ISSN: 0975-833X

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

International Journal of Current Research
Vol. 9, Issue, 12, pp.63627-63630, December, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

FORENSIC ODONTOLOGY AND ITS APPLICATIONS

[1,*]Dr. Manikantan, N.S. and [2]Dr. Dhanya Balakrishnan

[1]Amrita Viswavidyapeetham, Amrita University, Cochin, Kerala
[2]Private Practitioner, Trivandrum, Kerala, India

ARTICLE INFO

Article History:
Received 19th September, 2017
Received in revised form
23rd October, 2017
Accepted 19th November, 2017
Published online 31st December, 2017

Key words:
Age Estimation,
Bite Mark Analysis,
Forensic Odontology,
Identification.

ABSTRACT

Dental science has much to offer law enforcement agencies in the detection and solution of crime. Forensic Odontology, which is branch of dentistry, plays a major role in the identification of those individuals who cannot be identified visually or by other means. The teeth may also be used as weapons, and under certain circumstances, may provide information about the identity of the biter. Tooth has been used as the cornerstone in positive identification of living or deceased persons using unique traits and characteristics. Hence dental professionals play a major role in keeping accurate dental records and providing all necessary information so that legal authorities may recognize malpractices, negligence, and fraud child abuse and also identify an individual. This article analyses the various aspects of forensic odontology and the role of dentists in detail.

Citation: Dr. Manikantan, N.S. and Dr. Dhanya Balakrishnan, 2017. "Forensic odontology and its applications", *International Journal of Current Research*, 9, (12), 63627-63630.

INTRODUCTION

Forensic odontology or forensic dentistry was defined by Keiser-Nielson in 1970 as "that branch of dentistry which, in interest of justice deals with proper handling and examination of dental evidence, and with the proper evaluation and presentation of dental findings (Sukul, 2010). A number of characteristics of the human dentition separate humans from the other animals and provide certain uniqueness. The first of this results from the intermixing of genetic racial characteristics that have upset the balance between size and shape of the teeth with the supporting jaw bones. The second is the chemical and structural modifications of the teeth resulting from disease processes or the attempt to cure such diseases. The journey of forensic dentistry starts from Agrippinna, the mother of Roman Emperor Nero, in 49 A.D, when she recognized her rival Lollia-Paulina's discolored front teeth after her assassination. Forensic dentists require knowledge encompassing a number of disciplines, since the dental records obtained can identify an individual or afford the information needed by the authorities to establish neglect, fraud or abuse (Sweet, 1996; Girish *et al*., 2010). Overall, in the world scenario, forensic dentists play a major role in human identification, bite mark analysis, and maxillofacial trauma.

Corresponding author: **Dr. Manikantan, N.S.,**
Amrita Viswavidyapeetham, Amrita University, Cochin, Kerala

IDENTIFICATION

Dental identification can have three different applications (Sweet *et al*., 2001; Saxena *et al*., 2010):

- Comparative identification in which the post-mortem dental records are compared with the ante mortem records of an individual in order to establish whether both records correspond to the same person.
- The obtainment of dental information to narrow the search for an individual when the ante mortem records are not available and there are no possible data referred to the identity of the subject.
- DNA profiling to oral tissues: This method is used when dental records are not available for comparison.

Role of radiographs

Comparison of ante mortem and post-mortem radiographs is an accurate method for identification. Observations such as distinctive shapes of restoration, root canal treatment, buried roots, tooth-root morphology; sinus and jaw bone patterns can be identified with the help of radiographs (Chomdej *et al*., 2006). Original ante mortem radiographs are of immense value for comparison so should be adequately fixed and washed so that they remain viewable for longer time. The cone beam computed cosmography (CBCT) and X-ray micro focus CT can be used to get pulp and tooth volume ratio.

A range of conclusions can be reached when reporting a dental identification. The American board of forensic odontology recommends that these be limited to the following four conclusions (Pretty *et al*., 2001; Valenzuela *et al*., 2000):

- Positive identification: The ante- and post-mortem data match in sufficient detail, with no unexplainable discrepancies, to establish that they are from the same individual
- Possible identification: The ante- and post-mortem data have consistent features but, because of the quality of the either the post-mortem remains or the ante mortem evidence, it is not possible to establish the identity positively
- Insufficient evidence: The available information is insufficient to form a basis for a conclusion
- Exclusion: The ante mortem and post-mortem data are clearly inconsistent.
- The importance of identification of human remains is summarised in Table 1.

mucosa; this is a potential source of DNA. Numerous enzymes from a variety of sources are present in saliva. The Streptococcus salivarius and Streptococcus mutans present in the saliva and on the teeth provides means with which to identify the bacterial composition from bite marks and that can be matched exclusively to those from the teeth responsible (Demirjian *et al*., 1973; Mohite *et al*., 2011).

Sex can be determined with very minute quantities of DNA. Amelogenin (AMEL) is one of the major matrix proteins secreted by the ameloblasts, which is a sex‐linked gene. The AMEL gene, coding for a highly conserved protein, is located on the X and the Y‐chromosomes in humans. The two alleles are similar for the exonic sequences but differ in the intronic sequences. Thus, the females (XX) have two identical AMEL genes but the males (XY) have two non‐identical genes. The fact that the X and Y‐specific AMEL genes are 106 and 112 base pairs (bp) in length, respectively, provides a relatively direct procedure to discriminate between male and female AMEL (Lysell, 1955).

Table 1. Common reasons for identification of found human remains

	Common reasons for identification of found human remains
Criminal	Typically an investigation to a criminal death cannot begin until the victim has been positively identified.
Marriage	Individuals from many religious backgrounds cannot remarry unless their partners are confirmed deceased.
Monetary	Payment of pensions, life assurance and other benefits relies upon positive confirmation of death.
Social	Many religions require that a positive identification be made prior to burial in geographical sites.
Burial	Society's duty to preserve human rights and dignity beyond life begins with the basic premise of an identity.
Closure	The identification of individuals missing for prolonged periods can bring sorrowful relief to family members.

Determination of species, gender and race

Species determination usually presents no difficulties unless only patchy evidence is found at the scene of crime. Recently, it has been shown that dentinal fluids contain special species information. These fluids may be compared using counter current electrophoresis with artificially antisera (Kumar *et al*., 2011). This technique can determine species up to at least 12 months after death. There are certain features noted as in Mongoloid and American Indians, concave upper incisors and grooves on rear surface of upper incisors (shovel shaped appearance) while Europeans has flat lingual surface on the incisor teeth.[11] Almost 100% of Japanese have ridges on lingual surface on the incisor teeth. Besides, the lower first molar of Caucasoid appears long with more tapering form while Negroid molars are small and square. Thus, by focusing on these types of findings on teeth, ethnic race can be established (Valenzuela *et al*., 2001; Condon *et al*., 1986).Forensic odontology plays a major role in determining the sex of the victims with bodies mutilated beyond recognition due to mass disaster. Sex can be determined based on the data from morphology of skull and mandible, metric features as well as by DNA analysis of teeth. Teeth may be used for differentiating sex by measuring their mesiodistal (MD) and buccolingual (BL) dimensions. The canines show the maximum sex difference followed by premolars, maxillary molars. In a study, Iscan and Kedici could accurately establish sex in 77% of the cases using maxillary and mandibular canines and mandibular second molar (Czermak *et al*., 2006).

Sex determination by DNA analysis

The successful isolation of DNA from both saliva and salivary stained material occurred in 1992. Saliva contains sloughed epithelial cells from the inner surface of the lips and oral

AGE ESTIMATION

Human dentition follows a reliable and predictable developmental sequence, and the use of radiographs is characteristic of the morphologically distinct stages of mineralization (Thomas *et al*., 1983). Use of attrition and development of third molars have been suggested as means of ageing for individuals over 18 years, are unreliable (Lamendin *et al*., 1992; Shukla *et al*., 2011). Other techniques such as occlusal tooth wear, incremental lines of cementum, and radiographic method that used pulp size measurement of six teeth observed on periapical radiographs have been suggested (Nayak *et al*., 2007). The age of children can be determined by the analysis of tooth development and subsequent comparison to development charts, usually to an accuracy of approximately 1.6 years. Newer techniques like aspartic acid racemisation and translucent dentine have been proposed and proved to be highly accurate in adult age assessment (Hauser *et al*., 1989; Ohtani *et al*., 2008; Sivapathasundharam, 2001).

Gustafson's method

In 1950, Gosta Gustafson developed a method for age estimation based on morphological and histological changes of the teeth. They assessed regressive changes such as attrition (A), secondary dentine deposition (S), loss of periodontal attachment (P), cementum apposition at the root apex (C), root resorption at the apex (R), and dentin translucency (T). For each of these regressive changes or variables, different scores ranging from 0-3 were assigned. This applies that attrition could have anyone of four scores (AO, A1, A2, or A3) and similar one of four scores for the other variables. Adding the allotted score for each variable (e.g. A3 + S2 + P2 + C1 + R2 +

T1 = X), a total score (X) was obtained. It was found that an increase in the total score (X) corresponds to an increase in age. Age was estimated using the formula: Age = 11.43 + 4.56x (Caldas *et al*., 2007).

Dentin translucency method

Root dentin starts to become translucent during the third decade of life, beginning at the apex and advancing coronally. The alteration may be due to the decreased diameter of dentinal tubules caused by increased intratubular calcification. The difference in refractive indices between intratubular organic and extratubular inorganic material is equalized, resulting in increased translucency of the affected dentin. Based on tooth type, a number of regression formulas have been provided for age estimation (Valenzuela *et al*., 2009; Ohtani *et al*., 2008).

Age estimation from incremental lines of cementum

An estimate of age from incremental lines of acellular cementum is possible by using mineralized, unstained cross sections of teeth, preferably mandibular central incisors and third molars. The accuracy is claimed within 2-3 years of the actual chronologic age (Renaud, 1973; Saraf, 2011).

Comparison of teeth image by cone beam computed tomography and Xray micro focus CT

The cone beam computed tomography (CT) and Xray micro focus CT [5] can be used to obtain pulp and tooth volume ratio. [22] Xray provides two dimensional information at low resolution while cone beam CT technique allows the three dimensional structure of the root canal of the extracted tooth. It works with the same scanning principle as in medical computed tomography (CT) is utilized; however, the spatial resolution is orders of magnitude higher. The coronal pulp cavity ratio is a reliable biomarker for age assessment in the forensic context, especially in the living individuals of unknown data (Thomas, 1983; Kapali, 1997).

BITE MARK AND LIP PRINT ANALYSIS

MacDonald defined bite mark as "a mark caused by the teeth either alone or in combination with other mouth parts". Bite marks are usually associated with sex crimes, violent fights, child abuse and theft (Acharya *et al.,* 2011; Sherfudhin *et al*., 1996). Generally, bite marks consist of superficial abrasion, and subsurface haemorrhage, or bruising of the skin because of the bite (Endris 1979) (Saraf, 2011). The marks, single and multiple in nature may be of varying degrees of severity, ranging from a mild marking of the tissues to deep perforation of the epidermis and dermis (Noss *et al*., 1983). To avoid discrepancy and to increase the validity of bite mark analysis, American Board of Forensic Odontologist (ABFO) has created a bite mark methodology guideline to collect and preserve the marks. Animal bites are usually distinguished from human bite injuries by differences in arch alignments and specific tooth morphology. Animal bites often cause shear rather than impact injuries, producing lacerations of the skin and open wounds (da Silva *et al*., 2007; Nascimento Correia Lima *et al*., 2012). The injuries caused by teeth can range from bruises to scrapes to cuts or lacerations. To avoid discrepancy and to increase the validity of bite mark analysis, American Board of Forensic Odontologist (ABFO) has created a bite mark methodology guideline to collect and preserve the marks. To record a bite mark, an exact photographic documentation and a one to one transfer to transparent paper or acetate sheet are indispensable. Stains of saliva or human cells for a DNA analysis should be collected whenever possible (Wright and Dailey 2001[29], Lessig and Benthaus 2003 (Vale *et al*., 1983; Pretty, 2000; Sweet *et al*., 1997). Chelioscopy, which is the study of lip prints for human identification was first suggested in 1950. Susuki and Tsuchihasi have classified lip prints into many types depending on the pattern of grooves as type I (vertical), type II (branched), type III (intersected), type IV (reticular), and type V (other). Gender differences with certain types predominant in females (I and II) and in males (III and IV) are found.[37] The study of the investigation of bite marks and lip prints, requires the employment of specialized techniques of photography, impression taking, and electric microscopy. The list of procedures to properly collect the evidence includes: 1) Case Demographics, i.e. vital information pertaining to the case; (2) Visual Examination of the bite mark; (3) Photography, i.e. extensive orientation and close-up photographs; (4) Saliva Swabs collection, and (5) Impression taking, i.e. an accurate impression of the bitten surface by vinyl polysiloxane or polyether (Sweet, 1998; Datta, 2012).

Healing process

The healing process of bite marks can be useful in determining the time of the bite mark, is inflicted relative to the time of death in cases where death has occurred because of strangulation. As all healing processes cease upon death, the redness of the bite mark relative to the redness of bruises on the neck indicate the timing of the infliction of the bite mark relative to the murder (Sansare, 1995).

Conclusion

Forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or by other means. Forensic dentistry involves the processing, review, evaluation and presentation of dental evidence with the purpose of contributing scientific and objective data in legal processes. Forensic dentists require knowledge encompassing a number of disciplines, since the dental records obtained can identify an individual or afford the information needed by the authorities to establish neglect, fraud or abuse. A forensic odontologist must have broad background knowledge of general dentistry, encompassing all dental specialties. He must also have the basic knowledge of the role of forensic pathologist and the methods used in autopsy, as dental evidence is the most valuable and reliable method. We need beforehand trained forensic odontologist to be prepared with a skilled team on priority basis. This branch needs further research and recognition in India.

REFERENCES

Acharya AB, Prabhu S, Muddapur MV. 2011. Odontometric sex assessment from logistic regression analysis. *Int J Legal Med.,* 125:199-204.

American Board of Forensic Odontology. 1994. Body identification guidelines. *J Am Dent Assoc*. 125:1244-6, 1248, 1250 passim.

Caldas IM, Magalhães T, Afonso A. 2007. Establishing identity using cheiloscopy and palatoscopy. *Forensic Sci Int.,* 165:1-9.

Chomdej T, Pankaow W, 2006. Choychumroon S. Intelligent dental identification system (IDIS) in forensic medicine. *Forensic Sci Int.*158:27-38.

Condon K, Charles DK, Cheverud JM, Buikstra JE. 1986. Cementum annulation and age determination in Homo sapiens. II. Estimates and accuracy. *Am J Phys Anthropol*. 71:321-30.

Czermak A, Czermak A, Ernst H, Grupe G. 2006. A new method for the automated age-at-death valuation by tooth-cementum annulation (TCA). Anthropol Anz.64:25-40.

da Silva RH, Sales-Peres A, de Oliveira RN, de Oliveira FT, Sales-Peres SH. 2007. Use of DNA technology in forensic dentistry. *J Appl Oral Sci.,* 15:156-61.

Datta P, Datta SS. 2012. Role of deoxyribonucleic acid technology in forensic dentistry. *J Forensic Dent Sci.,* 4:42-6.

Demirjian A, Goldstein H, Tanner JM. 1973. A new system of dental age assessment. *Hum Biol.,* 45:211-27.

Girish K, Rahman FS, Tippu SR. 2010. Dental DNA fingerprinting in identification of human remains. *J Forensic Dent Sci.,* 2:63-8.

Gustafson G. 1950. Age determination on teeth. *J Am Dent Assoc.* 41:45-54.

Hauser G, Daponte A, Roberts MJ. 1989. Palatal rugae. *J Anat.,* 165:237-49.

Kapali S, Townsend G, Richards L, Parish T. 1997. Palatal rugae patterns in Australian aborigines and Caucasians. *Aust Dent J.,* 42:129-33.

Kumar VJ, Gopal KS. 2011. Reliability of age estimation using Demirjian's 8 teeth method and India specific formula. *J Forensic Dent Sci.* 3:19-22.

Lamendin H, Baccino E, Humbert JF, Tavernier JC, Nossintchouk RM, Zerilli A. 1992. A simple technique for age estimation in adult corpses: the two criteria dental method. *J Forensic Sci.,* 37:1373-9.

Lysell L. 1955. Plicae palatinae transversae and papilla incisiva in man; a morphologic and genetic study. *Acta Odontol Scand.,* 13:5-137.

Mohite DP, Chaudhary MS, Mohite PM, Patil SP. 2011. Age assessment from mandible: comparison of radiographic and histologic methods. *Rom J Morphol Embryol.,* 52:659-68.

Muruganandhan J, Sivakumar G. 2011. Practical aspects of DNA-based forensic studies in dentistry. *J Forensic Dent Sci.,* 3:38-45.

Nascimento Correia Lima N, Fortes de Oliveira O, Sassi C, Picapedra A, Francesquini L Jr, Daruge E Jr. 2012. Sex determination by linear measurements of palatal bones and skull base. *J Forensic Odontostomatol.*1:38-44.

Nayak P, Acharya AB, Padmini AT, Kaveri H. 2007. Differences in the palatal rugae shape in two populations of India. *Arch Oral Biol.,* 52:977-82.

Noss JF, Scott GR, Potter RH, Dahlberg AA, Dahlberg T. 1983. The influence of crown size dimorphism on sex differences in the Carabelli trait and the canine distal accessory ridge in man. *Arch Oral Biol.*28:527-30.

Ohtani M, Nishida N, Chiba T, Fukuda M, Miyamoto Y, Yoshioka N. 2008. Indication and limitations of using palatal rugae for personal identification in edentulous cases. *Forensic Sci Int.,* 176:178-82.

Pretty IA, Sweet D. 2000. Anatomical locatios of bitemarks and associated findings in 101 cases from the United States. *J Forensic Sci.,* 45:812-4.

Pretty IA, Sweet D. 2001. A look at forensic dentistry--Part 1: The role of teeth in the determination of human identity. *Br Dent J.,* 190:359-66.

Renaud M. 1973. [Cheiloscopic identification in forensic medicine]. *Nouv Presse Med.* 2:2617-20.

Sansare K. 1995. Forensic odontology, historical perspective. *Indian J Dent Res.* 6:55

Saraf A. 2011. Rugae patterns as an adjunct to sex differentiation in forensic identification. *J Forensic Odontostomatol.* 29:14-9.

Saxena S, Sharma P, Gupta N. 2010. Experimental studies of forensic odontology to aid in the identification process. *J Forensic Dent Sci.,* 2:69-76.

Sherfudhin H, Abdullah MA, Khan N. 1996. A cross-sectional study of canine dimorphism in establishing sex identity: comparison of two statistical methods. *J Oral Rehabil*. 23:627-31.

Shukla D, Chowdhry A, Bablani D, Jain P, Thapar R. 2011. Establishing the reliability of palatal rugae pattern in individual identification (following orthodontic treatment). *J Forensic Odontostomatol.*29:20-9.

Sivapathasundharam B, Prakash PA, Sivakumar G. 2001. Lip prints (cheiloscopy). *Indian J Dent Res.,*12:234-7.

Sukul B, Deb U, Ghosh S. 2010. Why a "dental surgeon" for identification in forensic science? *J Indian Med Assoc.* 108:769-70, 775.

Sweet D, DiZinno JA. 1996. Personal identification through dental evidence--tooth fragments to DNA. *J Calif Dent Assoc.* 24:35-42.

Sweet D, Lorente M, Lorente JA, Valenzuela A, Villanueva E. 1997. An improved method to recover saliva from human skin: the double swab technique. *J Forensic Sci.,* 42:320-2

Sweet D, Pretty IA. A 2001. look at forensic dentistry--Part 2: teeth as weapons of violence-- identification of bitemark perpetrators. *Br Dent J.*190:415-8.

Sweet DJ, Hildebrand DP. 1998. Recovery of DNA from human teeth by cryogenic grinding. *J Forensic Sci.,* 43:1199-202.

Thomas CJ, Kotze TJ. 1983. The palatal rugae pattern in six southern African human populations. Part II: Inter-racial differences. *J Dent Assoc S Afr.* 38:166-72.

Thomas CJ, Kotze TJ. 1983. The palatal ruga pattern: a new classification. *J Dent Assoc S Afr.,* 38:153-7.

Vale GL, Noguchi TT. 1983. Anatomical distribution of human bitemarks in a series of 67 cases. *J Forensic Sci.,* 28:61-9.

Valenzuela A, Martin-de las Heras S, Marques T, Exposito N, Bohoyo JM. 2000. The application of dental methods of identification to human burn victims in a mass disaster. *Int J Legal Med.,* 113:236-9.

****