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EXPLORING THE SIGNIFICANCE OF ENDODONTICS IN THE FIELD OF FORENSIC ODONTOLOGY: A COMPREHENSIVE OVERVIEW

[1]Shafaq Maqsood, [2]Sidra Munir, [3]Mariam Raza Mallick
[1]21732-D, shafaqmaqsood95@gmail.com
[2]9909-D, siddymunir@outlook.com
[3]16453-D, mariam_raza@outlook.com

Abstract:
It has always been difficult to determine someone's identity, whether they are alive or dead. It is important to carefully examine any evidence that may be used to confirm the identification. Records of previous treatments, together with knowledge of the genetics and morphology of the dentition, provide useful information. When more traditional forensic science tools have fallen short of providing a conclusive identification, forensic odontology has repeatedly been shown to be an essential tool. This is because teeth can tolerate environmental pressures and do not quickly deteriorate. The substances used to line root canals have also shown persistence in challenging circumstances and increased the variances that might aid in identification. This article intends to examine the different ways that root-filling materials and the area of endodontics might support forensic identification.
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Corresponding author:
Shafaq Maqsood,
21732-D,
shafaqmaqsood95@gmail.com

QR code

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INTRODUCTION:

Using dental expertise to solve medical and legal issues is the practice of forensic odontology. [1] Forensic odontology is described by the Federation Dentaire International (FDI) as "that field of dentistry which, in the interests of righteousness, involves the right way to handle and examine dental proof as well as the appropriate assessment and reporting of dental discoveries. "One of the most important methods for victim identification, according to Interpol, is dental identification.[2]

Dentists with advanced training in forensic odontology examine prosthetics and teeth to gather information for their cases. To determine the identities of bodies and figure out the gender, race, and age of the corpses in criminal inquiries or major catastrophes, forensic odontologists use teeth. If there are antemortem documents available, it is possible to establish identification by comparing them to X-rays and post-mortem dental files.[3] It has been observed that those who have had dental treatment are easier to recognize than people who have not.[4] Finding a corpse that can be identified for legal reasons might be difficult, particularly if it has been mutilated and mangled beyond recognition.[5] It becomes challenging in these situations to record fingerprints and gather samples for DNA analysis.[6] Due to the distinctive morphological characteristics of teeth and their capacity to withstand decomposition, forensic odontologists are sought out in these difficult circumstances. In light of this, forensic odontology has emerged as one of the most widely used and trustworthy techniques for unambiguous identification.[7]

Endodontics is a specialty of dentistry that focuses on the pathology, physiology, and morphology of the human tooth stem and periradicular cells, according to the American Association of Endodontics (AAE). The fundamental and clinical sciences are covered in both its study and practice, as well as the biology of the healthy pulp and the causes, diagnoses, preventative measures, and remedies for illnesses, injuries, and periradicular ailments that affect the pulp. Endodontics specifically addresses the morphology of the root and canal. To stop subsequent infections, the diseased root canal systems are cleaned and filled with an inert substance. Depending on the clinician's training or practice philosophy, different methods, and materials are used, but the final goal is always to implant a radiopaque substance that can be visible on X-rays to assess the efficacy of the therapy.[8] Any dental office that offers root canal therapy will often recommend it to customers. The utilization of materials utilized during the procedure, anomalies in the morphology of the root canals, and radiographs recorded while the procedure was being performed are all thought to be potential markers.[9] Human teeth exhibit a broad variety of variations in root canal morphology, including an increase in the number of s-shaped, c-shaped, lateral canals, and other morphological anomalies. These different canal designs may serve as an exceptional characteristic that assists in identification since they are less common.[10] A characteristic is considered remarkable if it only appears in 10% or less of the population.[11] When compared to antemortem data, these canal changes and radiographic characteristics may help with post-mortem identification. Forensic odontologists should be aware of these factors. An endodontist is a specialist who may be contacted, when necessary, since their field of dentistry, endodontics, deals with root canals.[12]

The techniques listed below show how instruments and supplies made specifically for endodontics might facilitate identification.

1. **One-dimensional radiography for identification:** Due to the impossibility of direct root canal vision, radiography is a critical component of endodontic practice. Radiographs capture the canal shape and aberrations, making them a valuable source of antemortem data. They can be simply duplicated by other operators and are not prone to the subjective inaccuracies that might happen in written texts. This function is beneficial for post-mortem comparison.[13]

   A tooth that has undergone endodontic treatment has more individuating information than a tooth that has not. This claim is supported by the fact that any readily accessible root canal sealant may be used in conjunction with silver points or gutta-percha to obturate a tooth that has had a root canal procedure. Finally, every tooth that has had endodontic treatment receives some kind of post-endodontic restoration. Some teeth need support, which is often given by metallic or fiber supports. Since each of these materials utilized in root canal treatment has a distinct radiopacity, radiographs may be used to identify them.[13]

   In 1921, Schuller described the first instance of dental radiography being used for forensic identification. By comparing the radiographs of the lateral incisor that had undergone root canal treatment ante- and post-mortem, Weisman 1996 was able to positively identify a burn victim.[14]

This spurred curiosity, which led researchers to investigate the viability of obtaining an identification using X-rays of teeth that had undergone endodontic treatment.

A research compared the radiographic characteristics of teeth with restorations, without restorations, and with root canal treatments after being exposed to extreme temperatures. Up to a temperature of 11,000°C, the endodontically treated teeth's radiographic appearance had discriminatory potential.[15]

Similar to this, in separate research, the radiographic characteristics of single-rooted teeth after obturation were examined, and several doctors were requested to compare the antemortem and post-mortem images. He concluded that single-rooted teeth had radiographic pictures that were distinctive and may aid in identification. It was hypothesized that in some instances when the doctors were unable to make the match, it was likely because the X-ray tube was held in a different position, changing the orientation of the pictures.[16] A situation where they were able to recognize a person even in the lack of any teeth was described in another investigation. This was due to the erupted endodontic material that was left around the left maxillary sinus. The identification was verified since the extruded obturation material's appearance in the post-mortem radiograph matched that in the antemortem scan.[17] Orthopantomograms (OPG), intra-oral periapical radiographs (IOPA), and Bitewings images are often considered as the most effective in forensic dentistry. The same procedure has also been done using frontal sinus radiography. [18] Endodontic radiographs can't always be used to identify a person because of improper radiography practices, low radiograph quality, and records that can't be read. Therefore, it is recommended that practitioners keep clear records and take radiographs using the appropriate procedures.[19]

2. **Determination of endodontic components using analysis of elements:** The mandibular and maxillary bones, the gingiva, the facial muscles, and the skin all serve as insulators to protect the teeth.[20] The periradicular tissues around tooth roots make them more accessible for forensic testing in situations involving high temperatures, such as heat burns or blast incidents.[20] According to research, incineration accident victims are subjected to temperatures as high as 11,000°C.[21]The pulp boils as a result of this abruptly rising temperature, and finally, the pressure buildup causes the crowns to burst. As a result of the tooth breaking off along the gingival border, there is no frontal tooth anatomy remaining to identify it.[20] In contrast to coronal structures, which are always exposed to alterations due to wasting illnesses and dental procedures, roots can keep more morphological information, according to studies on the endurance of teeth under extreme temperatures.[11]

In a prior investigation, it was discovered that although the hardened material on the root of teeth may stay intact at extreme temperatures, the dentin and enamel can separate. The tooth's root structure often survives crown loss without being harmed. If the tooth has already had root canal therapy, the materials utilized in the process may be examined for their elemental makeup. However, care must be taken while handling heated materials since, contingent upon the temperature and length of exposure, their compressive strength may considerably decrease.

Endodontic materials, including gutta-percha and silver points, can be identified up to temperatures of 1100°C for root canal filling. At temperatures above 600°C, gutta-percha can soften and flow into lateral canals and anastomoses, resulting in a "honeycomb" appearance. However, at temperatures exceeding 800°C, endodontic materials may appear powdery white and be difficult to differentiate from burnt dentin.

To find out whether endodontic materials can still be distinguished using SEM/EDS at high temperatures, research was done to look at how endodontic materials behave under such conditions. To replicate cremation and incineration temperatures, the materials were examined before being heated to 900°C for 30 minutes in the teeth. The samples were re-examined to see whether their elemental makeup and properties had not changed. The precise heavy metal included in each endodontic sealer's formulation, which increases radiopacity, may be determined. During root canal therapy, accidents like instrument detachment might happen. If the instrument cannot be recovered, it forms a component of the eventual obturation. The most often used endodontic devices are made of stainless steel and nickel titanium. When non-surgical root canal therapy fails, surgical

endodontics must be performed. The apex of the root is cut off during surgical endodontics, and then a retrograde filling substance is used to close the apical end. Mineral trioxide aggregate (MTA) and Biodentine are two types of retrograde filling materials that are often used. Because of changes in the amounts of iron oxide and aluminum oxide, grey and white ProRoot MTA may be distinguished from one another by their distinct elemental fingerprints.[21]

The study's findings demonstrated that if comprehensive and up-to-date antemortem data are available, it is possible to identify people who have had surgical and non-surgical root canal treatments by doing a material analysis on the samples. Every material has a unique composition, and the employment of various heavy metals results in a substance's specific elemental fingerprint. This helped to clarify the situation. Identification is aided by this.[21] To assist forensic odontologists with future reference, the data from this investigation was gathered and organized into an electronic repository corresponding to the root canal substances utilized and their elemental fingerprint. Due to these differences in composition, the forensic odontologist can correctly identify the substance that was utilized based on its elemental makeup, radiographic appearance, and location in the root.[21]

3. **Utilizing Cone Beam Computer Tomography (CBCT) for identification:** Endodontic imaging has seen constant development both in research and clinical practice. Cone beam computer tomography (CBCT) is one of these techniques that precisely captures the root canal morphology and periradicular cells in three different dimensions. These documents are digitally archived and provide a wealth of data that may be used to personalize.[23] Forensic examination of CBCT recordings as legal evidence was evaluated via research. To determine if CBCT pictures of burned teeth still had characteristics that may aid in identification, CBCT analysis was performed both before and after the incinerator. It was discovered that endodontically treated teeth still contained enough features to be recognized by CBCT analysis even after the incinerator heated the teeth to 800oC.[26] Forensic odontology's age assessment relies on the measurement of the pulp-to-tooth area ratio. This is explained by the fact that as people age, secondary dentin deposition rises and the pulp chamber's capacity gets more restricted, resulting in a decline in the pulp-to-tooth surface proportion. Without cutting teeth into sections and risking damage, CBCT analysis can precisely detect this ratio.[23]

DISCUSSIONS:

In situations of severe destruction, teeth could be the only thing that can be evaluated as evidence. Due to exorbitant costs, a lack of equipment, pollution, and decomposition in heat, fingerprints may be destroyed and DNA evaluation might not be feasible.[24]

A reliable and efficient technique of identification has been recognized as the juxtaposition of post-mortem and antemortem dental information.[25] However, this approach must be able to read legible antemortem data to be as effective as possible. An accurate medical, familial, and dental procedure record, as well as any necessary radiographic pictures of high quality and the names of the treatment supplies utilized, should all be included in a proper antemortem record. For simple storage and access, it should be thought about digitizing these documents.[26]

CONCLUSIONS:

It is vital to find any proof of identification. Endodontics' potential contribution to forensic dentistry has received increased attention lately. The curiosity is primarily explained by the persistent necessity for antemortem radiographic evidence in forensic dentistry, while endodontics constantly calls for the recording of each clinical procedure on film. One should not undervalue the possibilities of dental procedure data and dental components as distinctive identifiers. This topic requires further investigation. Future forensic initiatives may benefit from the establishment of an infrastructure that consolidates all dental care data in one location.

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