

Validation of post mortem dental CT for disaster victim identification



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ABSTRACT

The objective of this study was to test the accuracy and inter-reader variability of comparative radiologic identification based on dental post mortem computed tomography (PMCT) and ante mortem (AM) dental radiographs.

Five raters with varying degrees of expertise and experience independently compared 115 dental PMCT images to 114 AM dental radiographs to identify matching pairs ($n=98$), unmatched PMCT images ($n=17$), and unmatched AM radiographs ($n=16$). Levels of confidence (LOC) and number of concordant features (NOCF) of matched pairs were documented. Accuracy of matches/exclusions, interrater correlation coefficient and correlation between correct matches/exclusions, LOC and NOCF were calculated for all raters.

Mean accuracy was 92% for matches and 80% for exclusions. Interrater correlation coefficient regarding LOC and NOCF were 0.623 and 0.907 respectively. LOC were correlated with NOCF of matched pairs but accuracy of matches/exclusions was neither correlated to LOC nor to NOCF.

This study shows that visual comparison of PMCT images with AM dental radiographs is a reliable method for identification. Accuracy of identification using PMCT/AM dental radiographs was as high as in comparable studies using post mortem (PM) dental radiographs/AM dental radiographs. Raters with practical experience in forensic identification and experience with the imaging modality (in this case: dental PMCT) achieved higher accuracy than inexperienced raters. Match accuracy did not correlate with subjective confidence or number of concordant features. It is advised to work in teams rather than individually when dealing with real cases in forensic identification, to minimize subjective interpretation and avoid confirmation bias.

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1. Introduction

Identification of the dead is a fundamental part of forensic investigation [1]. Individual identification relies on comparison of

ante mortem (AM) and post mortem (PM) data, typically fingerprints, DNA samples, or dental records [2]. Interpol offers general guidelines for victim identification in mass disasters [2]. However there are no internationally recognized guidelines in isolated cases and the procedure differs as a function of local conventions, availability of experts, and the scenario [3].

In the past 15 years, the use of post mortem computed tomography (PMCT) in forensic death investigations increased [4] and its potential for disaster victim identification was put to the test both in actual and simulated mass disaster scenarios [5–7]. Today,

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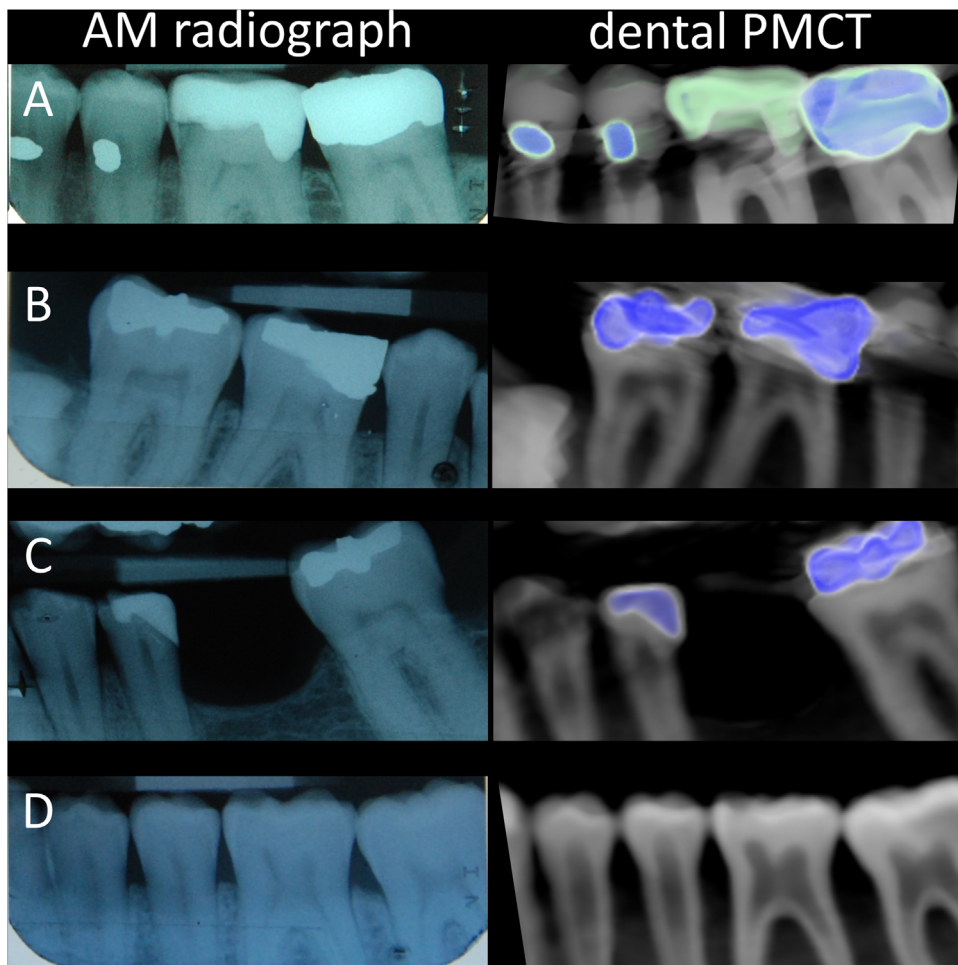


Fig. 1. Four sample images of corresponding ante mortem radiographs and reconstructed post mortem computed tomography (PMCT) of one quadrant. A–C feature cases where restorative materials are present. D features a case without restorative materials. PMCT has several advantages over plain film dental images, including three-dimensional image reformatting, acquisition in a non-invasive fashion, and anatomical and pathological information not only of the teeth but of the surrounding connective tissue including the mandibular and the paranasal and maxillary sinuses. The main limitation of dental PMCT is the occurrence of metal artifacts (beam hardening artifacts) from restorative materials with a high radiologic opacity which obscure the edge detail of restorative materials. (e.g. A and B). This study found no evidence that the accuracy of this approach suffers from the presence of CT image artifacts.

PMCT has an established role in disaster victim identification (DVI) [8]. One of the principal reasons for the rapid adoption of PMCT for identification is that data from whole-body PMCT scans can be reformatted and rendered to match almost any AM imaging examination, including dental radiographs [4]. Such individually reformatted PMCT images of the dentition (sometimes referred to as “dental CT” or “dental PMCT”) for comparative identification were introduced to forensic sciences a decade ago [9]. Today, radiologic identification through comparison of dental PMCT with AM dental radiographs is routinely used for personal identification by various institutions (including those of several of the authors).

Principal advantages of dental PMCT over normal post mortem dental radiographs are: (1) three-dimensional image reformatting (e.g. dental PMCT images may be matched to any type of AM dental radiographs, including panorex/orthopantograms and bite-wing radiographs); (2) PMCT images are acquired in a non-invasive fashion (e.g. no need to incise the masseter muscles or extract the mandible for adequately positioned PM dental radiograph); (3) PMCT provides detailed anatomical and pathological information not only of the teeth but of the surrounding connective tissue including the mandibular and the paranasal and maxillary sinuses (which may contribute to identification) [5,9–13].

There is further consensus in the literature that the main

limitation of dental PMCT is the occurrence of metal artifacts (beam hardening artifacts) from restorative materials with a high radiologic opacity, such as gold or amalgam [5,9–11,13,14]. These metal artifacts obscure the edge detail of restorative materials. Several authors speculated that this type of artifact might potentially affect the reliability of comparative radiologic identification based on dental PMCT and AM dental radiographs, although no evidence has been published to confirm this hypothesis [5,9–11,14]. Nevertheless, several methods were developed to reduce streak artifact [13–15] and overall, most authors are confident that PMCT is a useful and reliable tool for dental identification both in single identification cases and mass fatality events [3,5,10,12]. The hypothesis is that comparing dental PMCT to AM dental radiographs is (at least) as valid for identification as the traditional method of comparing PM dental radiographs to AM dental radiographs [16–19]. The accuracy of comparative identification using dental PMCT and AM dental radiographs has not yet been directly evaluated.

The objective of this study was to test the accuracy and inter-reader variability of comparative radiologic identification based on dental PMCT and AM dental radiographs in a fictitious mass fatality scenario using multiple readers with varying degrees of expertise and experience.

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