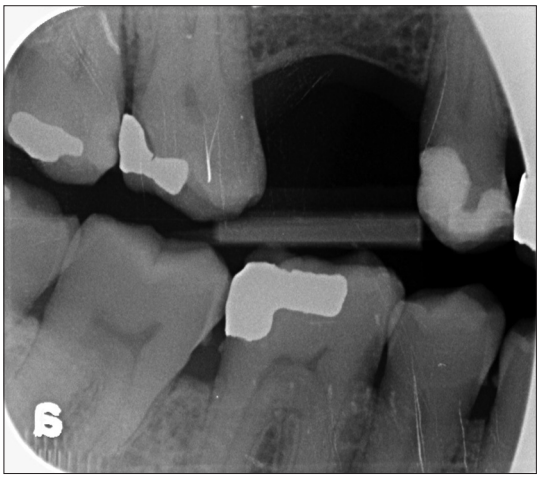

Figure 4: This is the same right bitewing taken with reversed placement. The exposure is done with the correct side of the receptor not facing the X-ray source. Note the only clue is the indicator appearing on the lower right distal corner of the image; the contrast and clarity of the image is not affected

Figure 5: This is the same radiograph as the one in Figure 4. It was laterally rotated to correct the alignment of the indicator, resulting in an inversion of what was a right bitewing into a left bitewing

In digital intraoral radiographs, the indicator may be marked on CCD plates and phosphor plates. These indicators are reproduced on the resultant image on the monitor. The embossed dot on an exposed dental intraoral film and the indicator on digital receptors in the resultant images allow orientation of the radiographs when viewing, giving a guide to the site of exposure. There may be protocols as to how the X-ray should be placed. For example, in bitewings, it may be recommended that the embossed dot on an analog film be placed in the distal portion of the quadrants, and in a periapical view, the embossed dot might be placed in the occlusal area. This is analogous with the indicator on digital receptors. The indicators also help with proper mounting for viewing and comparing the images.[7] This may not always be the case in practice; nevertheless, an experienced clinician is usually able to identify the region the radiograph is obtained from based on characteristics of the different teeth and surrounding structures together with the position of the indicator when the receptor has been placed with the recommended surface toward the radiation source in digital radiographs. However, this may become a problem when the radiograph is viewed at a later date or by a different operator.

PSP intraoral receptors come in different sizes analogous to the plain dental radiographic films. The lack of an attached wire, unlike CCD receptors, makes their use similar to plain film X-rays and thus easier to use as most clinicians are familiar with analog films. However, the recommended side of exposure in some older model is not as obvious compared with CCD receptors for the same reason.[6] Reverse placement of the receptor has been reported.[6,9] More recent receptors have an indicator incorporated to help orientate films. However, at least in one older model, when the wrong side of the receptor is exposed, there is no visual clue to indicate the reversed placement.[9] When this happens, a clinician might confuse the right and left side, especially when there are no, or few restorations, or lack of distinctive characteristics.

Unlike analog periapical films where the characteristic "herring bone" appearance, due to the lead lining incorported on the reverse side of the film,[7] provides a clue to the fact the exposure has been done on the wrong side of the film, this is not apparent in PSP receptors. Certain types of digital intraoral radiographs do not provide any indicators equivalent to the embossed dot on analogous films. This is further complicated by the fact that most native or included software viewers for dental radiographs allow rotation and lateral inversion of the image.

Inverted or reversed placement of the digital PSP OPG system[7] receptor has been reported to cause confusion of the true left and right.[6] Backward placement of OPG cassette[10] may have caused the lateral inversion of the OPG films in the case examples.

In clinical practice, failure to detect this error can result in initiation of procedures on the wrong tooth or site, especially when this error is not detected in patients with few distinctive characteristics to help orientate the radiograph. For example, in bitewings of fully dentate individuals with the absence of existing restorations. In addition, dental records are legal records; when legal disputes arise, inaccurate records can be confusing and problematic.[2]

Some may argue that in routine practice, if the clinician who takes the X-ray is the end user, the clinician should be able to orientate the X-ray to allow meaningful analysis and correct interpretation. However, if the X-ray is used for a referral, this may cause confusion as to the area of interest and result in a procedure being carried out on the wrong tooth or site.

In forensic dentistry, radiographs are of high diagnostic and analytical value.[5,11] They give assurance and weight to decisions of identification.[4,5,12-15]

Non-radiographic dental records alone have been shown to be a valuable source as the different permutations and combinations of patterns of missing and filled teeth may allow identification to be done with a certain degree of confidence.[16] However, such records have also been shown to contain mischarting, incorrect reports, and even fraud.[2,11,17,18] Therefore, radiographs have always been considered as more reliable. McKenna states that radiograph provides "irrevocable evidence".[12] Forrest and Wu state that radiographs "are a direct representation of a physical item and are an objective method of recording information", whereas clinical notes are less reliable especially when recording may not even be done by the clinician.[11] Wood and Kogon mentioned that few odontologists would be

confident enough to depend solely on non-radiographic records and that X-rays are important component in identification.[5] Radiographs are also useful when few restorations are present, where other anatomical features may be used such as root morphology, canal, trabecular bone pattern, and sinus radiographic outlines.[1-3,13,19]

When dental records are required to be submitted as antemortem records (and this can occur months or years since last visit or treatment), the clinician responsible for submitting the records may have forgotten about the error or may overlook the mistake.

It is important to submit original and full records[19,20] even though some records may seem irrelevant. Full records afford the opportunity and possibility of this error being noted by the dentist who receives the antemortem record for transcription into antemortem chart. Otherwise, errors of this nature can result in exclusion due to visually obvious non-matching of X-rays. Furthermore, partial recovery of remains or inexperienced forensic odontologists may lead to exclusion, particularly in mass fatality incidents where multiple reconciliations are required.

In a disaster victim identification (DVI) situation, this problem can be magnified when the number of victims is large. DVI is a complex process, especially when different nationalities are involved, and where different disciplines are required to work together for the process to work. This usually involves multidisciplinary collaboration and numerous people working within each discipline to collate information under the challenging physical and political backdrop of the inherent chaos that accompanies the event.[21] Within the forensic odontology discipline, there will usually be teams working in each section with rotation of personnel in a large-scaled DVI. Quality management comprising quality assurance and control has been given much attention. The complexity of a large-scale operation with information (antemortem and postmortem data) coming from different sources and often at different points of time throughout the process provides the potential for complications.[21-23] The compilation and management of information becomes a Herculean task.

Often, multiple antemortem dental records from one potential victim can come from different practitioners and may be only made available at different points during the progress of the DVI process. Dental records can be handwritten or computer generated; the task of collating and consolidating records and X-rays for each possible victim is an onerous one. In addition, there can be a large amount of postmortem information by virtue of the sheer number of victims involved. For example, in the Thai tsunami, as many as 200 dental radiographs were obtained in a single day.[24] This, together with many other challenges that are inherent in a large-scale DVI process, e.g., physical and mental fatigue or when records are from international sources with different languages and systems of recording, can further complicate the process.[25]

Sweet (2010) mentions the importance of original records.[19] One of the reasons why original X-rays are important is that original analog X-rays allow unambiguous identification of the correct site.

Digital clinical record keeping is becoming more popular. Digital radiographs do not allow physical verification of the orientation unlike analog dental radiographs. This applies to films that have been scanned or photocopied, and this important information may not be transmitted correctly.[19] With scanned digital radiographs, mistakes have been made where the radiographs have been scanned in a reversed order.[24]

Conclusion

Identification by comparison of dental features is a primary scientific method that is "stand alone" identification in DVI Interpol guidelines. In routine practice, a majority of cases are confirmatory, where possible identification has already been made and a dental identification is needed to confirm other evidential or circumstantial finding.[14] The task of matching antemortem and postmortem radiographs is one where judgment is required as differences may be explainable.[13-15] The Australian Society of Forensic Odontology recommends the inclusion of statements about the consistencies and lack of irreconcilable discrepancies in reports of cases of established identification.[23] The occurrence of errors in the interpretation of antemortem and postmortem radiographic or digital images will lead to incorrect identifications. This will have disastrous consequences for the integrity of the entire investigation.

Forensic odontologists do not have complete control of the antemortem evidence submitted; it is not possible to check the whole trail and history of the evidence to ensure that evidence submitted is true and correct. Quality checks can be done, e.g. through direct communication with the dentist who submitted the evidence to confirm records but this can only go so far. In DVI situations, original records may not be submitted[25] and communication with the treating dentist can be difficult especially where the records are from overseas. It is important to include in statements and reports, descriptions of the evidence as they were received.

In other areas of clinical practice, being aware of the possibility of such error can save some difficult and troublesome medicolegal problems at a later stage.

References

1. Wood RE. Forensic aspects of maxillofacial radiology. Forensic Sci Int 2006;159:S47-55.

2. Hinchliffe J. Forensic odontology, Part 1. Dental identification. Br Dent J 2011;210:219-24.
3. Forrest AS. Collection and recording of radiological information for forensic purposes. Aust Dent J 2012;57:24-32.
4. Nicopoulou-Karayianni K, Mitsea AG, Horner K. Dental diagnostic radiology in the forensic sciences: Two case presentations. J Forensic Odontostomatol 2007;25:12-6.
5. Wood RE, Kogon SL. Dental radiology considerations in DVI incidents: A review. Forensic Sci Int 2010;201:27-32.
6. Chiu HL, Lin SH, Chen CH, Wang WC, Chen JY, Chen YK, *et al*. Analysis of photostimulable phosphor plate image artifacts in an oral and maxillofacial radiology department. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:749-56.
7. Evelyn M. Thomson BSDH, MS, Orlen N. Johnson BS, DDS, MS. 2007. Essentials of Dental Radiography for Dental Assistants and Hygienists-9th Ed. Pearson Education, Inc. ISBN-10: 0-13-801939-8, ISBN-13: 978-0-13-801939-6. STAT!Ref Online Electronic Medical Library. http://online.statref.com/Document.aspx?fxId=190 and docId=1. [Last accessed on 2014 Feb 28].
8. Brennan J. An introduction to digital radiography in dentistry. J Orthod 2002;29:66-9.
9. Phosphor Storage Plate (PSP) Reversed Image Prevention. USAF Dental Evaluation and Consultation Service. Available from: http://airforcemedicine.afms.mil/idc/groups/public/documents/afms/ctb_108728.pdf' [Last accessed on 2012 Oct 11].
10. Backward Cassette Placement with Panoramic X-Ray Machines (2004) USAF Dental Evaluation and Consultation Service. Available from: http://airforcemedicine.afms.mil/idc/groups/public/documents/afms/ctb_108745.pdf' [Last accessed on 2012 Oct 11].
11. Forrest AS, Wu HY. Endodontic imaging as an aid to forensic personal identification. Aust Endodont J 2010;36:87-94.
12. McKenna C. Radiography in forensic dental identification--a review. J Forensic Odontostomatol 1999;17:47-53.
13. Pretty IA, Sweet D. A look at forensic dentistry--Part 1: The role of teeth in the determination of human identity. Br Dent J 2001;190:359-66.
14. Pretty IA, Pretty RJ, Rothwell BR, Sweet D. The reliability of digitized radiographs for dental identification: A Web-based study. J Forensic Sci 2003;48:1325-30.
15. Raitz R, Fenyo-Pereira M, Hayashi AS, Melani R. Dento-maxillo-facial radiology as an aid to human identification. J Forensic Odontostomatol 2005;23:55-9.
16. Adams BJ. Establishing personal identification based on specific patterns of missing, filled, and unrestored teeth. J Forensic Sci 2003;48:487-96.
17. Borrman H, Dahlbom U, Loyola E, René N. Quality evaluation of 10 years patient records in forensic odontology. Int J Legal Med 1995;108:100-4.
18. Delattre VF. Antemortem dental records: Attitudes and practices of forensic dentists. J Forensic Sci 2007;52:420-2.
19. Sweet D. Forensic dental identification. Forensic Sci Int 2010;201:3-4.
20. Hill AJ, Hewson I, Lain R. The role of the forensic odontologist in disaster victim identification: Lessons for management. Forensic Sci Int 2011;205:44-7.
21. Lake AW, James H, Berketa JW. Disaster victim identification: Quality management from an odontology perspective. Forensic Sci Med Pathol 2012;8:157-63.
22. Kvaal SI. Collection of post mortem data: DVI protocols and quality assurance. Forensic Sci Int 2006;159:S12-4.
23. AUSFO. Disaster Victim Identification Forensic Odontology Guide Version 2. Australian Society of Forensic Odontology. Available from: http://www.ausfo.com.au/images/members_only/AUSFO_Disaster [Last accessed on 2012 Oct 11].
24. James H. Thai tsunami victim identification overview to date. J Forensic Odontostomatol 2005;23:1-18.
25. De Valck E. Major incident response: Collecting ante-mortem data. Forensic Sci Int 2006;159:S15-9.

How to cite this article: Chiam S. A note on digital dental radiography in forensic odontology. J Forensic Dent Sci 2014;6:197-201.

Source of Support: Nil, **Conflict of Interest:** None declared