REVIEW ARTICLE

Endodontics and forensic personal identification: An update

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ABSTRACT

Dental identification of a deceased individual is a core task in forensic odontology. The accurate recording of clinical dental procedures has become more important over time because of the increasing trend of lawsuits worldwide. Previous reports have discussed the practical usefulness of endodontic evidence for human identification. Advances in endodontic imaging, root and root canal anatomy, and biomaterials have been consistently emerging in endodontic research and practice. This article provides an update on the interrelationship between endodontics and forensic personal identification.

Key words
Anatomy, endodontics, forensic dentistry, forensic odontology, imaging

INTRODUCTION

The distinctiveness of human teeth has facilitated personal identification throughout history.[1] Dental identification of a deceased individual is a core task in forensic odontology.[1] Forensic dentistry/odontology is a dental specialty which applies dental knowledge and expertise to legal issues. Forensic identification, by comparing recorded dental features and treatment against those of a postmortem dentition, is one of its core tasks and is considered essential from both humanitarian and judicial reasons.[2,3]

The accurate recording of clinical dental procedures has become more important over time because lawsuits exhibit an increasing trend worldwide, and because the teeth are the most indestructible components of the human body and may remain intact for many years after a person's death.[3,4] In this context, root/root canal morphology and posttreatment endodontic radiographs present particularly rich sources of features that would facilitate individuation.[5]

The expanding knowledge on root and root canal anatomy and the advances in endodontic imaging and biomaterials are at the forefront of endodontic research and practice. This article provides an update on the impact of current advances in endodontic research and practice on forensic personal identification.

DISCUSSION

Dental identification plays an important role in the identification of remains when postmortem changes, or there is a lack of a fingerprint record.[6] The identification of dental remains is of a prime importance when the deceased person is decomposed, burned, or dismembered. Even the status of a person's teeth changes throughout life and the combination of decayed, missing, and filled teeth is measurable and comparable at any fixed point in time.[6]

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Knowledge on root and root canal anatomical variations

In the human dentition, a wide range of anatomical variations in each tooth type has been reported.[7] For instance, the occurrence of supernumerary roots in the primary and permanent human dentition is well documented and the prevalence can reach up to >30% in mandibular molars, and current reports continue to demonstrate high percentages of middle mesial canals in mandibular molars, more common occurrence of double and three canals in anterior teeth and maxillary premolars than previously reported, respectively.[8-13] Therefore, a forensic odontologist should be aware of such anatomical variations and their radiographic landmarks, which may facilitate postmortem personal identification when compared to antemortem records.[14] The application of cone-beam computed tomography (CBCT) can help the forensic odontologist to identify such anatomical variations.[15]

Use of periapical radiographic images

Postmortem radiographs are ideally taken in a way that the original conditions presented in a antemortem image are duplicated as closely as possible, and the similarity between the two images can be confirmed by superimposition.[5] Periapical radiographs also are useful to identify root canal filling materials such as gutta-percha, silver points, root canal sealers in addition to metallic and fiber posts, and postendodontic coronal restorations.[5] The complexity and variability in postdesign and placement, core material, and coronal restorations provide further individuating features to each such treated tooth.[5] It is worth noting that comparison of dental anatomical features in the absence of dental/endodontic restorations is more complex than when such evidence is present.

Use of three-dimensional imaging techniques for pulp canal space and age determination

The pulp-dentinal complex shows physiological changes that mainly result in the reduction of the pulp chamber volume resulting from the continual deposition of secondary dentin.[16] Forensic scientists have been using the decrease in size of the pulp chamber for a long time as an important marker for identifying the age of individuals. Panoramic and periapical radiography provides a valid nondestructive approach for age estimation. However, the edges of the pulp usually become blurred, and the diffuse edges could thus cause differences between the measurements of the same tooth by different observers when the three-dimensional (3D) pulp is reproduced in a two-dimensional radiograph.[16,17]

The analysis of the volumes of the pulp chamber and the tooth is more reliable than the calculation of areas, possibly because secondary dentin formation may not be uniform along all pulp surfaces, and therefore, measurements of projected areas could provide an incorrect impression of the extent of this process.[18] Existing projects utilize 3D diagnostic modalities to examine the relationship between age and age-related changes in pulp–tooth volume ratio with the use of micro-CT.[17,19] Several studies have also confirmed that CBCT allows for the accurate calculation of tooth volumes, and the method is highly reproducible because of the good inter-examiner agreement.[16,18,20,21]

Identification and characterization of endodontic materials

In addition to matching antemortem and postmortem radiograph images, complete and accurate antemortem dental records could be used to identify individuals that have undergone surgical or nonsurgical root canal therapy based on the postmortem elemental analysis of the obturation material.[22] This database of elemental fingerprints of root canal filling materials can be kept as an immediate reference for forensic odontologists.[22]

The identification of victims of incineration events is a daunting and intensive task that requires the coordination of professionals of different disciplines.[22] Victims of incineration events result from airline accidents, automobile accidents, bombings, or wrongful cremation.[22] Teeth are components that often survive severe fires because of their particularly resistant composition, influenced by the protection provided by the soft tissues of the face. In fact, only fragments of teeth are often available, and obtaining their radiographs is therefore more important.[23] A study examined the behavior of endodontically treated teeth under thermal stresses,[23] and results showed that the obturation material can be recognizable till 1100°C; however, a "honeycomb" appearance (radiolucent areas within the endodontic treatments) was observed over 600°C as a result of the softening of the obturation material, which can even flow to fill the missing root canals.[23] Changes in the shape and dimension of the obturation material, especially if defective, can also be observed at lower temperatures [Figure 1a-d]. Broken files can also be observed at such elevated temperatures.[23] Intracoronal restorations, such as amalgam and resin composite fillings, can also maintain their integrity at elevated temperatures.[23]

Other investigators have examined the physical changes in endodontically treated teeth in materials after their exposition to high temperatures of up to 1000°C.[24] Results showed that dental tissues and materials offer great resistance to high temperatures. However, at temperatures above 800°C, endodontic materials (gutta-percha/zinc oxide eugenol and gutta-percha/resin cement combinations) tend to change to chalk-like whitish hue, which is difficult to recognize from the incinerated dentin.[24]

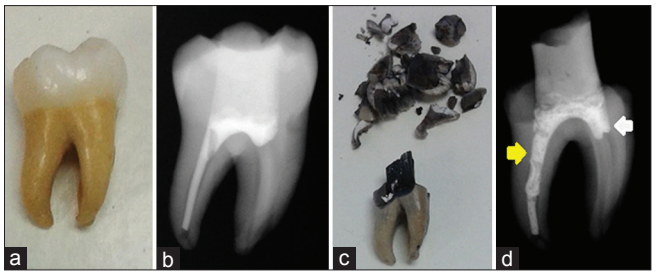

Figure 1: a) A sample of an extracted mandibular first molar tooth. b) An access cavity was prepared, and the distal root was obturated using a single cone (gutta percha size 30 – 0.04 taper). The mesial root was left untreated, and the access cavity was restored. The sample was introduced in a furnace at 500°C for 20 mins. c) After cooling, the sample showed fracture of the crown into pieces, and the colour turned black. d) A periapical radiograph showing the effect of heat on the gutta percha in which the spaces left from inadequate obturation in the distal root were filled by the molten gutta percha leaving some voids (yellow arrow). The molten gutta percha was able to go few millimeters into the mesial orifices (white arrow)

Another study has examined the surface and elemental analysis (using scanning electron microscopy [SEM]/energy dispersive X-ray analysis [EDX]) of endodontic materials before and after the heat incineration of filled teeth at 900°C.[22] A glacier-like surface coating was observed on the nickel-titanium (NiTi) composed of titanium when NiTi files are exposed to elevated temperatures within the root canal system. A positive elemental fingerprint was also identified with the other endodontic materials exposed to elevated temperatures, such as stainless steel files, Gray ProRoot MTA, AH26, Apexit, and Epiphany.[22] Notably, portable elemental analytical devices, such as the X-ray fluorescence spectrometer, could be more suitable for investigations in contaminated or dangerous field settings than SEM/EDX.[22]

Considerations

- Digital periapical radiography and CT provide valid approaches for forensic personal identification. However, the lack of standardized procedures that protect radiographic data against manipulation and guarantee authentication is a major disadvantage of using digital images in dentistry.[25] Endodontists should be aware of the problem and potential solutions concerning image protection[25]
- The responsibility of an endodontist is not limited to root canal treatment procedures but also extends to unfortunate events in which a patient may need to be identified based on their antemortem records. Therefore, endodontists are strongly encouraged to include the brand name of every endodontic material placed in a tooth[22]
- Assessments of the physical and chemical changes of current endodontic instruments of different alloys and filling materials of different composition at elevated temperatures can be a subject of future research collaborations between researchers of different disciplines (endodontics and forensic odontology). This is of particular importance because the teeth of persons burned in fires of extremely high temperatures are often their only means of identification[26]
- The application of root canal treatment procedures lessens the likelihood that organic material would survive in the root dentin sufficient for DNA extraction.[27] One study showed that DNA extraction can be successful even after 3 months of pulp extirpation.[28] Even if the avulsed root canal treated tooth did not show remaining pulp tissues, the root dentin (dentinal tubules) and more importantly the cementum can still be sources for DNA.[27] Therefore, an avulsed root canal treated tooth can be of particular importance when an intact tooth is not available.

CONCLUSIONS

Adequate knowledge on root and root canal variations is essential for forensic personal identification. The application of 3D technological advances provides a more accurate method for age determination, and assessment of the root and root canal morphology for forensic identification of compromised human skeletal remains. The properties of current endodontic materials challenged at elevated temperatures should be further investigated. Endodontists should be aware of their responsibilities that can aid in forensic personal identification.

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Conflicts of interest

There are no conflicts of interest.

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