**Research Article**

## SCOPE OF PERIODONTICS IN FORENSIC DENTISTRY: A REVIEW

### Dr. Reshmi V Nair, Dr. Suchetha A, Dr. Darshan B M, Dr. Divya Bhat, Dr. Apoorva S M and Dr. Sapna N

CA-37, 24TH Main, J P Nagar ITI Layout, 1ST Phase, Bangalore

| ARTICLE INFO | ABSTRACT |
|---|---|

Forensic odontology is the application of dentistry in the administration of law and promotion of justice by proper handling, examination and evaluation of dental evidence. The evidence derived from teeth can be used to determine the age of a child or adolescent as a proof for undertaking them into juvenile custody and also used to identify the person to whom the teeth belong, which can be done using either dental records or ante-mortem photographs. Periodontics is a clinical dental specialty used to identify the morphology and pathology of periodontium of an individual. There are also studies wherein the knowledge of periodontics is used to estimate the age by determining the level of attachment of periodontal ligament, root transparency and root length. The aim of this article is to highlight the contribution of a periodontist towards the field of forensics to unravel various crime scenes. The use of periodontal tissues along with saliva and implants have shown to play a critical role in identification. Thus, the dental professionals play a significant role in keeping accurate dental records and providing all the necessary information to the legal authorities so that they may recognize malpractice, negligence, fraud or abuse, and identify unknown humans.

## INTRODUCTION

Forensic odontology is the application of dentistry in the administration of the law and the promotion of justice by the proper handling, examination and evaluation of dental evidence. The evidence derived from teeth can be used to determine the age of a child or adolescent as a proof for undertaking them into juvenile custody and also used to identify the person to whom the teeth belong, which can be done using either dental records or ante-mortem photographs[1].

Forensic odontology is defined as that branch of dentistry which deals with the proper handling and examination of dental evidence along with the proper evaluation and presentation of these dental findings in the interest of justice[2].

Every branch in dentistry contribute their support to forensic research pertaining to dentistry in the identification of the deceased[3].

Periodontics is a clinical dental specialty used to identify the morphology and pathology of periodontium of an individual.There are also studies wherein the knowledge of periodontics is used to estimate the age by determining the level of attachment of periodontal ligament, root transparency and root length[4].

*Corresponding author:* **Dr. Reshmi V Nair**
CA-37, 24TH Main, J P Nagar ITI Layout, 1ST Phase, Bangalore

Periodontium consists of gingiva, periodontal ligament, cementum and alveolar bone that undergoes changes over a duration of time.

The aim of this article is to highlight the contribution of a periodontist towards the field of forensics to unravel various crime scenes.

### Historical Background

The use of tooth as an evidence for identification dated back to 66 A.D, was that of the Agrippina and Lollia Pauline case. Agrippina, who after her marriage with Claudius, emperor of Rome, feared of rich divorcee Lollia Paulina, of still being a rival for her husband, and thus decided to kill Lollia Paulina with the help of her soldier, who was instructed to bring the head back. The death of Lollia Paulina was later confirmed by the identification of the dental alignments and certain distinctive characteristics. It was the first use of dental identification where there is a record[1].

John Talbot, who died in the Battle of Castillion in 1453 was the first case to have been recorded by dental identification. Dr. Paul Revere, the first forensic odontologist, identified the body of Dr. Joseph Warren, a revolutionary in 1775 by identifying the silver and ivory bridge that Paul had constructed 2 years before the death of Joseph[3].

The first forensic identification in India started in 1193 that of Jai Chand, a great Indian monarch who was destroyed and

murdered by Muhammad's army and he was identified by his false teeth[1].

The first comprehensive text on forensic odontology was published by Dr. Oscar Amoedo entitled, "L' Art Dentaire en Medicine Leagale". He was also known as the father of forensic odontology[3].

### Application of Teeth in Forensic Dentistry

Age estimation in children and adolescents is important for a variety of legal procedures such as child labor, employment, status of majority, rape, adoption, eligibility for marriage, and also in cases where the birth certificate is not available.

The dental age can be estimated either in an invasive or the non-invasive method. Dental age is estimated by the (i) presence or absence of mamelons (ii) presence of teeth (iii) Schour and Massler method wherein the dental age is estimated through histological method (iv) Nolla's method ( a serial radiographic study) (v) Moorrees, Fanning, and Hunt method (vi) Demirjian's method (vii) Open apex method (viii) Mincer's method (ix) Kohler's method (x) Anderson's method (xi) AlQahtani's method (xii) Balaraj's method[5,6].

Mandibular canine tends to show sexual dimorphism which tends to correlate to canine arch width. The ability to determine sex was found to be accurate to 84.3% in males and 87.5% in females by comparing mandibular canine index (MCI) with the calculated standard MCI value which can be of significance in investigating the fragmented human remains as well the method is rapid and inexpensive[7].

Tooth eruption was seen to be accelerated in early maturing girls and also showed significant correlation between certain stages of tooth formation or movement or menarche. The calcification of the complete tooth was seen to be earlier in females than in males in both primary and secondary dentition[8].

The teeth can provide an important information such as the habits and occupation of an individual. Notching of the incisors can be seen in tailors, cobblers; attrition of teeth can be seen in individuals who has the habit of pencil and pen biting, opening tops of the bottles with teeth. Habits such as smoking through pipe or cigarette smoking and also tobacco chewing can lead to presence of marks on the teeth. Severe tooth wear has been observed in mining industry. The presence of enamel pearls can also be used to identify an individual by comparing their ante-mortem and post-mortem reports[2].

Pink tooth phenomenon has also been noticed in individuals who die by drowning or of asphyxia, wherein the pink tooth appears due to the breakdown of hemoglobin of red cell in the pulp that results in the release of hemosiderin[9].

Dental radiographs though rarely used, are the non-destructive tools of forensic dentistry. Dental age can be estimated by the use of a custom-made analysis software that can be used to obtain the numerical values of pulpal and tooth volume from the radiographs and it showed promising results in a non-destructive manner using X-ray microfocus computed tomography[10].

### Contribution of periodontal tissues to forensic odontology

### Histological changes in gingiva

The body undergo physico-chemical changes in a sequence following the death of an individual until it decomposes. At the cellular level, the respiration tends to cease and glycosis proceeds thereby terminating all the activities of cell metabolism, resulting in autolysis. Post-mortem changes are associated with tissue degradation and putrefaction and thus the normal morphology of the oral mucosa is lost. These cellular changes can be a useful criterion and marker for estimating the post-mortem interval.

The initial changes in the early post-mortem period of epithelium can be observed from 0-8 hours which progressively increases to 16-24 hours owing to the homogenization and eosinophilia that spread the entire thickness of the epithelium[11].

### Alveolar Bone

K.K. Koh *Et al*. conducted a study to estimate the age from the structural changes of teeth and buccal alveolar bone level using CBCT. From the results of the study, it was concluded that measurement of buccal bone level from CBCT correlated best with chronological age. Therefore, buccal bone level is suitable to estimate the forensic age, wherein the estimation can be done by direct measurement of bone level on skulls of unidentified bodies[12].

### Cementum

When the information about the deceased is less, age estimation plays as an important criterion in the identification process.

Cementum deposition occurs throughout the life in the form of concentric incremental lines wherein each line corresponds to 1 year of life. And they are considered to be a reliable source when compared to other human morphological or histological traits[13].

A longitudinal ground section of a tooth is mounted on a microscope, to assess the alternate light and dark bands at the apical and middle third of the root, and these bands are counted on a pictomicrograph. They are calculated as follows:

The number of incremental lines $(n) = X/Y$ where,

$X$ = determines the total width of cementum from dentino-cementum junction to cementum surface, and
$Y$ = determines the width of cementum between two adjacent incremental lines.

The age of an individual can be calculated by adding the eruption of the tooth with the number of incremental lines.

Dental cementum increment analysis (DCIA) is a newer method to determine the age of an individual. A case was reported wherein the DCIA method was used to determine the age and death of an unidentified female corpse during her exhumation analysis which took place 37 years after her death. This was the first ever application of cementum study for human identification which helped to solve the crime[3].

B Azaz *et al*., conducted a study to determine the correlation between the age and thickness of cementum in impacted teeth wherein sixty impacted, nonfunctioning permanent canines and premolars were taken from patients aged between 9 to 70

years. The results showed that there was direct relation of thickness of the cementum and aging of teeth[14].

A study conducted by Godishala Swamy Sugunakar Raju *et al.,* to correlate the thickness of cementum to determine the age in forensic dentistry. The results concluded that there was significant increase in thickness of cementum in the apical third of the root with age in both erupted and unerupted tooth. Cementum deposition occurs as a continuous process throughout life and it has also shown to triple in thickness between the ages 20 and 60 years[15].

GG Stott *et al.,* from his findings suggested that, it is through proper processing and also with the use of light microscopy and photography, the cementum layer counts can be used to determine the age in humans[16].

### Periodontal Ligament

The thickness of the periodontal ligament is directly related to age and the mesiocclusal drifting of teeth. A study on rats inferred that periodontal ligament thickness is directly proportional to root dimensions[4].

The width of the periodontal ligament varies among individuals and also on various areas of the tooth. The periodontal ligament in the distal side of the root is wider than that in the mesial side. As the age advances, the mesial side become narrower than the distal side due to mesiocclusal drifting of the tooth and also due to the difference in the cementum width. Thus, the cementum and ligament width are narrower on the mesial side that becomes more prominent as the age advances[17].

The recession of periodontal ligament has been used as one of the several methods of age estimation. The recession was observed to be more rapid in males than females[18].

### Sex Determination from Dental Calculus

Dental calculus can also be used for sex determination using the PCR method wherein the primers are used to recognize DYZ3 region of Y-chromosome and DXZ1 of X-chromosome. The minimum amount of DNA for sex determination is 3 pg. Sex determination in dental calculus can be done using DNA which is useful for forensic application as it can be done without destruction of morphological characteristics of teeth[19].

### Saliva

Saliva is a complex body fluid which plays a crucial role in forensic evidence. Saliva contains epithelial cells, that has increased its application for sex determination of the executioner. Based on successful results to identify the sex using blood stains, two parameters have been proposed. The first one is the detection of sex chromatin: Barr bodies in females and F bodies in males. The second one is the determination of sex hormone levels which is done based on the detectable quantities and ratios of 17 B-estradiol and testosterone.

Salivary DNA can be recovered from different non-living objects including clothing, foods, tobacco products, drink containers, oral hygiene devices, stamps, dental prostheses, envelopes, etc. Deoxyribonucleic acid is isolated from the saliva sample using phenol–chloroform method[20].

Saliva can be collected via two methods, (a) single swab technique and (b) double swab technique. Saliva is the most reliable source for human identification wherein 1 ml of saliva has shown to possess a DNA typing strength equivalent to 10 μl of whole blood[3]. Salivary concentrations of a particular drug can normally be directly correlated to the concentration of the same drug in blood as enter saliva. Saliva biomarkers are also used in cases involving bitemarks for the identification of people and for victim identification in mass disasters[20].

### Use of Implant in Forensic Odontology

The identification of charred bodies is a challenging procedure in the forensic routine wherein the hard and soft tissues may become fragmented and burnt, hampering facial recognition, fingerprint analysis, and dental identification. Metallic dental implants, however, play a valuable role as highly resistant post-mortem (PM) evidence for comparative dental identifications. Patidar *et al*, 2010, revealed that teeth and mandible bone become ashy and cracked when exposed to 1100° Celsius for 15 minutes. Yet metallic materials such as silver amalgam and titanium tend to resist up to 1100° Celsius and 1668° Celsius, respectively[21].

Implant Recognition Software is a software tool that is used in the field of forensic dentistry. This software simplifies the clinician's and the technician's job in identifying the dental implants present in the patient's mouth and can also be of potential use in forensic dentistry[22].

## CONCLUSION

This review article focuses on the various aspects in which the knowledge of periodontics can be used in forensic dentistry. Forensic odontology and periodontics should go hand-in-hand, so as to enhance the extensive interactions with the enforcers of law, the judiciary and the forensic fraternity at various forums[23]. Thus, the dental professionals play a significant role in keeping accurate dental records and providing all the necessary information to the legal authorities so that they may recognize malpractice, negligence, fraud or abuse, and identify unknown humans[8].

## References

1. Balachander N, Babu NA, Jimson S, Priyadharsini C, Masthan KM. Evolution of forensic odontology: An overview. *Journal of pharmacy &bioallied sciences*. 2015 Apr;7 (Suppl 1):S176.
2. Krishan K, Kanchan T, Garg AK. Dental evidence in forensic identification–An overview, methodology and present status. The open dentistry journal. 2015;9:250.
3. Gattani DR, Deotale SP. Forensic dentistry: Adding a perio'scope'toit!. *Journal of Indian Society of Periodontology*. 2016 Sep;20 (5):485.
4. Shamim T. Periodontics perspective in identification and age estimation. Eur J Forensic Sci● Oct-Dec. 2014;1(1):19.
5. Chaudhary RK, Doggalli N. Commonly used different dental age estimation methods in children and adolescents. *International Journal of Forensic Odontology*. 2018 Jul 1;3 (2):50.
6. Williams G. A review of the most commonly used dental age estimation techniques. J Forensic Odontostomatol. 2001;19(1):9-17.
7. Rao NG, Rao NN, Pai ML, Kotian MS. Mandibular canine index—a clue for establishing sex identity.

Forensic science international. 1989 Aug 1;42 (3):249-54.

8. Ahuja V, Ahuja AV. Teeth: Important Forensic tools in Dentistry. *Indian Journal of Forensic Medicine and Pathology*. 2011 Oct;4(4):183-91.

9. Soriano EP, Carvalho MV, Santos FB, Mendoza CC, Araújo MD, Campello RI. The post-mortem pink teeth phenomenon: a case report. Med Oral Patol Oral Cir Bucal. 2009 Jul 1;14(7):E337-9

10. Bandari Purnima, Harish K., AR Pradeep, Mallika, Sanjana.M. Periodontist's Role In Forensic Odontology. Journal of Dental and Medical Sciences.2017 Mar; Volume 16, Issue 3 Ver. VII: PP 143-146

11. Yadav AB, Angadi PV, Kale AD, Yadav SK. Histological assessment of cellular changes in postmortem gingival specimens for estimation of time since death. *The Journal of forensic odonto-stomatology*. 2015 Jul;33(1):19.

12. Koh KK, Tan JS, Nambiar P, Ibrahim N, Mutalik S, Asif MK. Age estimation from structural changes of teeth and buccal alveolar bone level. *Journal of forensic and legal medicine*. 2017 May 1;48:15-21.

13. Harshni TS, Umayal M, Selvan NM, Nivetha R. Evidence of perio in forensic. Journal of Indian Academy of Dental Specialist Researchers¦ Volume. 2017 Jul;4(2).

14. Azaz B, Ulmansky M, Moshev R, Sela J. Correlation between age and thickness of cementum in impacted teeth. Oral Surgery, Oral Medicine, Oral Pathology. 1974 Nov 1;38 (5):691-4.

15. Raju GS, Keerthi M, Nandan SR, Rao TM, Kulkarni PG, Reddy DS. Cementum as an age determinant: A forensic view. *Journal of forensic dental sciences*. 2016 Sep;8(3):175.

16. Sousa EM, Stott GG, Alves JB. Determination of age from cemental incremental lines for forensic dentistry. Biotechnic & histochemistry. 1999 Jan 1;74 (4):185-93.

17. Louridis O, Demetriou N, Bazopoulou-Kyrkanidou E. Periodontal ligament thickness as related to age and mesiocclusal drifting of teeth: a histometric study. Journal of periodontology. 1974 Dec;45 (12):862-5.

18. Solheim T. Recession of periodontal ligament as an indicator of age. *The Journal of forensic odonto-stomatology*. 1992 Dec;10 (2):32-42.

19. Kawano S, Tsukamoto T, Ohtaguro H, Tsutsumi H, Takahashi T, Miura I, Mukoyama R, Aboshi H, Komuro T. Sex determination from dental calculus by polymerase chain reaction (PCR). Nihon hoigakuzasshi= *The Japanese journal of legal medicine*. 1995 Jun;49(3):193-8.

20. Susmita Saxena, Sanjeev Kumar. Saliva in forensic odontology: A comprehensive update J Oral MaxillofacPathol. 2015 May-Aug; 19(2): 263–265.

21. Silva RF, Franco A, de Castro MG, Dumont JAV, Garcia RR and de Souza JB. Dental Human Identification using Radiographic Records of Oral Implant Placement – a Case Report. Austin J Forensic Sci Criminol. 2014;1(1): 3.

22. Michelinakis G, Sharrock A, Barclay CW. Identification of dental implants through the use of Implant Recognition Software (IRS). *International dental journal*. 2006 Aug;56(4):203-8.

23. Malaver PC, Yunis JJ. Different dental tissues as source of DNA for human identification in forensic cases. *Croatian medical journal*. 2003 Jun 1;44(3):306-9.

*******