Forensic dentistry: Adding a perio ‘scope’ to it!

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Abstract:
Human identification during mass disasters using the stereotyped techniques such as fingerprint analysis is a cumbersome task. With a view to overcome this predicament, dental evidence of the deceased has gained importance in the recent years. Various branches of dentistry have augmented forensic research through innumerable scientific contributions. The following narrative review of literature aims to summarize the findings of studies that reported periodontal associations or potential associations that could play a role in forensic research. It is designed to inspire the “perio‑society” to lend a helping hand to forensic odontology.

Key words:
Forensic odontology, forensic research, periodontal tissues

INTRODUCTION

To reach the depth of the criminal investigation, combined efforts of a multidisciplinary team are required. The report presented by a forensic expert plays a crucial role in the conviction of a criminal. This makes it evident why he/she must be precise, methodical, elaborative and foremost, unbiased. The science of using oral structures for human identification, better known as forensic odontology, is a special branch of forensic medicine. It is performed by a comparative evaluation of the antemortem and postmortem records.

The first ever case that recorded the use of dental identification was that of John Talbot, who fell in the Battle of Castillion in 1453. Dr. Paul Revere, who identified the body of Dr. Joseph Warren, a revolutionary in 1775 by identifying the silver and ivory bridge he had constructed for the latter, 2 years prior, was the first forensic odontologist. The first comprehensive text on forensic odontology entitled, “L’ Art Dentaire en Medicine Leagale” was published by Dr. Oscar Amoedo, who is also known as the father of forensic odontology.

Forensic research pertaining to dentistry has taken several turns and reached a crossroad where every separate branch has an entity to contribute to support identification of the deceased. The prime focus of this article is to highlight how a periodontist can contribute to the field of forensic odontology by associating the following parameters of his domain, to unravel a crime scene. This narrative review of literature aims to summarize the findings of studies that reported periodontal associations or potential associations that could play a role in forensic research.

METHOD OF DATA ACQUISITION

A PubMed search was conducted using the keywords “forensic dentistry,” “cementum annulations,” “dental implants,” DNA analysis” to identify articles published until May 2014. A plausible link between forensic odontology and the scope of periodontology was sought for and all important facts were compiled to formulate the review.

DEOXYRIBONUCLEIC ACID ANALYSIS

Human identification by deoxyribonucleic acid (DNA) isolation from several biological...
samples is one of the most sought after approach practiced worldwide. Crime scenes are prospective sources for procuring DNA from the vicinity. Although whole blood is a prolific cache for DNA, its collection and storage require high-level precision, aseptic environment, and a professional approach. Therefore, noninvasive sources such as saliva have come into the limelight in the present years. Saliva, an abundantly available oral fluid, can be procured from bite marks, edibles, cigarette butts, and other objects and easily stored in most different conditions. Moreover, 1 ml of saliva has been shown to possess a DNA typing strength equivalent to 10 µl of whole blood making it a reliable source for human identification.\(^4\)

**ASSESSMENT OF GINGIVAL EPITHELIUM**

Cell death occurs by apoptosis, necrosis, or autolysis. Liberation of tissue fluids causes cell autolysis summing up to cause evident decomposition of a corpse. As the body continues to alter after death, it is of great importance to acknowledge the postmortem changes in medicolegal practice. These changes vary among individuals and these can be precisely studied through cellular changes under the microscope. Histological examination of gingival tissues procured from postmortem and antemortem samples at different time intervals revealed that decomposition process is initiated within 10 h after death and other cellular changes occur subsequently.\(^5\) The use of oral epithelium cells harvested by pressure application of a toothbrush to assess the minute qualities of DNA of individuals followed by gender identification by sex determining region-Y (SRY) gene amplification was carried out using real-time polymerase chain reaction. The authors claimed that this was a valuable and sensitive tool and functional amounts of DNA could suffice from SRY gene amplification for human gender identification.\(^6\) Quantitative cytomorphometric analysis of exfoliated healthy gingival cells which were obtained by scraping attached gingiva to assess the age- and gender-related alterations in the nuclear area, cytoplasmic area, and nuclear: Cytoplasmic ratio values of pathologic smears of oral premalignant and malignant lesions has revealed that attached gingiva can be studied for human identification.\(^7\)

**CEMENTUM: A MARKER FOR AGE ESTIMATION**

Age estimation is an important criterion in the identification process when very less information about the deceased is available. Cementum is a connective tissue and part of the periodontium that surrounds the tooth and is deposited throughout life. Deposition occurs in the form of concentric incremental lines and each line corresponds to 1 year of life. Contemporary reports have shown that tooth cementum annulations (TCAs) are a reliable source as compared to other human morphological or histological traits for age estimation.\(^8\)

A longitudinal ground section of a tooth mounted on a microscope is used to assess the alternate light and dark bands at the apical and middle third of the root, which are counted on a pictomicrograph. Examination can be done under light microscopy, polarized microscopy, or phase-contrast microscopy.\(^9\)

Number of incremental lines (n) = X/Y where,

- X = Total width of cementum from dentino-cementum junction to cementum surface.
- Y = Width of cementum between two adjacent incremental lines.

Addition of the eruption age of the tooth with the number of lines can give us the age of the individual. However, to assure a high reliability of the method, TCAs diagnosis has to be based on several teeth of one individual if possible and needs to be supported by different techniques in forensic cases.\(^10\)

Dental cementum is laid down in alternating opaque and translucent bands representing winter (dormant) and summer (growth) seasons. Wedel in 2007 had a vision that if the timing of the transition between winter and summer bands could be identified in humans, dental cementum increment analysis (DCIA) could be used to specify the season at death. Hence, through his pilot study, the former stated that a transition from translucent to opaque bands was observed in teeth extracted in early October while teeth extracted in early April showed nascent translucent bands. Further, significant correlations were observed between band thickness and number of days into either season, suggesting that bandwidth increases as either season progresses. Hence, he was successful in providing a resource to forensic anthropologists for determining the season at death through DCIA.\(^11\)

Evaluation of the influence of periodontal disease on age estimation by analyzing both the number of cementum lines and the correlation between cementum thickness and actual age on freshly extracted teeth showed that the technique was reliable for periodontally sound teeth but not for periodontally diseased teeth.\(^12\)

A new method was reported using DCIA to determine the age and season at death of an unidentified female corpse during her exhumation analysis which took place 37 years after her death. The method helped solve the crime which makes it an interesting first ever application of cementum study for human identification.\(^13\)

**IMPORTANCE OF IMPLANTS IN FORENSIC ODONTOLOGY**

Apart from the various periodontal aspects that aid forensic researchers, use of implants for the same is the most recently acknowledged innovation. Although dental implants lack individuality, they have an advantage of being corrosion resistant and having a high melting point. Extreme heat causes central vaporization of pulp tissues leading to disintegration and separation of the tooth crown and root. Unlike the conventional restorative materials such as dental amalgam, composite resin, and gold which may melt or distort in high temperatures, titanium and its alloys which is commonly used to manufacture dental implants has a melting point above 1650°C which helps them sustain thermal insults. These properties of implants have shown to give them added importance for playing evidence in victim identification.
Pre- and post-incineration imaging of the laser etched batch number on the implant body, using a microscope attached with a digital camera, showed that the batch number was persistent even after the implant was subjected to high temperature. The presence of the batch number postfiring was dependent on the depth of etching and the presence of the oxidation layer on the implant surface. This unique concept could be utilized by implant manufacturers in labeling their implants which could help suffice the goal of victim identification.\cite{14}

One of the latest innovations is an implant recognition software, consisting of a database fed with a set of questions that determine the different implant systems. In addition, radiographic and clinical images of the implant systems are also provided in the software database. At the end of the search, complete manufacturing details are revealed that can aid in case recognition and simplifies the job of a forensic odontologist.\cite{15}

**Future directions**

1. Acknowledging the other methods and parameters for human identification using periodontal tissues such as the study of Barr bodies for sex-determination in gingival epithelial cells can be conducted for optimum results
2. A practical approach to the accomplished facts should be set into motion by assessing them in the judicial system.

**CONCLUSION**

This literature compilation has tried to provide inputs from the field of periodontology that could possibly promote forensic research by their methodical approach. It helps us understand that like specialists from other dental fields, even a periodontist can make valuable contributions to forensic odontology. This knowledge update inspires further “peri-scoholic” research in the multitude of discoveries pertaining to the field of forensic odontology.

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**Conflicts of interest**

There are no conflicts of interest.

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