

## REVIEW ARTICLE

### Forensic Odontology - A New Scope in Dentistry

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#### **ABSTRACT:**

Forensic Odontology uses the skill of the dentist in human identification during mass calamities, sexual assault and child abuse to name a few. It's role and importance in the judiciary is rapidly growing and hence in depth knowledge in this field seems more than justified. In recent time this branch has shown its potential for growth and to discuss its scope and future prospects is need of the hour.

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#### **Introduction**

When human remains are found, the first priority of is to identify who the individual was in life. To attain this goal, investigators have used various methods from many fields of science. To reach the depth of the case, combined efforts of a multidisciplinary team are required. 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 which is a special branch of forensic medicine

#### **History**

Forensic Odontology was defined by Keiser-Neilson in 1970<sup>1</sup> as "that branch of forensic medicine which, in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findings". Most dentists have the basic knowledge and skills to perform forensic dental analysis. Analysis of dentition generally includes examination of position and shape of fillings, presence or absence of teeth, and shape of molar roots. Usually, this information is gained through the use of radiographs. By comparing these data, an identification of

the unknown individual may be reached. Forensic dentistry is most commonly used for purposes of identification, but is also useful in the evaluation of bitemark evidence. The significance of forensic dentistry was officially recognized in 1969 with the establishment of the American Society of Forensic Odontology and in 1970 with the formation of an Odontology Section within the American Academy of Forensic Sciences (Sopher 1976). Next to fingerprints, teeth are the most useful tool in determining positive identification of human remains. Teeth are the most durable portion of the body and have the ability to resist erosion, deterioration, and fire long after death. Teeth must be exposed to a temperature of over 500°C (932°F) to be reduced to ash. Teeth demonstrate a variety of form and varied conditions of wear, trauma, disease, and professional manipulation. 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 (Rogers 1986; 1987; 1988). 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.

### TOOTH AS A TOOL FOR FORENSIC EVIDENCE

Teeth are unique; no two people have the same teeth. Knowledge of dental anatomy is very important; when examining a tooth, one must differentiate between deciduous and permanent teeth. Subsequently, he must determine the group in which the tooth belongs (incisors, canines, premolars, molars), and whether it is superior or inferior. He must identify the abnormal situation and implement a corresponding dental formula. Identification by teeth is important especially in cases of major disasters, in which often only the dental arches remain because of their resistance to high temperatures and bad weather. The expert must be prepared to work with the arches and teeth together and with each as individual elements, in which only one tooth is found. He must then be able to tell whether the element is of human origin, and the position in which it would be found. Periodontics is a clinical dental speciality dealing with diseases of periodontium. This speciality is utilized for identification of individuals through morphology and pathology of periodontium and is also utilized for age estimation studies which include (periodontal ligament attachment level) periodontosis, root transparency and root length<sup>2</sup>. This paper aims to discuss the periodontics perspective in identification and age estimation in terms of the following aspects.

### DISCUSSION

#### GINGIVAL EPITHELIUM

Gingiva is a part of the oral mucosa that covers the alveolar processes of the jaws and surround the neck of teeth in a collar like fashion. It consists of epithelium and connective tissue. The epithelium can be keratinized or non keratinized. Cell death occurs by apoptosis, necrosis, or autolysis. 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.<sup>3</sup> 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.<sup>4</sup> 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 gingival can be studied for human identification.

#### CEMENTUM

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.<sup>5</sup> 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.<sup>6</sup>

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. 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.<sup>7</sup> 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.<sup>8</sup>

#### Future implications

For human identification using periodontal tissues such as the study of Barr bodies for sex-determination in gingival epithelial cells with a practical approach to the accomplished facts should be set into motion by assessing them in the judicial system.

## **Identification**

Periodontics is the speciality of dentistry dealing with diseases of the gums and other structures around the teeth. This speciality is utilized for identification of individuals through gingival morphology and pathology, periodontal ligament morphology and pathology, status of alveolar bone and periodontal cosmetic surgeries .

## **Gingival Morphology and Pathology**

The clinical parameters of the gingiva such as contour, recession, enlargements, interproximal craters, color (inflammatory changes, physiological [racial] or pathological pigmentations), dental plaque and calculus deposits were taken into consideration for establishing identity of the individuals.

## **The Contour of the Gingiva**

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. The harmony of gingival contour is jeopardized by improperly constructed dental restorations and prosthetic abutments. 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<sup>8</sup>.

## **Gingival Recession**

Gingival recession is an undesirable condition presenting as localized and generalized form resulting in root exposure.<sup>9</sup> 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. Gingival recession was reported in young Israeli adults with history of past orthodontic treatment and oral piercing. 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.<sup>9</sup> Gingival recession is also associated with clinical crown length, arch relationship and frenum involvement.

## **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.<sup>10</sup>

## **Interproximal Craters**

Interproximal craters are usually presented in necrotizing ulcerative gingivitis with interdental necrosis, punched out ulcerated papillae, gingival bleeding and pain. Similar ulcerative changes of gingiva is also reported in Fanconi's anaemia and HIV infection<sup>11</sup>.

## **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. 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<sup>12</sup>.

## **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<sup>13</sup>.

## **Periodontal Ligament Morphology and 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.

## **Thickness of Periodontal Ligament**

The thickness of the periodontal ligament will be directly related to age and mesioocclusal drifting of teeth. A more recent study on rats about the importance of periodontal ligament thickness, it was interfered that periodontal ligament thickness is directly proportional to root dimensions<sup>14</sup>.

## **Widening of Periodontal Ligament**

The widening of the periodontal ligament space is seen related to bisphosphonate-associated osteonecrosis of the jaws, progressive systemic sclerosis and primary hyperparathyroidism.

## **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. Tobacco consumption induces alveolar crest height loss independently of mandibular bone mass and bone density. Osteoporosis or low systemic bone mineral density is considered as a risk factor for periodontal disease progression<sup>15</sup>.

#### **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.

#### **Bone Loss (Horizontal or Vertical)**

Horizontal alveolar bone loss is seen more often than the vertical bone defects in periodontal patients.

#### **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. The effect of esthetic crown lengthening procedures play 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<sup>16</sup>.

#### **Root Hemisection along with Regenerative Surgery**

Hemisection is a viable method of preserving periodontally or endodontically compromised teeth or roots (mainly mandibular first molars). Among regenerative surgical procedures in periodontics, guided tissue regeneration is still the favourable technique with significant clinical and histologic documentation of periodontal regeneration.

#### **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<sup>17</sup>.

#### **Age Estimation**

One of the interesting applications of forensic odontology is age estimation by means of teeth. Periodontics is also utilized for age estimation studies which include periodontosis (gum recession), root transparency and root length.

#### **Periodontosis**

Periodontosis is one of the six dental changes that is used along with attrition, secondary dentin deposition, root translucency, cementum apposition and root resorption to estimate age by Gustafson's method.

#### **Root Transparency and Root Length**

The dental features such as root translucency and root length can be used along with the extent of periodontosis to estimate age in adults<sup>18</sup>. Lamendin *et al.* developed a general technique to estimate age of adults at death using two dental features (periodontosis and translucency of the tooth root) and Prince and Ubelaker modified this method, creating a formula for each sex and for different ancestries and obtained more precise age estimations .

#### **CONCLUSION**

To conclude, this article hopes to sensitize all dental fraternities and periodontics specialists around the globe to know the interrelationship of periodontics with forensic odontology.

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