CLINICAL ARTICLE

Fraudulent management of digital endodontic images

P. Güneri & B. G. Akdeniz
Department of Oral Diagnosis and Radiology, Ege University School of Dentistry, İzmir, Turkey

Abstract

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Aim To present examples of radiographic image reconstructions in endodontic treatment, to discuss the potential problems arising from the use of image processing software and to mention some current methods to prevent such counterfeit utilization of digital endodontic radiographs.

Summary Conventional Ultra-Speed periapical films of root canal treatment were digitized with a flatbed scanner (Umax Powerlook II, Umax Technologies, Inc., Taiwan). Digital images were altered with PHOTOSHOP 6.0 software (Adobe Corporation, San Jose, CA, USA). Carious lesions, periapical pathoses, fake root canals and artificial fillings were created, and inadequate treatment was corrected by application of various image manipulation functions of the software.

Key learning points

- Digital endodontic images can be altered with image processing software.
- The use of digital radiographic data inevitably raises concerns about security, reliability and the potential for fraud.

Keywords: digital imaging, endodontics, image processing, radiographic images.

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Introduction

Developments in dental imaging have enabled dental researchers to assess and evaluate even minor changes in alveolar bone, to detect peri-implant bone healing, and to identify caries more accurately (Matteson *et al*. 1996, Versteeg *et al*. 1997). Digital imaging has several potential advantages over conventional methods particular in the immediate acquisition of images (Frederiksen 1995), patient education (Lavelle 1999), eradication of film processing chemicals and equipments (Vandre & Webber 1995), storage of the images indefinitely (Wenzel 1998), reduced patient exposure to radiation (Hayakawa *et al*.

Correspondence: Pelin Güneri, Department of Oral Diagnosis and Radiology, Ege University School of Dentistry, İzmir 35100, Turkey (Tel.: +90 232 3881081; fax: +90 232 3880325; e-mail: peleen_2000@yahoo.com/pelin@dishekimligi.ege.edu.tr).

1997) and enhancement of images (Wenzel *et al*. 1993, Fuge *et al*. 1998, Friedlander *et al*. 2002). In endodontic practice, instantaneous production of radiographic images, as well as numerous image processing algorithms, places a particular value on digital radiographic techniques (Horner *et al*. 1993). Reduction of chair-side time, and the possibility of repositioning the X-ray tube head while maintaining the original sensor position when a different angulation is desired are amongst other potential benefits of digital radiography in endodontics. Additionally, most of the digital systems provide the capability to electronically manipulate the image stored in the computer without additional radiation exposure to the patient (Kerosuo & Ørstavik 1997). Hence, proper and accurate determination of radiographic canal length, technical quality of treatment and healing outcome can be rapidly achieved with digital imaging systems (Borg & Gröndahl 1996). However, it is also reported that the image enhancement features of digital radiography allow mishandling or potential abuse (Tsang *et al*. 1999). It has been shown that by using various software packages created for graphic design and image manipulation, digital information can be altered, added or removed (Horner *et al*. 1996). Studies investigating the potential fraudulent use of digital radiography have warned that unethical practitioners may attempt to manipulate radiographic images in order to mask an unsatisfactory treatment, or a treatment that has not been performed (Horner *et al*. 1996, Tsang *et al*. 1999). If it is possible to modify the digital radiographic data to obtain authorization from insurance companies as suggested by Tsang *et al*. (1999), it may be possible to adapt images to endorse a particular medication, method or approach, even when the truth may be to the contrary. Particularly in endodontics, both the inital diagnosis and the final result of a treatment are established via radiographs, and therefore, manipulation of radiographic images may be a potential problem.

The aim of this article was to investigate the use of image manipulation software in modifying digital endodontic radiographs. Examples of altered images, with notes on avoiding such potentially fraudulent use, are presented.

Materials and methods

Five conventional periapical radiographs were taken using Kodak Ultra-Speed periapical films (58 × 76 mm; Eastman Kodak Co., Rochester, NY, USA), exposed at 70 kV and 10 mA for 0.64 s with a dental X-ray unit that had 2.5 mm of Al equivalent filtration (Trophy, Vincennes, France), and with a 40-cm film-target distance. The films were processed in fresh solutions (Hacettepe, Ankara, Turkey) in an automatic processor (Dürr XR 24; Bietigheim-Bissingen, Germany) at 28°C for 4.3 min. Films were then digitized with a flatbed scanner (Umax Powerlook II; Umax Technologies, Inc., Taipei, Taiwan) at 300 dpi and 8-bit resolution.

ADOBE PHOTOSHOP 6.0 software for PC (Adobe Corporation, San Jose, CA, USA) was used to alter the digitized images. Carious lesions, periapical pathoses and root fractures were created; inadequate treatments were corrected and teeth were erased from the images by application of the software.

Results

Original and altered digital radiographic images

The original radiographic image displaying a root-filled mandibular molar tooth is shown in Fig. 1. In the altered image, the tooth was observed as a sound mandibular molar, and the root canal treatment was erased with the airbrush, smudge and blur functions of the software Fig. 2).

Figure 1 The original radiograph of a mandibular first molar tooth with root filling treatment and amalgam restoration.

Figure 2 With the software, the root filling and coronal restoration were erased.

A mandibular first molar with an amalgam filling was observed in the original image (Fig. 3), and was altered into one with a secondary carious lesion and apical pathosis by using the functions of the software (Fig. 4).

The original image presented a second maxillary premolar with normal dental and bone structures (Fig. 5). With the help of the airbrush, smudge and blur functions of the software program, a root filling was created on the image (Fig. 6).

A maxillary first molar with a root filling and a poor coronal restoration was present on the original radiograph (Fig. 7). With the airbrush function, a 'fake lateral canal' was created within the buccomesial root (Fig. 8).

Discussion

Even though a specific software program was employed to alter digital radiographs in this study, it is important to clarify that this type of manipulation can be achieved with many common software packages. Each PC owner can modify and alter any kind of digitized images with free software programs from the Internet, or the supplier of digital imaging systems. The software program used in this study has many functions to alter digitized radiographic images, and it can be utilized without additional expertise. Using airbrush,

Figure 3 The original radiograph of a mandibular first molar tooth with healthy occlusal filling and periapical bone.

Figure 4 With the software, secondary caries and a periapical lesion were created.

Figure 5 The original radiograph of a second maxillary premolar with normal dental and bone structures.

Figure 6 With the software, a root filling was created.

Figure 7 The original radiograph of a maxillary first molar with a root filling and poor coronal restoration.

Figure 8 With the software, a 'false canal' was created within the buccomesial root.

smudge and blur functions of the software after 500% zooming into the image would be enough to perform the desired alterations.

Obtaining a correct working length is critical to the success of root canal treatment. Failure to identify this crucial measurement can result in untoward treatment outcomes, which may include increased patient discomfort, possible infection or extrusion of intracanal medicament into the periradicular tissue. Whereas digital images offer many potential sensor, display and archival advantages over film-based radiographs (Lavelle & Wu 1995), the disadvantages of this system have also been raised leading to speculation about the vulnerability of digital images to fraud. The possibility of fraud does exist in any profession, including dentistry; but the most obvious rationale for such use may be in receiving authorization from dental insurance companies, and improperly supporting a particular treatment approach.

Recently, software producing companies have established measures to secure the original images by adding embedded encryption (based on a set of keys and algorithms for transforming data into an encrypted form and then back), error correction-code memory (involving special circuitry/software to test data in transit and assure its accuracy) and digital watermarks (invisible digital signals that are embedded into carrier digital signals) (Wadkins 2000). By using one of these modalities, authenticity of digital data may easily be provided, and fraudulent use of digital images may be precluded. Additionally, acceptance of only original radiographs during the evaluation process of scientific manuscripts would be another way to preclude fraud. Tsang *et al*. (1999) showed that after digitization of conventional radiographs and subsequent alteration of the images, the altered images can be reverted and printed onto 35-mm black-and-white photographic negative films. Then, printing the reversed images onto negative film strips provides images identical to those seen on the original radiographic film. However, this time-consuming, cost- and practice-requiring process would probably be a less preferred method when compared to digital alteration and electronical transmission of radiographs.

In conclusion, the effectiveness of digital dental radiographic systems has been widely reported, but little attention has been drawn to its unscrupulous implementation. Therefore, both insurance companies and the editors of medical/dental journals should be informed and warned about the potentially fraudulent use of software programs, and possible utilization of not only endodontic, but also all altered digital radiographic images.

Disclaimer

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