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Review Article

Role of Periodontics in Forensic Dentistry

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ABSTRACT: Forensic dentistry deals with the examination, handling, and presentation of dental evidence for the legal system. It is a challenging and fascinating branch of dentistry that applies dental sciences and records for the identification of deceased individuals through comparison of premortem and antemortem records. Human dentition is a crucial key in the identification of individuals as it can be considered as a hard tissue analogue to the fingerprint. This review article focuses on the application of periodontology in the various aspects of forensic dentistry.

Keywords: Forensic dentistry, periodontics, age estimation, sex determination

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INTRODUCTION

Forensic dentistry has taken various twists and turns and now stands at a crossroads where practically every branch has something to add to the process of identifying the deceased. Forensic odontology, which spans multiple dental disciplines and necessitates interdisciplinary expertise for full field work and subsequent evaluation, has been identified as an important aspect of forensic medicine. Periodontics, as a clinical dental specialty concerned with periodontal diseases, has applications in forensic odontology for identifying individuals based on periodontal morphology and pathology, as well as age estimation studies involving periodontal ligament attachment level, periodontitis, root transparency, and root length [1-3]

HISTORICAL BACKGROUND

The Agrippina and Lollia Pauline case, which dates back to 66 A.D., was the first time a tooth was used as evidence for identification. Agrippina, who feared rich divorcee Lollia Paulina, still being a competition for her husband, after her marriage to Claudius, emperor of Rome, planned to kill Lollia Paulina with the help of her soldier, who was

directed to bring the head back. Lollia Paulina's death was later confirmed by the discovery of specific dental alignment traits [4]. The first example to be recorded by dental identification was John Talbot, who died at the Battle of Castillion in 1453. Dr. Paul Revere, the first forensic odontologist, identified the body of revolutionary Dr. Joseph Warren in 1775 by identifying the silver and ivory bridge that Paul had built two years before Joseph's death. In the year 2000, the first forensic identification was made [5].

APPLICATION OF PERIODONTAL KNOWLEDGE TO FORENSIC DENTISTRY IDENTIFICATION

To confirm identity, postmortem dental and antemortem dental records are compared, which include written notes, study casts, radiographs, and so on. Individuals who have had multiple and extensive dental treatments are usually simpler to spot than those who have had little or no restorative treatment [6]. Periodontics is a dental specialty that focuses on the diseases of the gums and supporting tissues of the teeth. Individuals are identified using the anatomical landmarks on the gingiva, the anatomic malformations and associated tissue pathologies, alveolar bone topography mucogingival malformations and implants.

IMPLANTS

Implants: dental implants is one such dental therapeutic option that has great significance in forensic applications. Dental implants are made of titanium and titanium-based alloys with a high melting point ranging over 1650°C. they withstand high thermal temperatures and thermal shock without melting. However, some amount of “sag” with slight shape deformation is noticed. They also have advantages such as corrosion resistance and a high melting point. These characteristics of implants have been demonstrated to make them more valuable as evidence in victim identification [5]. Using a microscope coupled digital camera, it was revealed that the laser engraved batch number on the implant body was still persistent even post-incineration [7].

Recently, an implant recognition programme was developed by G.Michelinakis', which consists of a database loaded with complete manufacturer information and technical specifications regarding various implant systems. In addition, the software database contains radiographic and clinical photographs of the implant systems. Following a series of questions regarding the nature of the obtained specimen, it enables in case recognition and make the task of a forensic odontologist easier [8].

DETERMINATION OF TIME OF DEATH BY – GINGIVAL TISSUES

The post mortem interval (PMI) is the period of time that has passed since a person died, and determining it has always been a difficult task in forensics. Histological and immunohistochemical study of various postmortem tissues have grown in importance over the years, since they may provide new insights that might help determine the time gap after death. The use of gingival tissue in the determination of time since death is one such method. To identify the post mortem interval, many alterations are examined, including:

a) histological changes,

b) ultrastructural changes,

c) electrolyte changes,
d) immunohistochemical distribution and mRNA expression of hypoxia inducible factor (HIF-1alpha)

At the cellular level, respiration tends to stop and glycosis takes over, effectively ending all cell metabolism processes and resulting in autolysis. The natural morphology of the oral mucosa is lost due to post-mortem changes associated with tissue degradation and putrefaction. These cellular alterations can be used to estimate the post-mortem interval as a criterion and marker. From 0 to 8 hours after death, the epithelium undergoes its first modifications, which are visible in the early post-mortem period. Due to homogenization and eosinophilia that spread across the full thickness of the epithelium, the time gradually increases to 16-24 hours [4].

Studies have proven the link between postmortal time intervals and the degree of cellular degenerative changes of gingival tissues. Within 10 hours of death, the decomposition process begins at the cellular level, and the rest of the clinical characteristics of decomposition follow [9]. A similar study compared the electrolytic changes with the histopathologic changes in the gingival tissues at regular intervals following demise. The results demonstrate that light microscopic changes might be seen as soon as 2 hours after death, however there was no statistically significant difference between 2- and 4-hours postmortem samples, despite an ultra-structurally significant difference in morphology [10].

AGE ESTIMATION

Cementum is one of the main markers for age estimation. When there is very little information on the deceased, age estimation is a crucial factor in the identification procedure. Cementum being a peri-radicular connective tissue that is deposited throughout life, plays a crucial role. Cementum is deposited periodic fashion leading to formation of incremental lines in the form of concentric incremental lines. Recent studies have revealed that dental cementum annulations (TCAs) are a valid source of age estimation when compared to other human morphological or histological features [11].

Number of incremental lines (n) = X/Y, where X is the total width of cementum and Y = The distance between two adjacent incremental lines in terms of cementum width. By dividing the number of lines by the tooth's eruption age, one can determine an individual's age. To ensure high reliability of the method, TCAs diagnosis must, however, if at all feasible, be based on several teeth of a single individual [12]. Dental cementum is divided into bands that are alternately opaque and translucent to depict the different seasons. Wedel had a hypothesis in 2007 that dental cementum increment analysis (DCIA) could be used to determine the season of death if the human body's transition between the seasons could be identified [13]. DCIA (dental cementum increment analysis) is a modern approach for determining an individual's age. The DCIA approach was utilised to estimate the age and cause of death of an unidentified female cadaver 37 years after her death.

Godishala Swamy Sugunakar Raju et al. conducted a study to correlate the thickness of apical cementum to identify

age in forensic dentistry. The findings showed that the thickness of apical cementum increased significantly with age in both erupted and unerupted teeth. Cement deposition is a continuous process that happens throughout life and has been proven to treble in thickness between the ages of 20 and 60 [14]. According to GG Stott et al findings, the cementum layer counts can be utilised to calculate the age in people with correct processing and the use of light microscopy and photography [15]. B Azaz et al. undertook a study to see if there was a link between age and cementum thickness in impacted teeth. They took sixty impacted, nonfunctioning permanent canines and premolars from patients ranging in age from 9 to 70 [16].

A MARKER FOR AGE ESTIMATION IS PERIODONTAL LIGAMENT.

The thickness of the periodontal ligament is proportional to both age and mesiocclusal tooth drifting. Periodontal ligament thickness is closely linked to root size, according to a rat study [12]. The width of the periodontal ligament varies between people and on different parts of the tooth. On the distal side of the root, the periodontal ligament is wider than on the mesial side. Because of mesiocclusal drifting of the tooth and the difference in cementum width, the mesial side becomes narrower than the distal side as one gets older. As a result, the cementum and ligament breadth on the mesial side are thinner, which becomes more noticeable as one gets older [17]. One of numerous approaches for estimating age has been the recession of the periodontal ligament. Males saw a faster rate of decline than females [18].

ROOT LENGTH AND ROOT TRANSPARENCY

Various dental anatomical and pathologic traits have been employed to estimate the age of the individuals. The root form, root length, root translucency and root surface changes due to periodontal disease process are useful in age estimation [19]. Lamendin et al. established a general technique for estimating the age of individuals at death using periodontitis and translucency of the tooth root which was later improved upon by Prince and Ubelaker by devising a formula for each sex and for various ancestries, resulting in more accurate age estimates [20].

SEX DETERMINATION

Gender Determination and Dental Calculus - The PCR method is used to determine sex using dental calculus and primers that recognise the DYZ3 region of the Y chromosome and DXZ1 region of the X chromosome. The sex determination required a minimum of 3 pg of DNA. Because it can be done without destroying the morphological properties of the teeth, sex determination utilising DNA in dental calculus will be very beneficial for forensic applications [21].

SALIVA

Saliva is a complicated bodily fluid that plays an important part in forensics. Saliva contains epithelial cells, which has enhanced its use in determining sex. Two factors have been proposed based on effective results in identifying the sex using blood stains. The first is detecting sex chromatin, which is represented by Barr bodies in females and F bodies in males. The second is the measurement of sex hormone levels, which is based on the amounts and ratios of

17 B-estradiol and testosterone that can be detected. Clothing, meals, cigarette items, drink containers, oral hygiene devices, stamps, dental prosthesis, envelopes, and other non-living objects can all yield salivary DNA. The phenol–chloroform method is used to isolate deoxyribonucleic acid from a spit sample.

Saliva can be collected in two ways: (a) with a single swab and (b) with a double swab. Saliva is the most trustworthy source for human identification, with 1 ml of saliva having the same DNA typing strength as 10 l of whole blood [5]. In most cases, the concentration of a drug in saliva is directly proportional to the concentration of the same substance in blood. In circumstances involving bitemarks, saliva biomarkers are also utilised to identify people and to identify victims in mass disasters [22].

CONCLUSION

This review article focuses on the numerous ways that periodontics knowledge can be applied in forensic dentistry. Forensic odontology and periodontics should work together to improve interactions with law enforcement, the judiciary, and the forensic community in a variety of settings [23]. As a result, dental practitioners play a critical role in maintaining correct dental records and supplying all required information to legal authorities in order for them to notice malpractice, negligence, fraud, or abuse, as well as identify unknown humans [24].

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