Review Article

Indian Journal of Forensic Odontology
Volume 10 Number 1, January - June 2017
DOI: http://dx.doi.org/10.21088/ijfo.0974.505X.10117.6

Applications of Periodontology in Forensic Dentistry: A Brief Outline

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Abstract

Periodontics can be considered as a clinical dental specialty with significant potential for applications in forensic odontology. This specialty can be utilized for identification of individuals through morphology and pathology of periodontium and also for age estimation studies based on root transparency and root length. The aim of this review is to briefly discuss a periodontal perspective in aiding forensic investigations.

Keywords: Age Estimation and Identification; Forensic Odontology; Forensic Sciences; Periodontics; Periodontium.

Introduction

Forensic odontology is a specialized field of dentistry which analyses dental evidence in the interest of justice. Dental evidence has been used for the identification of victims and suspects in mass disasters, abuse and crimes and can be presented in the following sequence in the court of law i.e., proper handling, thorough examination, evaluation and presentation [1].

Forensic odontology encompasses several dental specialties and requires an interdisciplinary knowledge for thorough field work and subsequent evaluation. Periodontics, as a clinical dental specialty dealing with diseases of periodontium, has utility in forensic odontology for identification of individuals through morphology and pathology of periodontium and also for age estimation studies which include periodontal ligament attachment level, periodontitis, root transparency and root length [2,3,4,5]. Several aspects of periodontology can be utilized for the purpose of forensic evaluation (Table 1) and are outlined below:

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Received on 10.03.2017, **Accepted on** 17.03.2017

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 [6]. A simple and cost-effective technique, easily performed in dental clinic practice using discarded Lead foil of the intraoral periapical radiograph as an inclusion agent in the dentures of the individuals for the identification process was proposed recently [7].

Therefore, noninvasive sources such as saliva have come into the limelight in the recent 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 [8,9]. 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 [10].

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. 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. An understanding of these postmortem changes is crucial for medico-legal practice [11].

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 can be carried out using real-time polymerase chain reaction. Quantitative cytomorphometric analysis of exfoliated healthy gingival cells 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 [12].

Cementum: A Marker for Age Estimation

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 for age estimation as compared to other human morphological or histological traits [13]. 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 [14].

The number of incremental lines (n) can be calculated by dividing the total width of cementum from dentino cementum junction to cementum surface (X) by the width of cementum between two adjacent incremental lines (Y) i.e., n=X/Y. 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 [15].

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. Through his pilot study he 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 [16].

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 [17]. 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 the first ever application of cementum study for human identification [18].

Root Transparency and Root Length

The dental features such as root translucency and root length can be used along with the extent of periodontitis to estimate age in adults [19]. Lamendin *et al*. developed a general technique to estimate age of adults at death using two dental features (periodontitis and translucency of the tooth root). Prince and Ubelaker modified this method, creating a formula for each sex and for different ancestries and obtained more precise age estimations [20].

Significance 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 [21].

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 post-firing 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 [21].

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 [22].

Table 1: Aspects of Periodontology for Forensic Identification

➢ Gingival morphology and pathology:
a. Contour, recession, focal / diffuse enlargements, interproximal craters
b. Colour-inflammatory changes, physiological (racial) or pathological pigmentations
c. Plaque and calculus deposits
➢ Periodontal ligament morphology and pathology:
a. Thickness
b. Widening
c. Lateral periodontal cysts and periodontal abscess
➢ Status of alveolar bone:
a. Height, contour, density of crestal bone
b. Thickness of interradicular bone
c. Pattern of lamina dura
d. Bone loss (horizontal / vertical)
e. Trabecular bone pattern and bone islands
➢ Periodontal cosmetic surgeries:
a. Crown lengthening procedure
b. Root hemisection along with regenerative surgery
c. Periodontal microsurgery
➢ Root transparency and root length

Conclusion

Inputs from the field of periodontology could possibly promote forensic research based on a methodical approach. The literature lends evidence that a periodontist can make valuable contributions to forensic odontology. This knowledge update should inspire further research efforts in discovering aspects of periodontics with potential applications in the field of forensic odontology.

Key Messages

- Periodontology includes several potential yet untapped methodologies that be utilized in aiding forensic dentistry
- Many of these concepts are still in a nascent stage and require in-depth research to further establish their usage for forensic investigations

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