Oral pathology in forensic investigation

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Forensic odontology is the subdiscipline of dentistry which analyses dental evidence in the interest of justice. Oral pathology is the subdiscipline of dentistry that deals with the pathology affecting the oral and maxillofacial regions. This subdiscipline is utilized for identification through oral and maxillofacial pathologies with associated syndromes, enamel rod patterns, sex determination using exfoliative cytology, identification from occlusal morphology of teeth, and deoxyribonucleic acid profiling from teeth. This subdiscipline is also utilized for age estimation studies which include Gustafson’s method, incremental lines of Retzius, perikymata, natal line formation in teeth, neonatal line, racemization of collagen in dentin, cemental incremental lines, thickness of the cementum, and translucency of dentin. Even though the expertise of an oral pathologist is not taken in forensic investigations, this paper aims to discuss the role of oral pathology in forensic investigation.

Keywords: Age estimation, forensic investigation, forensic odontology, identification, oral pathology

A review of the literature was done using PubMed to evaluate the role of oral pathology in forensic investigation. The following keywords were searched in PubMed: Identification, enamel rod patterns, sex determination using exfoliative cytology, identification from occlusal morphology of teeth, deoxyribonucleic acid profiling from teeth, Gustafson’s method, incremental lines of Retzius, perikymata, natal line formation in teeth, neonatal line, oral and maxillofacial pathologies with associated syndromes, age estimation, cemental incremental lines, dental (radicular) cementum, translucency of dentin, and racemization of collagen in dentin.

Identification

Oral pathology is utilized for individuals’ identification through oral and maxillofacial pathologies with associated syndromes, enamel rod patterns, sex determination using exfoliative cytology, identification from occlusal morphology of teeth, and deoxyribonucleic acid profiling from teeth.[1,4]

Even though the expertise of an oral pathologist is not taken in forensic investigations, this paper aims to review the role of oral pathology in forensic investigation.

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ORAL AND MAXilloFACIAL PATHOLOGIES WITH ASSOCIATED SYNDROMES

The individuals are identified from oral and maxillofacial pathologies with associated syndromes and are already narrated in the review. The individuals may be identified from dental traits of congenital syphilis and bilaterally impacted canines.

ENAMEL ROD PATTERNS

Biometrically, the undulated groups of enamel rods which extend from the dentinoenamel junction to the external tooth surface will form specific patterns on tooth surface. Enamel rod patterns are unique for each tooth in an individual, and the biometric study of enamel rod patterns from individual tooth for identification purpose is called ameloglyphics. It can be recorded from a tooth using cellulose acetate film, cellophane tape, or light body dental impression material.

SEX DETERMINATION USING EXFOLIATIVE CYTOLOGY

Human dentition is influenced by genetic and environmental factors that determine the position of teeth in the arch. The characteristic features of the teeth such as morphology, crown size, and root length will help to determine the sex of the individuals. The sex of a particular individual can be identified using a confocal microscope in exfoliative cytology from buccal mucosal scrapings for Barr body-positive cells. Exfoliative cytology can be done using acridine orange, acetoorcein, or Papanicolaou stains. There is a significant decrease in the cell size ranging from 0.002 to 0.017 mm/sq with aging, evident with exfoliative study using Papanicolaou stain. The sex of a male individual is determined from the pulp tissue stained with quinacrine mustard for fluorescent Y chromosome.

IDENTIFICATION FROM OCCLUSAL MORPHOLOGY OF TEETH

The individuals are identified from the occlusal morphology of the teeth. The high percentage of “+2” shaped groove pattern and low percentage of primitive “−y” shaped pattern were evident from a school population study conducted at Gujarat.

The other studies done related to occlusal morphology in various populations are as follows: (a) number of cusps and occlusal groove patterns of the permanent mandibular first and second molar in a Saudi population, (b) +4 occlusal form of mandibular second molars in Iranian adolescents, (c) cusp number and groove patterns of mandibular molars in Alaskan Eskimos, and (d) Associations between Carabelli trait and cusp areas in human permanent maxillary first molars in Australians of European descent. Other occlusal morphologic malformations exist in human population include talon cusp and Leong’s premolar.

DEOXYRIBONUCLEIC ACID PROFILING FROM TEETH

The role of deoxyribonucleic acid profiling from teeth is already explained in the review and previous studies.

AGE ESTIMATION

Oral pathology is also utilized for age estimation studies, which are carried out using ground sections of teeth. The age estimation studies include Gustafson’s method, incremental lines of Retzius, perikymata, natal line formation in teeth, neonatal line, racemization of collagen in dentin, cemental incremental lines, thickness of the cementum, and translucency of dentin.

GUSTAFSON’S METHOD

This is the most widely used age estimation technique in individuals above 21 years. Gustafson formulated following dental changes, namely, attrition, apical migration of periodontal ligament, deposition of secondary dentin, cemental opposition, root resorption, and transparency of the root dentin to estimate age. Age was estimated using the formula:

$$Y = 4.56X + 11.43$$

where X is the total score. The standard error with this method was 3.6 years. Later, Bajpai et al. modified Gustafson’s method by multiple regression analysis and formulated a more accurate formula:

$$Y = 5.6X + 1.81$$

for age estimation with a standard error of 6.35 years. Bajpai et al. conducted modified Gustafson’s technique in an Indian population with a sample of 228 extracted teeth and Kashyap and Koteswara Rao are forerunners of modified Gustafson’s method in the Indian population in 1990. Bajpai et al. established a positive correlation between age and total scores of physiological dental changes. In the present review, the author has excluded studies of Gustafson’s method using radiography which comes under oral medicine and radiology speciality.

INCREMENTAL LINES OF RETZIUS

Incremental lines of Retzius represent the discrepancy in the rhythmic mineralization of enamel prisms. This rhythmic mineralization appearing in enamel may be influenced by metabolic disturbances so that the lines may appear closer or the rest periods may be prolonged. In forensic odontology, incremental lines of Retzius act as a tool in the chronological mapping of dental development as evident from scanning electron microscopy.

PERIKYMATA

Perikymata are beautifully narrated as imbrication lines or in other words “the number and spacing of incremental
markings at the enamel surface. They are important indicators of the growth patterns of the teeth because they provide information on crown formation times and the underlying developmental processes. The authors have excluded animal studies related to perikymata in this review.

**Natal Line Formation in Teeth**

The natal line formations (either pre or post) in teeth are considered as birth indicators. These natal lines are more common in both enamel and dentin of deciduous teeth and permanent first molars which indicate the development during the transitional period between intra- and extra-uterine environments.

**Neonatal Line**

The neonatal line is a hypomineralized structure seen as a step-like rupture in the enamel matrix, due to disturbances in the enamel secretion stage. The presence of neonatal line indicates live birth by measuring the amount of postnatal hard tissue formation. In a population study reported from north-central Poland, a clear increase in the width of the neonatal line was observed along with a decrease in the child’s age at death. Recent evidence suggests that neonatal lines are produced due to alteration in the dimension, direction, and degree of mineralization of the enamel prisms and is considered as substantial evidence in infanticide cases brought before the law in India.

**Racemization of Collagen in Dentin**

The individual’s age at the time of death can be calibrated by the extent of racemization of aspartic acid in coronal dentin of normal permanent teeth. As age advances, there will be conversion of L-aspartic acid to D-aspartic acid. The same principle is also applied to calculate the racemization rate for age estimation of pink teeth. Pink teeth arise as a result of the seepage of hemoglobin caused by dental pulp decomposition. Trauma and moist environment may play a vital role in the appearance of pink teeth. Ground sections of pink teeth will show reddish brown discoloration of dentin. Clinically, the cervical region of the tooth will show pink appearance compared to the root portion, and it is highly appreciated in incisors, canines, and premolars. Pink teeth are a common finding related to medicolegal cases such as strangulation, drowning, and suffocation.

**Cemental Incremental Lines**

The incremental lines of cementum will guide to determine the age of adults. A major disadvantage of this method is that you cannot salvage the tooth (the tooth may either be extracted or sectioned) and it is not practical among living individuals.

**Thickness of the Cementum**

The thickness of the cementum will aid in age estimation. It was observed that the thickness of cementum is more statistically evident at the apex compared to the one-third of the root length from the apex.

**Translucency of Dentin**

The dentinal translucency is used frequently to estimate age because of its accuracy and simplicity. The estimation of dentinal translucency in elderly individuals is not feasible because the junction at translucent and nontranslucent zones is irregular. Age estimation using the dentinal translucency is more accurate in the methods by Sinhal et al. and by Prince and Ubelaker, with respect to that of Lamendin.

**Conclusion**

This article hopes to sensitize the dental fraternities around the globe to know about the relationship of oral pathology with forensic odontology. In the present scenario of mass disasters, the necessity of dental disaster squad in various nations is recommended.

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**Conflicts of Interest**

There are no conflicts of interest.

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