Pyrex Journal of Medicine and Medical Sciences

Vol 4 (4) pp. 21-28 September, 2017
Author(s) retain the copyright of this article
http://www.pyrexjournals.org/pjmms
ISSN: 2579-1230

Review paper

Methods of Identification in Forensic Dentistry: A Review

Naorem Jenny[1]* and Puyam Dhiraj Singh[2]

[1]MDS, Private Practitioner, PD Dental Health Care & Research Centre Canchipur, Manipur, India.
[2]BDS, Private Practitioner, PD Dental Health Care & Research Centre, Canchipur, Manipur, India.

Accepted 23rd, September 2017

Abstract

Forensic dentistry helps in positive identification of many unknown remains that cannot be identified using other means. Errors in evidence gathering can be devastating to families and unacceptable. All work should be based on scientific and evidenced based procedures. This article attempts to review all the methods and technology available so far of in English literature in PubMed database and Google search .Advances in technology and adapting new techniques in the identification procedures will facilitate a more organized and systematic data collection .This will bring awareness of the newer technology and methods among the dentist .It will also help in maintaining the standards of the investigation and in providing accurate results in reduce working time in the medico legal matters. It will ensure in bringing the situation of disaster in normalcy as early as possible and in creation of secure society by enhance the mental state of the local community.

Keywords: Forensic dentistry, Forensic identification, Forensic Odontology, DNA analysis.

INTRODUCTION

Forensic dentistry is one of the most important branches of dentistry that determines the source of bite mark injuries, in cases of assault or suspected abuse, estimates the age of skeletal remains, testifies in cases of dental malpractice and other mediolegal investigations, (Shroff, 1973). It involves dental information collection, input, interpretation, clarification and comparisons of ante mortem and post-mortem (Hinchliffe, 2011). Identification can be for reasons like criminal, marriage, monetary, burial, social and closure. (Pretty, 2001).Teeth are indestructible part of human body, (Whittaker, 1994) and its durability in case of fire and bacterial decomposition makes them invaluable for identification (Kaushals, 2003). According to American Board of Forensic odontology guidelines, most dental identification are based on restorations, caries, missing teeth and or prosthetic devices, (Sandeep, 2013).

Corresponding author email: naoremjenny11@gmail.com

Dental identification takes two main forms ante-mortem dental and a post-mortem dental record, (Sweet, 1996). Identification results into one of the following: positive, possible insufficient and exclusion identification, (Rawson, 1979). Victims possessing dentition have physical characteristics necessary for their identification, whereas for those victims without their teeth, information can be used from dental labelled prostheses, (Naiman, 2007), (Thomas, 2014). At times the only identification are victim's partial or complete dentures, (Berry FA, 1995). Labelling of all the dentures is recommended and in certain states of the USA, the labelling of dentures is regulated by legislative (Alexander PM, 1998).

Errors in forensic dentistry can be from collection to interpretation and it can be devastating to the families and unacceptable. The techniques and methodologies must be scientifically robust with regard to reliability, reproducibility and validity with standardizing collection methods .The ability of clinical practitioners to maintain accurate dental records is essential .All opinions and conclusions must be free from personal bias ,subjectively and emotion, and should withstand cross examination in

court. Forensic odontology relies on the ability to identify, collect, study and compare information from oral and facial structures, (Sweet D, 1998). Advances in technology and new techniques procedures will facilitate a more organized and systematic data collection. The primary aim of any case of victim identification is to enhance the mental state of the local community. When an efficient team works with full knowledge, making use of advanced technologies and it comes out with the best possible results. This review emphasizes the need of advanced techniques in forensic odontology that may reduce working time and number of investigators required in achieving a safe environment.

METHODOLOGY:

The dental literature was searched from Google search and Medline/PubMed from 1950 to 2017 using various combinations of the following terms: Forensic identification, Forensic dentistry, Forensic Odontology, DNA analysis and only the most relevant available full text article topics were selected . After reviewing the titles and abstracts, reviews, case reports, original research were included and the rest were excluded. This review focuses the discussion on identification using dental evidence and the key learning's of the past and the present techniques and methods that are used to make the identification process easier and efficient in terms of manpower and technology.

FORENSIC ODONTOLOGY

Forensic means legal, it is a word that comes from Latin, meaning "to the forum" (Encyclopaedia Britannica, 2009). The forum was the basis of Roman law and was a place of public discussion and debate pertinent to the law.

Forensic Odontology

Forensic dentistry is the study and practice of aspects of dentistry that are relevant to legal problems (Encyclopaedia Britannica, 2009). In 1970, Keiser Nielsen defined forensic odontology as that branch of odontology which is concerned with the proper evaluation, interpretation and presentation of dental findings in the interests of justice (Keiser Neilsen, 1980). Forensic odontology is an interdisciplinary filed between forensic medicine and dentistry. (John Wiley & Sons, Ltd, 2014). The British Association for Forensic Odontology defined Forensic Odontology as Branch of forensic medicine and, in the interests of justice, deals with the proper examination, handling and presentation of dental evidence in a court of law. (Chalishazar Monali, 2011). Dr. Oscar Amoedo is considered as the father of the forensic odontologist. The thesis done by him entitled 'L' Art Dentaire en Medicine Leagale' to the faculty of medicine earned him a doctorate. It is the first comprehensive text book on forensic odontology, (Amedo O Paris, 1898.)

SCOPE OF FORENSIC ODONTOLOGY:

Forensic odontologists assist legal authorities by preparing dental evidence in the following situations:

1). Identification of found human remains
2), Identification in mass fatalities
3). Assessment of bite mark injuries
4). Assessment of cases of abuse (child, spousal, elder)
5). Civil cases involving malpractice
6) Age estimation and sex determination (Hunter WW, 1885).

FORENSIC DENTISTRY IN VARIOUS FIELD OF DENTAL SPECIALITY

The central dogma for dental identification is that post-mortem remains can be compared with ante mortem dental records, written notes, study cast, radiographs, etc to confirm identity (Pretty, 2001). Post-mortem dental profiling will enable a more focused search for ante mortem records. A post-mortem dental profile will typically provide information on the deceased's age, ancestry background, sex and socio-economic status. Forensic odontology embraces all dental specialties (Sargaiyan, 2014). It involves the coordination and cooperation of law enforcement officials, forensic pathologists, forensic odontologists, forensic anthropologists, criminalists and other specialists as deemed necessary (Fixot RH, 2001).

Oral Pathology Microbiology

Ground sections of teeth are used for age estimation. Some of the techniques are Gustafson's technique, incremental lines of Retzius, perikymata, prenatal and postnatal line formation, racemisation of collagen in dentin, cemental incremental lines and translucency of dentin (Shamim, 2011).

Oral Medicine and Radiology

Comparison of ante mortem and post-mortem radiographs are the most accurate and reliable method of identification. Radiographic method age estimation include secondary dentin formation, changes in the orientation of mental foramen and inferior alveolar canal, eruption and formation of mandibular third molar, trabecular pattern in jaws, pulp/tooth area ratio of teeth and pattern of lamina dura.

Identification includes distinctive shapes of restoration,

root canal treatment, buried root tips, bases under restorations, tooth and root morphology, and sinus and jawbone patterns. Radiographs should be marked with holes to prevent confusion-one hole for ante mortem films and two holes for post-mortem films, (G, 1950). The Odontograms form a basic outline to compare dental characteristics at the simplest level, (Shamim, 2006). Mandibular ramus can be used for sex determination either on dry mandible or through orthopantomogram (Chandramani Bhagwan *et al.,* 2017)

Oral and Maxillofacial Surgery

Identification of individuals through maxillomandibular and dentoalveolar fractures, surgical repairs and implants and craniofacial superimposition.

Craniofacial superimposition is complimentary to fingerprinting. Photographs may be compared with images of skull and radiographs may be compared with skull to reconstruct face (Fenton T W, 2008). Age, sex, and blood group are more reliably determined in freshly extracted teeth, these variables may be of significant help in identification, (Nayar AK *et al.,* 2017)

Pedodontics

Age estimation by eruption sequence Schour and Massler chart, Demirjian's method (Quideimat MA, 2009) using dental maturation chart and Nolla's stages of calcification (Bolanas, 2000) are used to measure dental age in children and adolescents. Radiographical evidence of formation of crown and root completion has been utilized for this age group.

Periodontics

Age estimation include periodontosis, root transparency and root length (Ubelaker, 2008) and identification of individuals through gingival morphology and pathology, periodontal ligament morphology and pathology and status of alveolar bone (T S, 2011)

Conservative Dentistry and Endodontics

It includes identification of individuals through restorations and root canal fillings (Avon SL,2004), endemic fluorosis (Shamim, 2011).

Prosthodontics

The technique of identification of individuals through study models, old dentures, custom bleach trays and custom splints, dentures and prostheses, denture marking, denture labelling (T S, 2011) includes surface methods like scribing, engraving, embossing and inclusion methods like ID bands, paper strips, T bar, laser etching, electron microchips, radio frequency identification tags, lenticular system, denture bar-coding, photographs. Unlabeled dentures can be recovered then fitted to casts retained by the treating dentist or laboratory. Full facial and profile photographs and intra-oral exposures to depict the upper and lower dental arches and frontal and lateral views of the teeth in occlusion are produced. Accurate dental impression materials (vinylpolysiloxane / polyether) should be used, although custom special trays are seldom fabricated for the suspect. Two sets of study casts are usually poured using dental die stone.

RECENT ADVANCES

With the advancement of technology research groups like Computer Analysis and Response Team, the Scientific Working Group on Digital Evidence, the Technical Working Group on Digital Evidence and the National Institute of Justice are formed to discuss the computer forensic science as a discipline, (Micheal, 2000).

Computer-Generated Records

It can be easily networked and transferred for routine professional consultation. Computer assisted managemen-nt technology (e.g. WinID3dental comparison software bridged with the Dexis digital radiography program) has been an asset in expediting the comparison dental record information in recent events, including the World Trade Centre terrorist attack, the Indian Ocean tsunami disaster and the hurricane Katrina recovery effort (Shalini Gupta, 2014). Software such as Adobe Photoshop and Mideo systems case PACS, facilitates the superimposition of digitally scanned radiographs and photographs for comparison. (Neville BW, 2009.)

Forensic 3-Dimensional Photogrammetry

It is used for the evaluation of a forensically relevant object. It depends primarily on the proficiency in the preparation and subsequent photographic recording of these objects. Latest digital SLR cameras having high pixel counts have been used. Camera equipped with virtual points GPS tracking can also be advantageous (John William Berketa, 2012). High end digital single lens reflex are used to achieve. CAD supported photogrammetry plays an important role in the cases of soft tissue injury. Various techniques that are used in forensic photography:

i). Visible light photography: Digital photography, Visible light colour photography, Visible light black and white photography.
ii). Alternate light imaging and fluorescent techniques
iii). Non-visible light photography: Reflective long-wavelength ultraviolet photography, Infrared photography,

(Vinod Sargaiyan, 2015).

New of Scales for Forensic Photography

It resulted in the development of a two-legged (right-angled) scale, known as the ABFO 2 scale, which is used by modern crime scene photographers. This scale was developed by a photogrammetrist (Mr. William Hyzer) and a forensic dentist (Dr. Thomas Krauss) for the purpose of minimizing photographic distortion and ensuring accuracy in measurement. The photographer should retain the scale used in the photograph (Stimson, 1997) (Balaji *et al.,* 2014).

Radiographs

A new portable, hand held, light weight (approximately 2.6 kg), mains or battery powered X ray machines such as the Nomad, have proved to be of great value in the disaster situation (SL, 2004).

COMPUTER AND NETWORK FORENSICS METHODOLOGIES

The 3 A's

Kruse and Heiser's 3 basic components of the 3 A's of computer forensics investigations are - Acquiring the evidence while ensuring that the integrity is preserved. Authenticating the validity of the extracted data, which involves making sure that it is as valid as the original, analyzing the data while keeping its integrity (Kruse and Heiser, 2002).

Forensic Process Model

It is a process model in the Electronic Crime Scene Investigation, a guide to first responders that consists of four phases:

i). Collection: It involves the evidence search, evidence recognition, evidence collection and documentation.
ii). Examination: It is designed to facilitate the visibility of evidence, while explaining its origin and significance. It involves revealing hidden and obscured information and the relevant documentation.
iii). Analysis: It looks at the product of the examination for its significance and probative value to the case.
iv). Reporting: It entails writing a report outlining the examination process and pertinent data recovered from.

DNA analysis

Teeth as biological material can provide the necessary link to prove identity, (Sweet D H. D, 1988). Teeth represent an source of genomic DNA and mitochondrial DNA (Sweet D H. D., 1998) (Hutchison C A, 1980). Forensic DNA analysis can yield highly accurate results .Sex can be determined from minute quantities of DNA. The root body yields the highest quantities of DNA. Some of the techniques to extract DNA are Polymerase chain reaction analyses and Restriction fragment length polymorphism. Currently preferred method is Cryogenic grinding and it is effective method to extract forensic DNA. It involves cooling the whole tooth to extract to extremely low temperatures using liquid nitrogen and mechanically grinding to fine powder, (Sargaiyan V, 2014).

Sex determination

Clinical methods of sex determination includes tooth size, root length crown diameter, canine dimorphism, tooth morphology and sexing, dental index and odontometric differences (C. Monali *et al.,* 2011).Other newer methods includes PCR, Barr bodies and enamel protein.

PCR

PCR is a method of amplifying small quantities of relatively short target sequences specific oligonucleotide primers and the thermostable Taq DNA polymerases. PCR amplification has assists in accurately determination of the sex of the remains (Sivagami AV, 2000) (DayalPK, 1998). Prior to PCR amplification, DNA must be quantified to ensure optical amplification conditions. The ideal amount of DNA for forensic STR DNA amplification kits is 1.0ng. Different methods for DNA quantification: include agarose gels, slot blots, Pico Green Micro Tier Assay and Alu Quant TM Human DNA Quantification System. SLOT blot quantification is the most popular DNA Quantification in laboratories.

Barr bodies

They are X chromatin and intranuclear structures and it was discovered by barr and bertam and its presence as a mass against the nuclear membrane indicates female. (D, 2001)

Enamel Protein

Amelogenin or AMEL gene is the matrix proteins found in the human enamel and its presence encodes female amelogenin (Acharya AB, 2009), (Dayal PK,1998)

Short Tandem Repeat Typing

It helps in identifying victims of mass calmities from even old remains. They are detected by fluorescent detection methods using capillary or gel electrophoresis and even by ABI gel-based DNA sequencers while earlier works on detection involved silver-stained polyacrylamide gels,

(Sakari *et al.,* 2015).

SNP/Single Nucleotide Polymorphism

Provides valuable information on descent, sex, evolution and is highly automated. Their advantage is that they can identify highly degraded DNA fragments (S. Leena Sakari *et al.,* 2015).

Microarray Techniques

DNA analysis using microarray technology is used for single nucleotide polymorphism (SNP) genotyping, in identifying the individual and for paternity testing (S. Leena Sakari *et al.,* 2015). Next generation genome sequencing (NGS), permits analysis of several hundred loci or even the entire genome.

Facial Reconstruction

Application 3D Computed tomography scan and computer software facial reconstruction can be done with low standard error (0.85% to 3.09%). So, it can be used reliably in identification of individuals especially in mass disasters (Sdos S, 2003).

To obtain more accurate visualization and evaluation of third molar mineralization patterns from computed tomography images, a new software application Denta Vol was developed. Virtual computed tomography imaging can be considered a valid alternative to orthopantomography for evaluations of third molar mineralization, and therefore a complementary tool for determining the age of majority.

Maxillary Sinus in Gender Determination

Application of software and Computerized Tomography, measurements of width, the length and the height of the maxillary sinuses may be useful to support gender determination in forensic medicine; however, with a relatively low-accuracy rate (Teke, 2007)

3D Scanning

The use of a 3D laser scanner to document evidence at the scene of crimes (and disasters) is now widely accepted. They have been successful even to the level of tooth marks on chocolate. There has also been a mention about use of this method to obtain impressions of tools or teeth left on objects or people (Komar *et al.,* 2012).

3D printing

Highly accurate re-creations of dental images/data can now be manufactured using 3D printing for the last few years and it would be well worth to test if missing fragments of jaws found at disaster zones could be completed using a 3D scanner. These jaws could be printed using validated 3D printers. These technologies are being put to use in disaster victim identification, then collection and interpretation of data will be easier, quicker, more accurate and safer.

Lip Prints

It was recommended in 1932 by Edmond Locard in France (Thomas, 1950). The use of lip prints for human identification was first suggested in 1950 (Ganswindt M, 2003). Lip prints can provide a direct link to the suspect, wrinkles and grooves seen on the labial mucosa forms a pattern called sulci labriorum. The study of lip prints is called as chieloscopy (Sivapathasundharam B, 2001). Lipsticks (Al Amad S, 2007) have been developed in recent years that do not leave any visible trace after contact with the glass surface, clothing or cigarette butts. They are referred as persistent lip prints for the permanence. Invisible can be lifted by using materials such as aluminum.

Rugoscopy

It is the study of palatal rugae pattern for identification Trobo Hermosa proposed Rugoscopy in 1932 (Pueyo VM, 2009). It can be used to evaluate the dental movements, as they remain stable over a person's life. It shows a significant association between shapes and ethnicity. Sassouni stated that there is no two alike alternate palate in configuration (V, 1957). Special software was designed called the Palatal Rugae Comparison Software (PR S Version2.0) to match the clinical photographs taken using a SLR digital camera. The software recorded an accuracy of 99% in identification of individuals whereas manual methods have shown high false positive and negative cases (Hemanth, 2012).

Bite Marks

Mac Donald defined bite marked as a mark caused by the teeth either alone or in combination with other mouth parts (John Wiley & Sons, 2014). Advanced methods like laser scanning, scanning electron microscopy or cone beam tomography forensic odontologist may be able to identify more details in bite marks and in individual teeth of the bite (Foy CB, 2008). Application of software technology has of enable to use image perception technology to artificially color areas with equal intensity values and depict a 2-D image as a pseudo- 3-D surface object. This allows better visualization which is unavailable by any other method (Vander Velden A, 2006) (Sweet D, 1998).

Personal identification based on specific patterns of DMFS

Non-radiographic dental records even without radiographic lines of comparison, charts and notes are essential found to be helpful for the establishment of individual identifications (Adams, 2003). Using a special computer program (Odonto Search) individual dental patterns can determine.

Dental pulp in human blood group identification

Blood grouping from tooth pulp might be of great help in identification even after storing for relatively long periods. ABO blood groups obtained from dental pulp can be used to establish identity, where teeth happen to be the only remnants available for personal identification especially as in mass disasters (Saxena *et al.,* 2017).

Blood group determination from hard tissues

Modified Absorption elution technique can be used for blood group determination from hard tissues of the teeth which can be used as an aid in identification of individual (Ramnarayan BK, 2013)

Smile

Photograph of an individual‘s unique smile can make gender identification in dead bodies and remains (Sen *et al.,* 2017). But the drawback of this method is that the gender identification through smile from a photograph can be done more accurately only if the participant’s recent photograph is available as identification varies with the status of teeth which changes with age.

Semen, saliva and oral sex

After oral sex, sperm persists in the mouth up to 21 hours, anus (46 hours) and the vagina (5 days). It can be traced after gargling or on the teeth. Sperm are more in liquid saliva samples than on mouth swabs. On the suspect surfaces it can be examined using acid phosphatase screening test. In oral-vaginal and oral-anal cases, both internal and external swabs should be taken, and the clothing examined. Stains of saliva or human cells for a DNA analysis should be collected whenever possible (Wright, 2001) (Lessig, 2003). Salivary DNA evidence has been previously recovered from cigarette butts, postage stamps, envelopes, human skins and food.

Aadhar Number as Denture Marking

Aadhar Number is used as denture marking for forensic identification which is patient's unique identification number printed in the patient's Aadhaar card issued by Unique Identification Authority of India (UIDAI) (Reddy, 2017)

DISCUSSION

This review exemplifies the role of dental identification and its importance in other medico legal issues in forensic science Dental identification is an effective method of identifying people in situations such as a mass disaster Graham, 2006. It is based on studying Ante-Mortem and Post-Mortem records to identify matching features. It is however essential to obtain all relevant ante mortem dental records, (e.g. dental casts, radiographs, photographs, dentures etc) to achieve a successful analysis (Martínez, 2012). Emphasis must also be placed on collecting quality post-mortem evidence. Advances in technology and new techniques procedures will facilitate a more organized and systematic data collection. Dental identification is one of the quickest, cheapest and straight forward methods of identification available and its success is coherent with findings from other methods (Blau, 2009). The primary aim of any case of victim identification is to enhance the mental state of the local community. When an efficient team works with full knowledge, making use of advanced technologies and it comes out with the best possible results. This review emphasizes the need of advanced techniques in forensic odontology that may reduce working time and number of investigators required in achieving a safe environment.

LIMITATIONS

Potential problems associated with the ante mortem include interpretation of different charting, incompleteness of the record, inaccuracies, fraudulent entries. A contemporaneous and clear dental note is essential; errors can complicate and even negate a positive identification. It is in such situations where the errors highlighted by Borrman and others can cause crucial mistakes to be made. The key successful mass disaster identification is preparedness. Careful research would need to be designed in order to isolate the various possible causes of the errors and to try to develop ways to reduce errors stemming from those causes. False-positive errors could occur for a variety of reasons, pertaining to different aspects of the bite sources, tools for and conditions of visualizing the bite marks, or the perceptual and decision characteristics of examiners.

CONCLUSION

Among the method applied to identify victims and medico legal, forensic dentistry is also one of the important method that needs to be applied. The recent advances in identification like DNA profiling have made DNA evidence to be more widely accepted in courts. This has revolutionized the aspect of forensic odontology. In this brief overview, the authors have shown the reader some

of the traditional and upcoming techniques in this fascinating field.

CONFLICT OF INTEREST

None.

REFERENCES

Alexander PM (1998). An assessment of attitudes to and extent of the practice of denture marking in South Australia, Aust Dent J. 43:337–41.

American Board of Forensic Odontology, (1994). Body Identification Guidelines, J Am Dental Assoc. 125: 1244-1254.

Adams BJ. (2003). Establishing personal identification based on specific patterns of missing, filled, and unrestored teeth.. J Forensic Sci. 48 (3): 487-96.

Amedo O.Paris (1898). The role of dentist in the identification of the victims of the catastrophe of the " Bazar de la Charite" . Dent Cosm. 39: 905–12.

Amendo O.Paris (1898). Masson Co, Booksellers L' Academie of Medicine, Dentistry in Forensic Medicine.

Avon SL. (2004). Forensic odontology: The roles and responsibilities of the dentist. J Can Dent Assoc 70: 453-8.

Acharya AB, (2010).A new digital approach for measuring dentin translucency in forensic age estimation.Am J Forensic Med Pathol. 31:133-7

AshfaqYaqoob (2013) .Denture Identification Methods: A Review International Journal of Health Sciences & Research .3: 4

Adams BJ (2003). Establishing personal identification based on specific patterns of missing, filled, and unrestored teeth. J Forensic Sci. 48(3):487-96.

Barr ML et al (1950) .The morphology of the nerve cell nucleus, according to sex Anat. Rec. 107: 283.

Berry FA, Logan GI, Plata R, Riegel R (1995) .A post fabrication technique for identification of prosthetic devices. The Journal of Prosthetic Dentistry.73(4): 341-343.

Bite Marks- I. Douglas R. Sheasby. (2014) Forensic Odontology: An Essential Guide, First Edition. John Wiley & Sons, Ltd.

Bolanas MV(2009). Dentist involvement in identification and reporting of child physical abuse : Jordan as a case study. Int J Paediatrc Dent 19: 291-6

Boljuncic J.(2007). DNA analysis of early mediaeval individuals from the Zvonimirovo burial site in Northern Croatia: Investigation of kinship relationships by using multiplex system amplification for short tandem repeat loci. Croat Med J. 48:536–46.

Balaji N et al (2014). Forensic Digital Photography: A Review. Int J Dent Med Res;1(3):132-135

Blau S.(2009).Forensic anthropology and its contributions to police investigations, Australian Police Journal. 63(1): 4-14.

ChandramaniBhagwanMoreetal (2017)Morphometric analysis of mandibular ramus for sex determination on digital orthopantomogram. J Forensic Dent Sci .9:1-5.

C. Monali et al (2011).Gender determination a view of forensic odontologist. Indian Journal of Forensic Medicine and Pathology. 4:4

Dayal PK.et al (1998). Textbook of Forensic Odontology, first edition Paras Medical Publishers.

Friar JA, West MH, Davies JE(1989.) A new film for ultraviolet photography, J Forensic Sci 34(1) 234-8.

Fenton T W, Heard A N, Saurer N J(2008) .Skull photo superimposition and border death, identification through exclusion and the exclude. J forensic Sci.53: 34-40

Frank R. Shroff (I973) .Forensic odontology for the general practitioner. Australian Dental Journal.18:298-303.

Foy CB et al(2008).American Acedemy of Forensic Sciences.Exemplar creation in bitemarks analysis using cone beam computed tomography. F33 odontology section.

Gupta S et al (2014).Contemporary practice in forensic odontology. J Oral MaxillofacPathol.18:244-50

Graham, E.A., (2006) .Disaster victimidentification. Forensic Science,Medicine, and Pathology. 2(3): 203-207

Hemanth M et al . (2010). Identification of individuals using palatal rugae: Computerized method. J Forensic Dent Sci. 2: 86–90.

Hunter WW(1885). The Imperial Gazetteer of India,2nd ed. London: Trubner and Co

John Wiley & Sons, Ltd. (2014) .Handbook of Forensic Medicine .First Edition.

John William Berketa(2012.).Forensic odontology involvement in disaster victim identification .8 (2):148–156

JHinchliffe(2011).Forensic odontology, part 1. Dental identification .Br Dent J. 210: 219 - 224

Kruse W, Heiser J. (2002).Computer Forensics: Incident Response Essentials, Addison Wesley

Kaushal S et al (2003) .Mandibular Canine in Sex Determination.J AnatSoc India.52 ,2: 119-24.

Keiser-Neilsen S. (1980). Person Identification by Means of Teeth,John Wright and Sons,Bristol 190-225

K .Nicopoulou-Karayianni et al (2007) .Dental Diagnostic Radiology in the Forensic Sciences:Two Case Presentations. 25(1):12-16

Komar, D.A. et al (2012).The use of a 3-D laser scanner to document ephemeral evidence at crime scenes and postmortem examinations. J Forensic Sci. 57(1): p. 188-91

Lawney M.(1998).For the Record. Understanding Patient Record keeping. NY State Dent J. 64:34-43.

Michael N et al(2000). Recovering and Examining Computer Forensic Evidence. Forensic SciComm; 2(4):32-5.

ME. Paul Revere (1976). Dentist, and our country's symbol of freedom. N Y State Dent J. 42:598-601

MithunRajshekara, Marc Tennanta(2011). The Role of the Forensic Odontologist in Disaster Victim Identification.Malaysian, Journal of Forensic Sciences. 5(1);78-83

MartínezChicón, J. and A. Valenzuela,(2012). Usefulness of Forensic Dental Symbols and Dental EncoderDatabase inForensic Odontology. J Forensic Sci57(1): 206-211

Naiman M et al (2007) .The Role of the Dentist at Crime Scenes. Dent Clin N Am .51, 837–856.

Nayar AK et al (2017) .Determination of age, sex, and blood group from a single tooth. J Forensic Dent Sci.9:10-4.

Pretty I A, Sweet D. (2001). A look at forensic dentistry – part 1: the role of teeth in the determination of human identity. Br Dent J. 190:359–366.

Patel J (2013).Forensic odontology in the era of computer and technology. IJMDS 2: 1

Pueyo VM et al(2009).Odontologialegal, Forense. Masson, Barcelona Int. J. Morphol;. p. 819-25.

Pretty I A et al (2002).The use of quantitative light-induced fluorescence (QLF) to identify composite restorations in forensic examinations. J Forensic Sci ,47 :831–836.

Pope, S.R.(2002), 3D printer Modern Machine Shop. 75(2): 1.

QuedeimatMA ,Behbehami F.(2009). Dental age assessment for Kuwaiti children using Demirjian method .Ann Hum Biol. 36:695-704

Ramnarayan B K et al (2013). ABO blood grouping from hard and soft tissues of teeth by modified absorption-elution technique.J Forensic Dent Sci 5:28-34

Rawson RD et al (1979). Radiographic interpretation of contrast-media-enhanced bite marks. J Forensic Sci. 4: 898-901.

Rawson RD (1996). Computers in forensic dentistry.. J.Calf Dent Assoc 24(5):58-61.

R. N. Ravi Teja Reddy (2017).Denture Marking For Forensic Identification Using Aadhar Number : A Case Report International

Journal of Scientific Research in Science and Technology.(2)3: 627-630
Springer-Verlag Berlin Heidelberg (2013).DNA technology and Forensic Odontology. B. Rai, J.Kaur Evidence-Based Forensic Dentistry.
Sandeep Kaur Bali et al (2013).International Journal of Health Science and Research 3(4):100-104
Sweet D, D I Zinno J.A (1996) .Personal identification through dental evidence tooth fragments to DNA . J CalifAssoci.24:35 - 42
Shamin T et al (2006). Forensic odontology : a new perspective . Medicolgeal update 6:1-4
ShaminT .(2010) Forensic odontology. J CollPhysicians Surg Park 20:1-2
Sivagami AV et al (2000) A sample and cost effective method for preparing DNA from the hard tooth tissue, and its use in PCR amplification of amelogenin gene segment for sex determination in Indian population. Forensic Sci Int. 110: 107-15
Synder LM, Springfield: Charles C Thomas, (1950) .Identification Dead Bodies ,Textbook of Homicide Investigation. p. 65
Shafer, Hine, Levi (2006) .Shafer's text book of oral pathology, 5th edition, Elsevier p. 871-5.
Sweet, D. and D. Hildebrand,(1998). Recovery of DNA from human teeth by cryogenic grinding. J. Forensic Sci. 43, 1199-1202.
Sweet D, Hildebrand D, Phillips D. (1999) .Identification of a skeleton using DNA from teeth and a PAP smear. J Forensic Sci ,44: 630–633
Sdos S et al (2003) .Applicability of 3D-T facial reconstruction for forensic individual identification.PesquiOdontol Bras,17: 24-8.
Sweet D et al (1998) .Computer based production of bite mark comparison overlay. J Forensic Sci, 43: 1050-55.
Stimson P, Mertz.(1997).Forensic Dentistry, CRC Press.
Sivapathasundharam B et al (2001).Lip prints (cheiloscopy). Indian J Dent Res 12:234-7
S. LeenaSakari et al (2015).Role of DNA profiling in forensic odontology. J Pharm Bioallied Sci. 7(1): S138–S141.
Saxena V et al (2017) .The credibility of dental pulp in human blood group identification. J Forensic Dent Sci.9:6-9.
Sen S et al (2017).Experience of dental professionals in determination of gender by observing smile. Int J Forensic Odonto,l2:18-21.
Teke HY et al (2007).SurgRadiol Anat. 29(1) :9-13
Tsuchimochi T et al (2002). Chelating resin-based extraction of DNA from dental pulp and sex determination from incinerated teeth with Y-chromosomal alphoid repeat and short tandem repeats. The American journal of forensic medicine and pathology. 23(3): 268-271.
Van der Velden A et al (2006). Bite mark analysis and comparison using image perception technology. J Forensic Odontostomatol. 24:14-7.
VinodSargaiyan (2014).Forensic Odontology: A Review .Journal of Advanced medical and Dental Science Research .2(4):45-51
VinodSargaiyan et al (2015).Forensic Photography: A Review. IJOCR ,3 : 8:60-65
Williams A.R, Williams GF. (1993). The invisible image - a tutorial on photography with invisible radiation. Introduction and reflected ultraviolet techniques. J BiolPhotogr 61(4):119.
Whittaker DK (1994).Introduction to forensic odontology . Quienssence Int. 25: 723-30
Wright FD, Golden G,S (2010). The use of full spectrum digital photography for evidence collection and preservation in cases involving forensic odontology. Forensic Science International.201: 59-67
Wood R E (2006) . Forensic aspects of maxillofacial radiology. Forensic SciInt .159S: S47-S55.