TECHNICAL NOTE

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Computed Dental Radiography Used to Reproduce Antemortem Film Position

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ABSTRACT: Visual comparison of conventional antemortem and postmortem dental radiographs is often included in forensic identification. Ten forensic cases employing dry mandibular and maxillary bones and a dry study skull were exposed using the CDR digital dental X-ray system developed by Schick Technologies, Inc. Exposures of 0.08 s at 10 mA and 70 kVp were taken with an INTREX intraoral dental X-ray unit. Digital radiography has the ability to produce an image instantaneously, allowing an operator to retake an incorrectly aligned radiograph almost immediately. It gives the forensic scientist a simplified method for reproducing antemortem radiographic position more efficiently and often with greater accuracy than conventional radiography.

KEYWORDS: forensic science, forensic odontology, computed dental radiography, digital radiology

Traditional forensic identification often includes visual comparison of conventional antemortem and postmortem dental radiographs (1–4). Typically, a forensic scientist looks for missing or supernumerary teeth, malformed or ectopic teeth, existing dental restorations and their features, and atypical anatomical features or landmarks, any or all of which may assist in positively identifying a decedent. In individuals without any record of dental restorations, Borrman (5) noted a greater error in matching antemortem and postmortem dental radiographs and Bernstein (6) noted a particular case where it was impossible to conclusively identify an individual by dental means even though postmortem bitewing radiographs were positioned and exposed in a similar manner to antemortem bitewing radiographs.

Numerous difficulties are encountered in replicating antemortem and postmortem radiographs. Goldstein et al. used conventional bitewing radiographs and found that deviations by as little as 5 degrees horizontally in the plane of the bite made identification difficult (7). Other problems besides angulation error may include interpretation of alterations made to the dentition between ante- and postmortem examinations, and the physical demands placed on the operator in positioning dental films in a postmortem environment with complicating conditions such as rigor mortis of the oral musculature. Additionally, there is the inherent inability of reproducing antemortem conditions as a result of not having access to the same X-ray equipment, film, film processors, solutions, etc.

Although digitization of dental radiographs was introduced over a decade ago, and digital dental X-ray machines are widely commercially available, acceptance of this method into mainstream dentistry has been slow in the U.S. Based on a survey of dental radiology equipment and procedures, only 5% of general practice dental offices across the U.S. in 1997 use digital dental X-ray machines (8).

Direct digital radiography consists of four components: a conventional X-ray machine, a CCD (charge-coupled device) image receptor and a computer and printer. The CCD replaces the need for conventional film. A digitized image is produced on a computer monitor that can then be stored, printed onto paper or transmitted via modem to another distant location.

The purpose of this paper is to demonstrate a benefit of digital radiography in forensic identification using the CDR® (Computer Dental Radiography) dental X-ray system developed by Schick Technologies, Inc. (Long Island City, NY) to replicate antemortem radiographs in a postmortem environment.

Materials and Methods

Ten forensic cases, consisting of dry mandibular and maxillary bones with antemortem bitewing radiographs and a dry study skull used as a control, were radiographed. Maxillary and mandibular jaws were manually occluded and a CDR sensor was held either in a modified Rinn XCP® or Rinn Snap-a-ray® instrument. The XCP instrument facilitated positioning the sensor for exposing bitewings which display the crowns of both the maxillary and mandibular teeth simultaneously and the Snap-a-ray film holder for exposing one or more teeth in either the maxilla or the mandible in their entirety. The sensor was placed lingual to the existing dentition and exposures of 0.08 s at 10 mA and 70 kVp were taken with a Keystone INTREX® intraoral dental X-ray unit (Roebling, NJ). Multiple exposures were taken of each specimen with minor modifications of 5 degrees or less made to the position and angulation of the sensor. The resultant images were examined to confirm the replication of the antemortem radiographs.

Results

Figure 1 (antemortem radiograph) and 2 (postmortem radiograph) of a forensic case reveal close replication of radiographic

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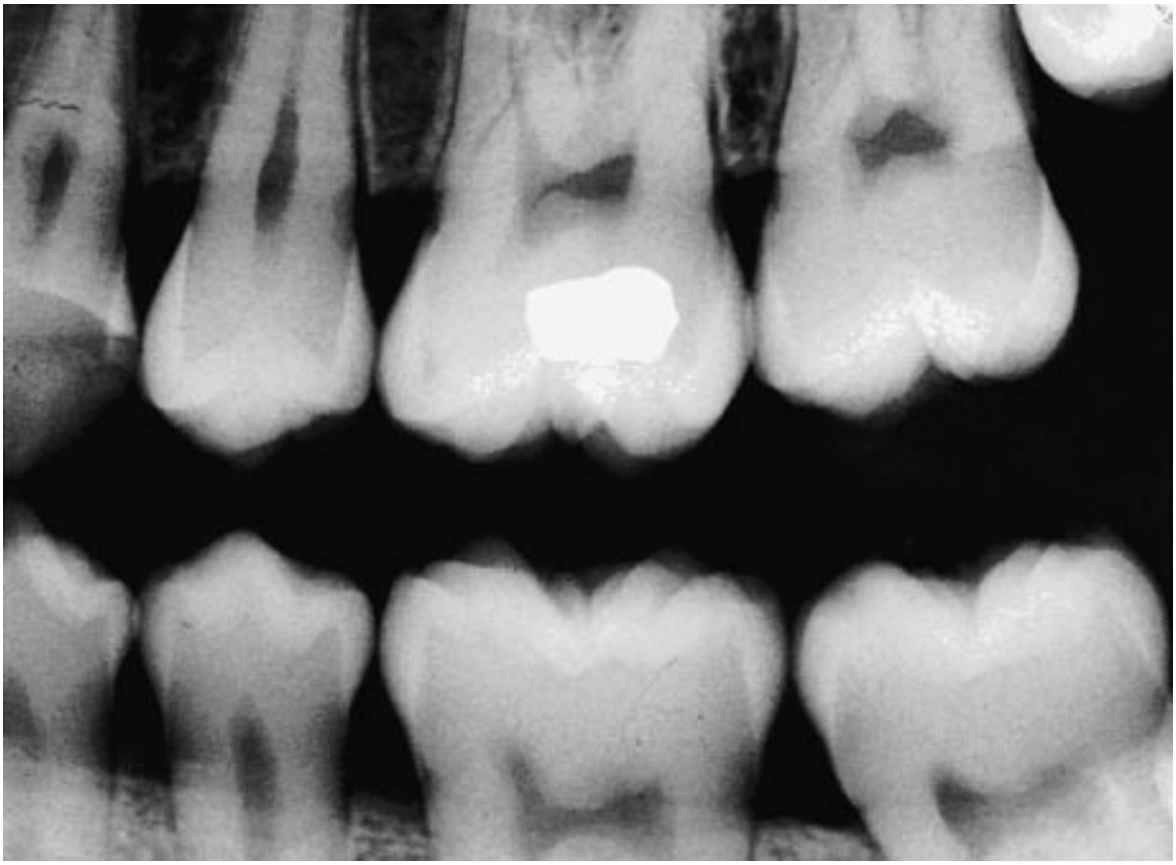

FIG. 1—*Antemortem bitewing radiograph.*

angulation and positioning using the CDR system. As evidenced in Fig. 3, excessive horizontal angulation make visual comparison of ante- and postmortem images virtually impossible. Although the images produced on a CDR number 2 size sensor were slightly smaller than the area covered on a corresponding conventional #2 size film, this was of no significance.

Discussion

The CDR system used for this study incorporated a 5-mm-thick sensor in size 2 which is slightly smaller than a conventional size 2 intraoral film. Schick claims the digital image size is approximately 90% as large as a conventional film. Although not used in this study, smaller size 0 and size 1 sensors are also manufactured for the CDR system. To complete the system, an IBM-compatible computer with a minimum of 8 MB RAM and an SVGA display adapter are required. A standard intraoral X-ray tubehead is all that is required to expose the subject and incidentally, the exposure time is approximately one-tenth that of conventional D-speed film.

Although infection control was not a primary concern with the specimens used in this study, sterile sheaths are available to cover the sensor prior to placement. The intraoral sensor was held in position with commercially available Rinn XCP and Snap-a-ray film holders designed specifically to accommodate the CDR sensor.

Once the sensor is positioned in the specimen to be radiographed and the tubehead positioned, one of the series of radiographs is selected by the operator and activated by using either a mouse or footpad. An image appears on the monitor approximately 5 s after the X-ray exposure. The operator can then accept, reject or retake the image. The accepted image is automatically saved on the hard disk. Within the CDR software, the accepted image may be enlarged, the brightness and contrast altered, rotated, or colorized. Selected images can also be tiled to view several images side-by-side for closer scrutiny. This allows for an easier comparison of a postmortem image with an antemortem radiograph. Subtle features difficult to visualize on conventional radiographs such as trabecular bone patterns are seen with greater detail digitally and may further help to corroborate identification of a decedent.

With the ability to view an image instantaneously, reposition the sensor and retake an exposure almost effortlessly, the examiner is afforded the best opportunity to replicate antemortem radiographic position and angulation. This is particularly valuable in situations where film processors may not be available on-site, or the ability to return and retake radiographs of a decedent at a future date is unlikely. In all ten test cases replication of antemortem radiographs was greatly enhanced with digital radiography and resulted in replication of dental features that might have been obscured or distorted by incorrect postmortem film placement. Conclusive identification of the decedents in this study was easily and quickly reaffirmed without the need for a darkroom facility and film processing apparatus.

Currently, the price of a complete CDR system is approximately $10 000. As more dental offices become equipped with digital dental X-ray units, and as the price per unit decreases, the number of digitized antemortem images will increase and the ability to reproduce them by a forensic scientist will dramatically improve using postmortem digital radiography. Furthermore, digitized images can be easily transmitted via modems to sites around the world where individuals are reported missing.

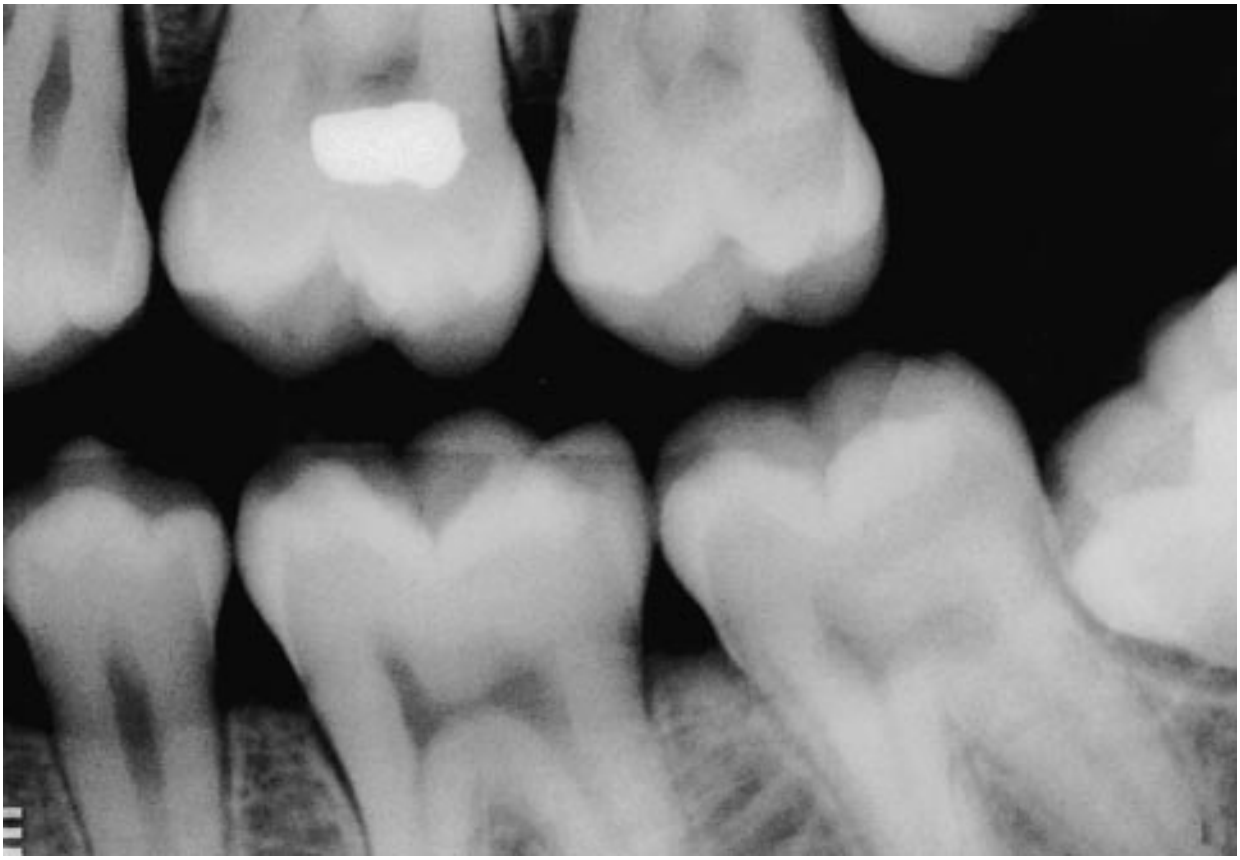

FIG. 2—*Postmortem bitewing radiograph closely replicating antemortem radiograph.*

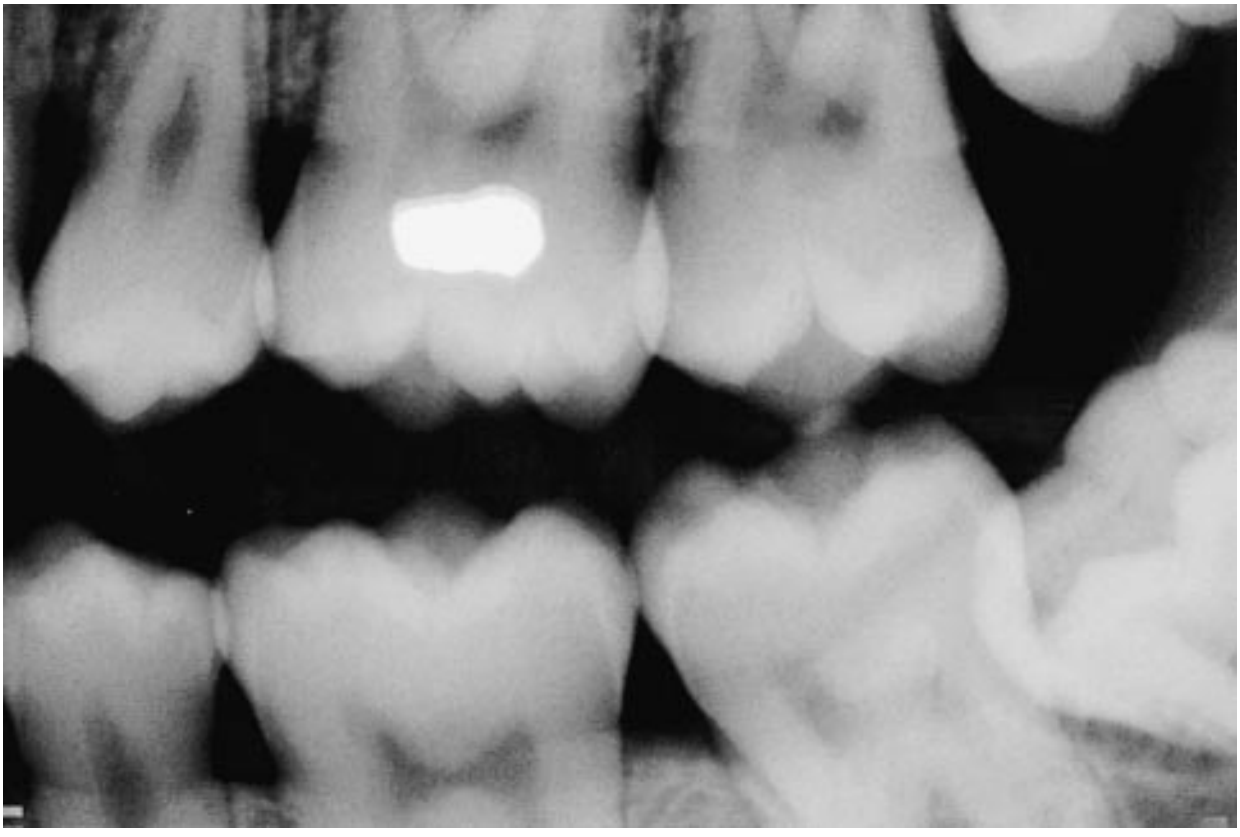

FIG. 3—*Postmortem bitewing radiograph demonstrating excessive horizontal angulation overangulation.*

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