ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 12, pp.8645-8649, December, 2019

DOI: https://doi.org/10.24941/ijcr.37488.12.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

FORENSIC PERIODONTOLOGY: AN OVERVIEW

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ARTICLE INFO

Article History:
Received 14th September, 2019
Received in revised form
28th October, 2019
Accepted 15th November, 2019
Published online 30th December, 2019

Key Words:
Forensic Odontology,
Periodontitis, Gingiva.

ABSTRACT

Forensic odontology is a speciality that relates dental evidence to investigation. The application of forensic techniques in identification, criminal justice and dental liability is being practiced widely worldwide. There has not been substantial literature dedicated towards the upcoming branch in medical sciences that is forensic medicine despite the leaps in modern technology, medical breakthroughs and the geographical changes that the last century has seen. Periodontics is a science which deals with diseases of periodontium. The study of the periodontal structures post mortem can help in the identification, determination of time of death, sex determination along with age estimation of the deceased. This article highlights the importance of Forensic Periodontology and reviews the role of the periodontist in the same. Dentists can assist those involved in criminal investigations by identifying the victims of crime and disaster through dental records, most common role of the forensic dentist is the identification of deceased individuals. . On the recent scenerio, periodontists have identified the features of ante mortem and postmortem changes in the periodontium. Thus, in the coming era, periodontist could also play an important role in forensic odontology.

Citation: Dr. Rugma U Menon, Dr. Radhika B., Dr. Amit k Walvekar, Dr. Kith P Jose, Dr Sneha Fal Dessai and Dr. Sujitha Golla. **2019.** "Forensic periodontology: an overview", *International Journal of Current Research*, 11, (12), 8645-8649.

INTRODUCTION

Forensic odontology is a field of dentistry which is involved in analyzing dental evidence in the interest of justice. Periodontics deals with diseases of the periodontium. Forensic dentistry deals with the identification of unique features present in an individual through morphology and pathology of the periodontium and is also useful for age estimation which includes periodontosis, root transparency and root length (Thorakkal, 2014). Forensic odontology has been designated as an important part of forensic medicine and the first ever evidence of the use of forensic odontology to identify a dead subject was done in the late 60's AD when King Nero recognized a lady through her peculiar teeth setting. The methods employed in identification involve dental comparisons, finger, palm or foot prints, DNA identification and radio graphic superimpositions (Stimson, 1997).

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In the present era of genomics and proteomics forensic dentistry has encompassed the use of deoxyribonucleic acid (DNA) and proteins as unique tools in identification (da Silva, 2007). Dental identifications plays a major role in identification of natural and manmade disaster situations that result in multiple casualties.[5]Periodontics deals with identification of individuals through morphology and pathology of periodontium and is also utilized for age estimation which includes (periodontal ligament attachment level) periodontosis, root transparency and root length (Shamim, 2011).

Comparetive dental identification

Legal identification of an individual's identity is based on numerous parameters centered about the appearance and personal effects (identity cards, jewellery clothes, etc)'. Teeth are the hardest substances in the human body and are capable of surviving post-mortem events which can alter or render unfit other body tissues as source of identification. Teeth are made of enamel so it can withstand trauma and varied conditions of wear, disease, and professional manipulation better than other tissues in body.

Approximate age and useful indications of probable sex, race, occupation, personal habits, medical history and environment can often be revealed by analysis of only teeth (Avon, 2004). The central dogma of dental identification involves comparison of postmortem dental remains with antemortem dental records, including written notes, study casts, radiographs etc, to confirm identity. Clearly, individuals with placement of custom restoration and other numerous and complex dental treatments ensure accuracy when the techniques are correctly employed than those individuals with little or no restorative treatment. The forensic dentist produces the postmortem record by careful charting and written descriptions of the dental structures and radiographs (Goldstein, 1998).

Specialized oral autopsy techniques like tenotomy and thread-wire saw myotomy of temporal is muscles and/ or mandibular periosteal stripping have been developed to facilitate the collection of post-mortem intra-oral evidence (radiographs or impressions) (Nalayama, 2001). Craniofacial reconstruction is used when there is a body that is unrecognizable due to its state of decomposition, skeletization, mutilation, or calcinations. It is used to recreate the face of the individuals immediately before their death and also computer software and several three-dimensional manual methods are available for forensic purpose (Kanaparthy, 2013). Computer aided comparison of data not only reduces the labor and time constraints but also eliminates subjectivity of the process.

The programs commonly in use today are:

Odontosearch: This software was developed by Central Identification Lab, USA' It compares an individual's pattern of missing, filled and unrestored teeth to a large sample group, representative of the US population.The database of the odontosearch receives inputs from various participants in dental health programs (Adams, 2003).

Automatic dental identification system (ADIS): is software similar to the automatic fingerprinting identification system and assesses radiographic data like the bone, root and tooth morphology. This can be achieved by tracing the outline of the root and tooth on a radiograph (bitewing or periapical) (Nassar, 2003).

Computerized assisted post-mortem identification System (CAPMI): Was developed by the US .Army dental Research institute with the aim of finding missing persons. It was found that if an individual possessed 4 or more characteristics then the individual could be separated from the entire group. It was also demonstrated that even in individuals with no missing or filled teeth even a single characteristic of diversity vastly improved identification (Lorton, 1988). WinlD-is a dental computer system that matches missing persons to unidentified human remains .The data is stored in a Microsoft access database. In problem cases, a variety of techniques are used to assist in the identification issue. These include (1) amino acid racemization studies, especially aspartic acid, (2) incremental line and other histology studies, (3) scanning electron microscopy with and without energy-dispersive X-ray analysis, (4) metal ratio analysis in bone and teeth, (5) serology studies for blood groups, serum proteins, and polymorphic enzymes, and (6) most recently, DNA analyses. The clinical parameters of the gingiva like contour, recession, enlargements, interproximal craters can help in identification of the individual by matching it with ante mortem records. Similarly The clinical parameters of the periodontal ligament such as thickness, widening and pathologies have been taken into consideration for establishing identity of the individuals. Comparison of the ante and postmortem radiographical records for the alveolar bone height, contour and density of crestal bone, thickness of interradicular bone, pattern of lamina dura, bone loss ,trabecular bone pattern and bone islands has helped in establishing the identity of the individuals. Records of the periodontal esthetic procedures have been used in identifying a person (Shamim, 2011).

Dental Profiling: When ante-mortem dental records are unavailable and other methods of identification like ethnic orgin, gender, age are used, this information will enable a focused search for ante-mortem records, the forensic dentist can limit the population pool to which the diseased belong and thus increase the likelihood of locating ante-mortem dental records. This process is known as post-mortem dental profiling (Pretty, 2001).

Age Determination: Age is one of the essential factors in establishing the identity of the person and a critical component in dental profiling. Small difference in the formation and eruption of tooth among people has made dental estimation of chronological age the primary method of age determination for younger persons (Ranganathan, 2008). The use of radiographs plays an indispensable role in the human age determination. It is based on assessment of various techniques that involve observation of the morphologically distinct stages of mineralization, formation of root and crown structures, the stage of eruption and the intermixture of primary and adult dentitions. Histological examination of teeth also used in the determination of age (Stimson, 1997). Amino acid racemization studies are also used to determine age (Ogino, 1989).

The various techniques used to determine age are

Radiographic Techniques: Dental radiographs are used rarely for dental age estimation and these are the nondestructive tools used in the forensic odontology.

Estimation of age using dental data

Dental pulp: As per the studies conducted before it is shown that with advancing age the size of the dental pulp cavity is reduced as a result of secondary dentine deposition, so that measurements of this reduction in dental pulp can be used as an indicator of age.

Estimation of age using periodontal data

Cementum in age determination: Cementum opposes continuously; if contributing conditions could be avoided for a reasonable period of time, this property of cementum apposition aids as an adjunct to biological age estimation, which may serve to be significant tool in forensic investigations. Cementum will be deposited throughout the life. Deposition will occur in the form of concentric incremental lines and each line corresponds to 1 year of life (Gattami, 2008). Tooth cementum annulations can be used for age estimation of the deceased (Kavitha, 2008). Cresyl fast violet, Toluidine blue, hematoxylin or periodic acid Schiff (PAS) can also be used for staining.

Since incremental lines are not destroyed by acids and stains (Kvaal, 1996). A new method was reported using Dental Cementum Increment Analysis (DCIA) was recently introduced to determine death of individuals.[19]Winter (dormant) and summer (growth) seasons are represented by alternating opaque and translucent bands laid down by dental cementum.Wedel 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, he was successful in providing a resource to forensic anthropologists for determining the season at death through DCIA (Wedel, 2007).

Gingival Marginal: The marginal tissue recession of the periodontium has been used as one of the several indicators of age in methods for age estimation (Soleheim, 1992).

Gingival tissue changes: Gururaj and Sivapathasundharam (Gururaj, 2004) studied the postmortem changes in gingival tissues. Gingival sections from dead individuals showed vacuolation of nuclei in the spinous layers of epithelium suggestive of autolysis. Gingival sections from living individuals showed no changes.

Langerhans cells: Modified adenosine triphosphatase (ATPase) histochemistry was used to identify and count Langerhans cells and the frequency of oral mucosal LC varies inversely with the degree of keratinization. There are regions of the oral mucosa that have no langerhans cell (Daniels, 1984).

Alveolar bone in age estimation: The measurements of alveolar bone level according to Lamendin indicated the process of alveolar resorption on the labial aspect of anterior monoradicular teeth to increase with aging (Sarajilic, 2009). Age can be estimated by histological evaluation of osteons in bones.

Gender Determination: Sex determination based on dentition is difficult for most forensic investigators. Sex differences in dentition are based largely on tooth size and shape. Dental calculus has been used for determination of sex by PCR method with the use of primers, which recognize DYZ3 region of Y-chromosome and DXZ1 of X-chromosome (Kawano, 1995). Oral epithelium cells which are harvested by pressure application of a toothbrush has been used to assess the qualities of DNA of individuals followed by gender identification by sex determining region-Y (SRY) gene amplification using real time polymerase chain reaction (Shamim, 2011). Quantitative cytomorphometric analysis of exfoliated healthy gingival cells which were obtained by scraping attached gingiva to assess age and gender associate with 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 (Patel, 2011).

Racial Determinants: Race determination in skeletal remains traditionally focuses on craniofacial characteristics such as the proportions of the orbital and nasal areas, nasal aperture characteristics, lower nasal border features, lower facial prognathism, palate form, cheekbone contours and incisor shoveling. From a dental viewpoint, both the mandible and dentition reflect racial characteristics. Craniofacial and dental characteristics can be used to reconstruct the likely visage of victim(s) or perpetrators under consideration. Computer age progression has been actively used by the FBI and by the National Center for Missing and Exploited Children.

Miscellaneous Determinants: Occassionally, examination of dental evidence may provide adjunctive evidence in the establishment of identity. The distribution of brown-black stains on the surface of teeth may be indicative of pigmentation from use of areca nut or tobacco the cultural usage of which are common in south asian countries. Increased in dental decay and low degree of restorative activity are likely indicators of low socioeconomic status (Stimson, 1997). Another penomenon with some application in forensic odontology, is the phenomenon of pink teeth. It has been assumed that pink teeth are analogous to post-mortem lividity can, but are not pathognomonic for a specific cause of death (Borrman, 1994). Oral soft tissues also contribute to the identification pool. Cheiloscopy and Rugoscopy are likely to find their niche in forensic odontology (Shamim, 2006). Cheiloscopy or study of lip prints which are normal lines and fissures in form of wrinkles and grooves present in the transition zone of the lip (Sivapathasundharam, 2001). Rugoscopy is the study of palatal rugae patterns. It has been observed that though shape and direction of rugae remain stable throughout life, there is disagreement over the variation in their mean number (Kapali, 1997).

Mass Disaster Identification: Mass disasters are events causing widespread human casualties as a result of natural events, such as severe flooding, earthquake, or volcanic eruption, or they may be associated with human activity, such as mass transport by land, sea, or air or terrorist activity (Pretty, 2001). Current interest in the digitalization of radiographs for teleradiology and telemedicine purposes and its potential application to dental radiographs such as pantomorphographs, especially in established databanks, should improve dental databases and provide an important tool in decedent identification efforts.

Bite Marks: Bite mark is defined as a mark made by the teeth either alone or in combination with other mouthparts. Bite mark can be found on human body or food materials or any other inanimate materials such as bottle caps, cigar/cigarette holders, pipes, musical instruments, etc., found at the crime scene. Bites are usually associated with sexual assaults, child abuse or self-defense. Bite mark is the most intriguing, complex and sometimes controversial challenges in forensic dentistry (Clark, 1980; Onmura, 1968; Rothwell,). Bite mark evidence can be documented by dental impressions, photography and use of overlays. Metric analysis can be done to measure the size of the tooth of the suspect and compared with the bite mark. To ensure uniformity among all experts and form a uniform pattern to follow and apply and validate it scientifically, scientific basis for statistical analysis of the uniqueness of human dentition in bite mark evidence was studied by the American Board of Forensic Odontology (ABFO) and has standardized bite mark analysis. ABFO has developed a scale (ABFO scale No.2) for effective standardized measurement and comparison of bite marks. Special techniques like scanning electron microscopy coupled with energy dispersive X-ray analysis to reveal the surface topography of bite marks (Rothwell).

Dna Analysis: In mass disasters, a common approach is to identify fragmentary remains by traditional means such as dental comparisons, fingerprints, or radiographic criteria (superimpositions), type recovered DNA from these fragments, and use that profile to re associate other fragmentary remains producing the same DNA profile pattern. Current advances and availability of biomolecular resources for human identification, it is possible to identify a person using small amounts of deteriorated biological material and teeth being their usual resistant selves are robust sources of DNA (Rai, 2007). Mitochondrial DNA can also be used for body identification. Its main advantage is the high number of copies per cell. Current DNA profiling or fingerprinting techniques are either restriction fragment length polymorphisms (RFLPs) on variable number tandem repeats (VNTRs) or polymerase chain reaction (PCR) analysis. The application of this DNA technology to forensic odontology cases relies on the principles presented and the general condition that this analysis will be done by other than forensic odontologists.. This success provides a basis for re association of body parts that might not be otherwise possible because of decomposition. mitochondrial DNA analysis is of particular interest because of its availability, especially in skeletal materials and its successful characterization by polymerase chain reaction.

Saliva in Forensic: Use of saliva and mouth swabs as sources of DNA shows some technical advantages over the use of blood. Saliva can be a medium for recovery of DNA proteins and dried saliva can be retrieved from many sources or surfaces. The challenge lies, not in identification of dried saliva, which is invisible once dry.

Role of dental implants for forensic: Dental implants are usually classified depending on implant design, properties, and attachment mechanism.[36] In dental implants, identifiable features include the grooves, holes, and threads on the implant's surface. These potentially enable forensic odontologists to determine the implant's made and design. Dental implants are used as an essential aid in emerging field of forensic identification because of its ability to resist higher temperature even after incineration (Berketa, 2011).

Conclusion

Maintenance of dental record is very important in the critical situations. The success of forensic dentistry is dependent on the availability of data. There is an urgent need to motivate dental practitioners to maintain dental records, apply distinctive marks in prosthesis and also maintain a database, which can be made available on request. Forensic odontologist identifies a person by determining sex and age, using various tissues, like gingiva, bone all forms of dental treatment and form dental records collect, preserve and interpret trace evidence to the judicial authority. Periodontist can also actively part-take in probable and possible identification of a known and unknown individual before and after death.

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