RESEARCH ARTICLE

PERIODONTICS AND FORENSIC PERSONAL IDENTIFICATION: AN UPDATE

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ABSTRACT

Human identification is a mainstay of civilization and the identification of unknown individuals always has been of paramount importance to the society. Traditional methods of identification have included visually recognizing the body, personal property like clothing, jewellery etc. These methods are however, not very reliable and can be a very traumatic experience for relatives and friends in burned & decomposed cases. The most reliable means of identification include finger prints, dental comparison and DNA profiling, which are unique to every person. Forensic Odontology is one of the most rapidly emerging branches of forensic medicine and forensic science. This branch gives immense importance to dental evidence for the identification of victims and suspects in mass disasters, abuse and organized crimes. Forensic Odontology involves the correct collection, management, interpretation, evaluation and presentation of dental evidence for criminal or civil legal proceedings: a combination of various aspects of the dental, scientific and legal professions. Literature reveals that human dentition is never the same in any two individuals; this is the main basis for dental identification (Each dentition is considered to be unique, although to the non-dental eye, they all may look the same. Variations in shape, color, position, age changes, wear patterns, caries and periodontitis, and all associated dental restorations and prosthetic work, make the dentition as individual as fingerprints. This review aims to discuss the utility of periodontal findings in the field of forensic odontology.

INTRODUCTION

As we enter a new millennium, society is faced with fresh challenges in every conceivable era. Despite leaps in modern technology, medical breakthroughs and the geographical changes that the last century has brought, crime still persists in all aspect of our lives. Violent & heinous activities, disasters like plane crash, fire incidents, various natural calamities like floods, tsunami's, earthquake's that shatter the lives of victims, their friends and families occur every day (Pretty, 2001). Human identification is a mainstay of civilization and the identification of unknown individuals always has been of paramount importance to the society (Wedel, 2013). Not only is it important to identify the deceased to ensure a proper burial, but also there are issues such as criminal investigations, insurance settlements and military proceedings that can be resolved only with a positive identification. Traditional methods of identification have included visually recognizing the body, personal property like clothing, jewellery etc. These methods are however, not very reliable and can be a very

traumatic experience for relatives and friends in burned & decomposed cases. The most reliable means of identification include finger prints, dental comparison and DNA profiling, which are unique to every person. However, epidermal ridges may undergo post mortem changes, or may be unavailable in cases involving fire decomposition and massive trauma (Rothwell, 2001). Through the specialty of forensic odontology, dentistry has played a significant role in identification in manmade and natural disasters resulting in multiple fatalities and crime investigations, that may not be identifiable through conventional means. Periodontics is a clinical dental speciality dealing with diseases of periodontium (Shamim, 2012). This speciality can be utilized for the identification of individuals through gingival, periodontal ligament morphology and pathology, status of alveolar bone and periodontal cosmetic surgeries, root transparency and root length (Shamim, 2011). This review of literature aims to discuss the periodontics perspective in identification and age estimation in forensic research.

Factors of periodontal disease in relation to forensics: It is important for the periodontist to note & record these various disease factors (patient's case history, photographs & casts documentation) that we are going to discuss that would

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definitely serve as an important tool in diagnosis of the deceased. Keeping in mind that the death of the soft tissues occurs after the clinical death of the deceased in 48 hours, the maintenance of the clinical photographs proves to be of utmost importance in evidence.

Interrelationship of periodontics with forensic odontology

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

Fig 1.0.

Gingival morphology and pathology

Gingival Contour: The contour or shape of the gingiva varies considerably among individuals and depends on the shape of the teeth and their alignment in the arch, the location and size of the area of proximal contact and the dimensions of the facial and lingual gingival embrasures (Fiorellini et al., 2012). The harmony of gingival contour is jeopardized by improperly constructed dental restorations and prosthetic abutments (Simon, 2010). The anatomical form, marginal adaptation, marginal discoloration and surface roughness of the dental restorations and prosthetic abutments in relation with the contour of the gingiva should be assessed. Stillman's cleft (apostrophe shaped indentations extending from the gingival margin apically) and McCall's festoons (life saver shaped enlargements of marginal gingiva in canine premolar region) associated with occlusal trauma will enhance the identification process (Bhola, 2008; Thom, 1979).

Gingival Recession: Gingival recession is an undesirable condition presenting as localized and generalized form resulting in root exposure. The etiology of gingival recession was traced to bad oral hygiene practices, high level of dental plaque and calculus and tobacco consumption habit with more cases reported in older population (Kassab, 2003). Gingival recession was reported in young Israeli adults with history of past orthodontic treatment and oral piercing (Slutzkey, 2008). The presence and extent of gingival recession will increase with age and it is frequently seen on buccal surfaces than on other aspects of the teeth. Gingival recession is also associated with clinical crown length, arch relationship and frenum involvement (Mathur, 2009). Gingival recession (gingival recession) is measured on the labial surface of each tooth and defined as the degeneration of the soft tissues surrounding the tooth progressing from the CEJ to the apex of the root. It is the maximum distance between the CEJ and the line of soft tissues attachment. Root Transparency is the physiologic feature that appears after age 20 and is due to deposition of hydroxyapatite crystals within the dentinal tubules.

The Lamendin technique measures translucency on the labial surface between the apex and the maximum height of translucency. Root height is that distance measured between the root apex and the CEJ (Lamendinetal, 1992). After these measurements have been recorded, then the following regression equations will be calculated: A = 0.18· P + 0.42· T + 25.53, where A = age in years, P = Periodontosis height · 100/root height, and T = Translucency height· 100/root height. Prince and Ubelaker evaluated this technique and suggested that sex and ancestry should be considered when estimating age at death based on translucency of the tooth root and periodontitis. This proposal has been supported by other studies.

Focal and Diffuse Enlargements of the Gingiva: Gingival enlargements are quite common and can be classified as focal and diffuse enlargements. The etiology of the gingival enlargement may be inflammatory (abscess), idiopathic (hereditary gingival fibromatosis), drug induced (calcium channel blocker, phenytoin, cyclosporine), granulomatous disease (tuberculosis), neoplasms (leukemia) and any other systemic and local pathology (Aghili, 2013; Gill, 2010; Livada, 2014; Subramani, 2013).

Interproximal Craters: Inter proximal craters are usually presented in necrotizing ulcerative gingivitis with interdental necrosis, punched out ulcerated papillae, gingival bleeding and pain.[9] Similar ulcerative changes of gingiva are also reported in Fanconi's anaemia and HIV infection (Mataftsi et al., 2011; Srirangarajan et al., 2011).

The Color of the Gingiva: The usual color of the gingiva is coral pink and gingiva will exhibit physiologic pigmentation. The most common site of physiologic pigmentation is the labial part of the gingiva, and the attached gingiva is the most common pigmented anatomic division. The highest rate of gingival pigmentation has been observed at the incisors (Tamizi, 1996). The pathologic pigmentations in gingiva may be smoker's melanosis, melanotic macule, oral melanoacanthoma, pigmentation by foreign bodies or induced by drugs, Peutz–Jeghers syndrome, Addison's disease and oral melanoma (Gondak, 2012).

Plaque and Calculus Deposits: The oral hygiene status can be assessed by recording plaque and calculus deposits and there is a definite correlation between bad oral hygiene status with higher plaque and calculus deposits. Plaque and calculus deposits will be higher in certain pathologic conditions (Gondak, 2012).

Periodontal ligament morphology & pathology: The clinical parameters of the periodontal ligament such as thickness of periodontal ligament, widening of periodontal ligament and pathologies of the periodontal ligament such as lateral periodontal cysts and periodontal abscess were taken into consideration for establishing identity of the individuals. The thickness of the periodontal ligament will be directly related to age and mesio-occlusal drifting of teeth. In a more recent study on rats it, was found interfered that periodontal ligament thickness is directly proportional to root dimensions. The widening of the periodontal ligament space is seen related to bisphosphonate-associated osteonecrosis of the jaws, progressive systemic sclerosis and primary hyperparathyroidism. The lateral periodontal cyst is a rare developmental odontogenic cyst seen in mandibular premolar

region of adults. Lateral periodontal cysts are non-keratinized cysts located adjacent or lateral to the root of a vital tooth. Periodontal abscess is localized, purulent infection within the tissues adjacent to the periodontal pocket that may lead to the destruction of periodontal ligament and alveolar bone (Cuoghi, 2013; Louridis, 1974).

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 (Stein, 1994). 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 (Pundir et al., 2009). 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 (Aggarwal, 2008). 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 (Wedel, 2007).

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 (Dias et al., 2010). 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 (Wedel, 2013).

Status of alveolar bone: The clinical parameters of the alveolar bone such as height, contour and density of crestal bone, thickness of interradicular bone, pattern of lamina dura, bone loss (horizontal or vertical), trabecular bone pattern and bone islands were taken into consideration for establishing identity of the individuals.

Height, Contour and Density of Crestal Bone: Bone mineral density is an important risk indicator for periodontitis in postmenopausal women (Singh et al., 2013). Tobacco consumption induces alveolar crest height loss independently of mandibular bone mass and bone density (Mesa et al., 2014). Osteoporosis or low systemic bone mineral density is considered as a risk factor for periodontal disease progression (Esfahanian, 2012).

Thickness of Interradicular Bone: The buccal interradicular cortical bone thickness between canine and first premolar or between first premolar and second premolar is the greatest and between central incisor and lateral incisor is the least and buccal and palatal interradicular cortical bone thickness and alveolar process width will tend to increase from crest to base of alveolar process (Sawada, 2013).

Pattern of Lamina Dura, Trabecular Bone Pattern and Bone Islands: Partial or complete loss of lamina dura, delicate or absent trabecular patterns, and an overall granular or chalky white appearance associated with an increase in radiographic density are seen in patients with renal osteodystrophy.[5] Trabecular pattern can be assessed in mandible using periapical and panoramic radiographs (Aranha Watanabe, 2009; Pham, 2010).

Bone Loss (Horizontal or Vertical): Horizontal alveolar bone loss is seen more often than the vertical bone defects in periodontal patients (Jayakumar, 2010).

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 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 (Berketa, 2010). 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 (Malkinson, 2013).

Periodontal cosmetic surgeries: The periodontal cosmetic surgeries such as crown lengthening procedure, root hemisection along with regenerative surgery and periodontal microsurgery were taken into consideration for establishing identity of the individuals.

Crown Lengthening Procedure: Open-flap and minimally-invasive flapless esthetic crown lengthening procedures are usually recommended for the treatment of excessive gingival display.[30] The effect of esthetic crown lengthening procedures plays a major role in the perception of whether a person is attractive and whether or not they are perceived as friendly, trustworthy, intelligent, and self-confident (Malkinson, 2013).

Root Hemisection along with Regenerative Surgery: Hemisection is a viable method of preserving periodontally or endodontically compromised teeth or roots (mainly mandibular first molars) (Ronay et al., 2012). Among regenerative surgical procedures in periodontics, guided tissue regeneration is still the favourable technique with significant clinical and histologic documentation of periodontal regeneration (Wolff, 2000).

Periodontal Microsurgery: Periodontal microsurgery is now grouped under minimally invasive periodontal therapy that preserves dentition and supporting structures and allows less extensive manipulation of surrounding tissues than conventional procedures and accomplishing the same treatment results.[13]

Conclusion

Forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or by other means. This branch gives immense importance to dental evidence for the identification of victims and suspects in mass disasters, abuse and organized crimes. Forensic dentistry is not a recent branch of dentistry. It has always been a part of forensic science. According to Harvey, the earliest known example of identification by dental means dates back to 49 B.C. From the earliest examples of forensic dentistry involving Agrippina, the mother of Roman Emperor, who ordered death of her rival Lollia Paulina, and demanded to see Lollia Paulina's head as a proof of her death, but she was not sure that her rival was dead, until she noticed Lollia Paulina's distinctive discolored front teeth to the case of December 2012 Delhi (Nirbhaya) gang rape case, in which forensic odontology was used to establish the guilt of all the accused. The use of teeth, biopsy samples, saliva, dentures and other aids have revolutionized forensic science. The teeth and facial bones are resistant to fire, burns and can be still recovered from disaster sites for use. The unique nature of our dental anatomy and placement of custom restorations ensure accuracy when the techniques are correctly employed. It is evident that identification of victims in accidents and natural calamities is of utmost importance and is a challenging task. So, likewise all other dental fraternities, periodontist can also put their valuable contribution in probable and possible identification of a known and unknown individual before and after death.

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