Review Article

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Orthodontics as Related to Forensic Odontology-A Review

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Abstract

Forensic odontology is proper handling, examination, and evaluation of dental evidences for people. The dental evidences are used for identification of a person to whom they may belong. The individual set of teeth which can be traced back to established dental records existing with the dental specialists are the highlight of forensic odontology as this can be helpful in finding missing individuals. The dental records in an Orthodontist's office starting from case history form, dental casts and bite registration, various radiographs and imaging, photographsetc. can be used for comparative evaluation and are helpful in assessing rugae pattern, mandibular canine index, lip prints etc. and their superimposition. Race gender and age estimation are also possible with most of these records. Promoting pulpal stem cell banking can even aiding DNA analysis for personal identification.This review is intended to provide an outlook for orthodontists to understand the importance and value of the patient records, how they are utilized in the field of forensic odontology and their responsibility to society and remind them about their liability to provide ante mortem evidences i.e. dental records.

Keywords: Forensic odontology; Records; Orthodontia; Lip prints; Rugoscopy.

Background

Forensic odontology is the art and science which requires a skill and scientific temper for handling, examining and evaluating the dental evidences. Dental evidences are useful in tracing back and identifying the person whom they belonged to. Knowledge of a forensic dentist should have an extended horizon to multiple disciplines as those multidisciplinary dental records obtained can identify an individual or afford the information that might lead the authorities to identification of the case.[1]

The individual set of teeth which can be traced back to established dental records existing with the dental specialists are the highlight of forensic odontology as this can be helpful in finding missing individuals.

Teeth can withstand trauma better than other tissues in body[2] and can withstand the temperature of 1100 degree celcious without the loss of microstructure.[3] Teeth is a source of DNA and can provide nuclear or mitochondrial DNA which helps in identification of a person. Thus, teethare valuable tool in forensic and thereby makes the role of forensic odontologist unique.

Basic knowledge about forensic dentistry and its importance and impact in judicial system should be acquired by every orthodontist. Being a specialist among dentistry our findings and conclusions are considered as an expert opinion. Lack of knowledge, training and experience always discourages an Orthodontist from facing the forensic related issues encountered in clinics. The accurately maintained dental records can act as valuable antemortem evidences.

This review is intended to provide an outlook for orthodontists to understand their responsibility to society and remind them about their liability to provide ante mortem evidences i.e. dental records.

Role Of Orthodontic Dental Records

1. Case history form

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2. Usage of dental casts for

A. Bite marks in personal identification

B. Palatal rugae in personal identification, racial, age and gender analysis

C. Mandibular Canine Index (MCI) in sex determination

Like finger prints each person has unique bite marks and rugae patterns. They can be used for identification by simple comparison of shape and metric values of bite marks and shape, size and number of rugae or by superimposition

Evaluation of Radiographs and Cbct for.

A. Age estimation from

1. Hand and wrist radiographs,CVMI, frontal sinus

2. Teeth – Intra Oral Peri Apical Radiograph,

B. Determination of gender – mandibular canine index(MCI)

C. Racial identification - cephalic index

Age can be estimated from dental development stages as well as eruption pattern seen in Intra Oral Peri Apical Radiograph, andPanoramic Radiograph/Viewwhereas hand wrist and cervical vertebrae helps in assessing skeletal maturation (prepubertal, pubertal and post pubertal stage).

Superimposition Using Computer Soft Wares

1. Craniofacial superimposition

2.Superimposition of photographs

3. Superimposition of cast

4. Superimposition of rugae pattern

Superimposition of postmortem radiographs and photographs over antemortemradiographs and photographs aids in easy identification of person. Even photos of cast and rugae patterns can be superimposed.

5. Identification From Dental Dna

Case History Form

The number of children and teenagers attending an orthodontist's clinic are high. We have the highest chance for identifying signs of abuse and neglect. Every orthodontist has a moral obligation for identifying and reporting forensic implications they came to face during the practice. "Any physician who fails to identify and report a child with historical, physical and radiological findings that indicate abuse is guilty of professional negligence.[4] Dental practitioners should consider the possibility of assault when the patient's explanation of how an injury occurred does not seem plausible or when there has been a delay in seeking medical care. Common types of injury include: Contusions, abrasions, and minor lacerations, as well as fractures or sprains. Sensible case history recordingincluding sexual or social history is a must for addressing sexual abuse or rape. Behavior features of battered women and neglected children should be identified and addressed.[5] Marks and patterns of battered baby like bruises in unexpected sites included belt or fist marks, cigarette burns and bite marks points towards child abuse. The child neglect victims are categorized under 1. Sexual abuse 2. Physical abuse 3. Emotional abuse 4. Neglect.[6] A depressed or problem child at school might be a signal of negligence or abuse.

Bite Marks

A bite mark is a pattern created by teeth contacting a surface, most commonly food but also other objects and even on human skin. Bite mark on human skin is a pattern of injury, its examination and analysis often becomes responsibility of forensic odontologist.[7] Bite marks have high evidentiary value as it accurately records distinct traits that can be used for comparisons with the suspect's teeth. If they are not recorded well in the injury, the overall forensic significance of the bite mark is reduced.[8]

Bite marks pattern association from ante mortem models are done with two methods. Direct method where model obtained from suspect is directly placed over bite mark and an indirect method where incisal and occlusal edges of suspect's teeth may be traced on a clear acetate and superimposed on life sized bite mark photographs.[9]

Bite marks of human and animals are different. Major differences are tabulated in Table I.

Burns from the end of a hair curling iron and patterns from the end of a lead pipe that closely resembled bite marks which are misleading and should be differentiated by the absence of class characteristics caused by human teeth in each case[7]. The authors believe that every member of the dental office from the chairside assistant to the orthodontist should be familiar with the presentations of bite mark and its implications.

Palatal Rugae

No two palates are alike in their configuration, there is no bilateral symmetry and the palatal prints will not change.[10] They serve as an important tool in forensic as they remain consistent in shape, direction, pattern and unification. Even in third degree pan facial burns 93% palatal rugae patterns are normal[11]. The internal position of rugae helps it from getting damaged from heat due to the insulating effect of tongue and buccal pad fat.[11] The events which may contribute to change in rugae are digit sucking, orthodontic persisting pressure, tooth extraction (lateral part only).[12] Rugoscopy is an effective and reliable tool in identification of individuals, gender determination[13] and ethnicity identification.

According to Lysell rugae can be classified based on their size as Primary rugae (>5mm),Secondary rugae (3–5mm), Fragmentary rugae (2<3 mm). Rugae<2 mm is not taken into consideration. Kapali et al. classified based on shape as straight, curved, circular,wavy,convergent and divergent[14] (Figure 1). Being a discrete variable rugae shape are better suited for the purpose of discrimination than continuous variables like rugae length.[15]

Mandibular Canine Index (MCI)

Odontometric sex assessment is possible with the help of canine index. Mandibular canine index found to be more reliable than maxillary.[16] It can be used only as a supplemental tool as the accuracy of sex determination never exceeded 87.5%. This index involves maxillary and mandibular canine width and the inter canine widths and calculation of Canine index (CI) and Standard Canine Index (SCI) using formula.[17]

If observed CI is greater than SCI it indicates a male and if less than or equal to the SCI- female. The formulas for calculating CI and SCI are

CI = mesio distal crown width of canine/ intercanine distance

SCI=(mean male CI-SD) + (mean female CI+SD)/2.

The measurement of canine index can be made in two ways. 1. Direct technique which is an in loco technique. 2. Indirect – a carbon bite mark is made on a paper and inter canine bite mark width is measured. (Figure 2)

Age Estimation from Teeth

Intra Oral Peri Apical Radiograph and OPG - Various methods and techniques are available for age identification using an Intra Oral Peri Apical Radiographbased on root formation, crown formation, dentine transparency, neonatal lines etc. Many methods like Demirjian's, Gusthafson's Nolla' sstaging etc. prevails for age estimation among which Demirjians method is followed widely.[18] Age estimation in Indians using Demirjian's 8-teeth method was formulatedby Ashith Acharya.[19] The formula for Indian norm is

Females = (0.3164*S)-13.154

Males = (0.3118*S)-12.852

Pulp tooth area calculated from Intra Oral Peri Apical Radiograph[20] serves in age estimation within the range of +/-5.4 years. Recently this ratio is being obtained from Cone Beam Computer Tomography (CBCT) images also.[21] Calcification of canine and development of third molar is also used as indicatorfor skeletal maturation.

Age estimation from bones

Hand wrist radiography as maturity indicator.

There are seven approaches found in literature for the assessment of hand wrist radiographs. The list and short description about various hand wrist radiographic techniques are given in table 2.

Greulich and Pyle[22] used two methods, acomparison method and another specific bone method.Tanner and Whitehouse used radius ulna and short bone score,carpal bone method and a modified TW^2 method where maturity level of each bone was assessed separately and scores were summed up to get final one for age estimation. Bjork, Grave and Brown assessed the relation between epiphysis and diaphysis.[22] Singer's[23] method which describes six stages of development. Fishman's[23] method which assess the skeletal maturation on the basis of 11 discrete Skeletal Maturity Indicators (SMI) which covered the entire period of adolescent development located on the six anatomic sites of thumb, third finger, fifth finger and radius. Haggand Tarangers method taken into consideration ossification of the ulnar sesamoid of metacarpalo phalangeal joint of first finger and some specified stages of middle and distal phalanges of third finer and distal epiphysis of

radius. A modified Hagg and Tarangers method was given by Rajgopal et al. where an additional stage was introduced.[22,23]

Lateral Cephalogram for

1. Cvmi

Cervical Vertebrae Maturity Indictor gives the percentage of growth remaining. Literature shows Lamparski[24] used cervical vertebrae as indicators for skeletal maturation first using Cervical vertebrae C^2 to C^6. Additional radiographic exposure was out of question as these vertebras were already included in routine lateral cephalogram. He found at different stages of skeletal development cervical vertebrae was found to have different shapes. The shapes of vertebral bodies change from wedge shape to rectangular to square to 'greater in dimension vertically than horizontally,' as skeletal maturity attained. The inferior vertebral borders were flat initially while they were immature and become concave when mature. Thyroid collar blocking 5th and 6th cervical vertebrae from radiographic images were the disadvantage faced by this method. This was overcome byHassel and Farman (1995)[25] as they used only 2nd, 3rd and 4th cervical vertebrae which were not hidden by thyroid collar. Later modified stages of CVMI was given by mcnamara, Bacetti and Franchi (2002) which was again modified by Bacetti (2005).[26,27] Both of these studies had 6 stages. According to Hassel and Farman peak growth velocity is seen at CVMI stage 3 and 4 and according to Bacetti peak high velocity happens at cervical stage.[3]

Later studies have shown Cervical vertebrae have the same potential as hand wrist radiographs for determining the skeletal maturation of an individual, thus protecting the patient from an additional radiographic exposure.[28]

2. Frontal Sinus

Even though Frontal sinus appears initially at the age of 1 year radiographically they appear by the age of 7–9 years only. They grow larger after puberty and attain maximum size by the age of 20 years and remainstable throughout rest of the life.[29]

Measuring the size of frontal sinus from lateral cephalogram for growth assessment was given by Ruf and Pancherz[23] in 1996. They compared the relations between frontal sinus growth and skeletal maturity and concluded that frontal sinus growth velocity during puberty is related to body height velocity. The threshold values obtained from their studies were compared with frontal sinus growth velocity and identified time of body peak growth velocity.[23]

Frontal sinus measurements are useful in gender prediction also. The length, and width of frontal sinus found to be higher in males.[29]

Gender Identification

Gender assessment was done with an accuracy of 70–99% by various studies using mandibular ramus flexure.[30] PA cephalogram and lateral cephalogram have an important role in gender identification from a defleshed skull. Next to pelvis skull is the most easily sexed portion of skeleton but it's not reliable until puberty as only female skull retains many pre-pubertal traits. [31,32] Sex prediction using complete cranium is better than using fragment calvaria.[33,32]

Craniofacial Superimposition Using Computer Softwares

Craniofacial superimposition is a forensic process in which photographs of a missing person are compared with a skull in order to determine whether is the individual depicted and the skeletal remains are the same person.[33] The advancement in technology and sophisticated latest digital equipment has resulted in a giant leap in the applicability of craniofacial superimposition in forensic identification. Superimposition can be done on photographs,[34] Panoramic Radiograph/ View, cast and rugae patterns in cast using Adobe photoshop.[35,36]

Forensic facial reconstruction is a topic which should be read along with superimposition. This technique is used to identify unknown human remains when other techniques fail. It can be done either manually or using specific soft wares for the creation of eithertwo dimensional (2D) pictures or three dimensional (3D) reconstructions. Facial reconstruction can be made possible even from an anonymous piece of skull with the help of latest techniques. Both scientific knowledge and an artistic sense along with good sculpting skills are necessary. Technological advancements and graphics have aided both in cost effectiveness and accuracy along with an appreciably reduced error rate. German anatomist Wilheim His in 1895 did first facial reconstruction.[37] Various 3D manual methods are Anatomical (Russian), Anthropometrical (American) and Combination Manchester (British) methods which were developed by Gerasimov,

Krogman and Neave respectively.[37]Amoung which British Manchester method is used widely in forensic facial reconstruction.

Identification from Dental dna

DNA contained in teeth, oral tissue and saliva can be extracted and typed. Dental pulp inside teeth survives almost all severe conditions and saved as a proof for many unsolved cases. Personal identification with an almost authenticity of 100% though some cases of contaminated DNA failure cases have been reported is possible with DNA analysis. The dental pulp is a good source for stem cells and DNA. The exfoliated, disimpacted or extracted tooth can be used for stem cell banking and thereby becomes a valid antemortm record. Y chromosome analysis from dental pulp of male can be done even after 1yr of death. AMEL gene responsible for an Enamel protein called Amelogenin [AMEL] is located on X & Y – chromosomes in humans. Females will have similar AMEL gene whereas males have dissimilar. Bar bodies and F bodies present exclusively in females also help in gender identification. Similarly, SRY (Sex-determining Region Y) gene marker is absent in males and present in females. These gene analysis helps in the gender identification.[38,39]

Importance of Dental Record Maintainence

The antemortem records should provide information from written notes, medical and dental histories, charts and diagrams, radiographs, clinical photographs, study models, reference letters, results of lab investigations and prescriptions.[40] Many of the cases attended in an orthodontic clinic are attempted for extraction orthodontics. Pulpal stem cell banking promotion by an orthodontist will be a useful way implication for making authentic antemortem record. Preservation of data in soft copy and its maintenance in proper manner can help orthodontists to present themselves as an expert witness. A centralized data bank with IDIS (Intelligent Dental Identification System) with for radiographs,[42] DNA digital impressions and photographs can also be a better idea unless and until it won't violate the basic human right of privacy.

Conclusion

According to Clark, 50% of identification are from dental evidence.[41] So, Odontologists definitely have a crucial role. Studies have shown lack of antemortem records were the major issue in identifying persons using dental records.[33] The aim of this review is justified if it gives an overview to an orthodontist aboutdifferent forensic parameters and how they can go hand in hand with judicial system in implementing proper law and order.

List of Abbreviations

1. MCI–Mandibular canine index
2. IOPAR– Intra Oral Peri Apical Radiograph
3. CVMI – Cervical Vertebrae Maturity Indicator
4. PA cephalogram–Postero

anterior Cephalogram

5. OPG – Panoramic Radiograph/View
6. CBCT – Cone Beam Computed Tomography
7. CI – Canine Index
8. SCI - Standard Canine Index
9. AMEL gene – Amelogenine gene
10. SRY gene – Sex determining Region Y
11. DNA – Deoxyribo Nucleic Acid
12. SMI – Skeletal Maturity Indicators
13. 3D – 3 Dimensional
14. IDIS – Intelligent Dental Identification System

List of Figures:

Fig. 1: Kapali et al 14 classification of Palatal rugae

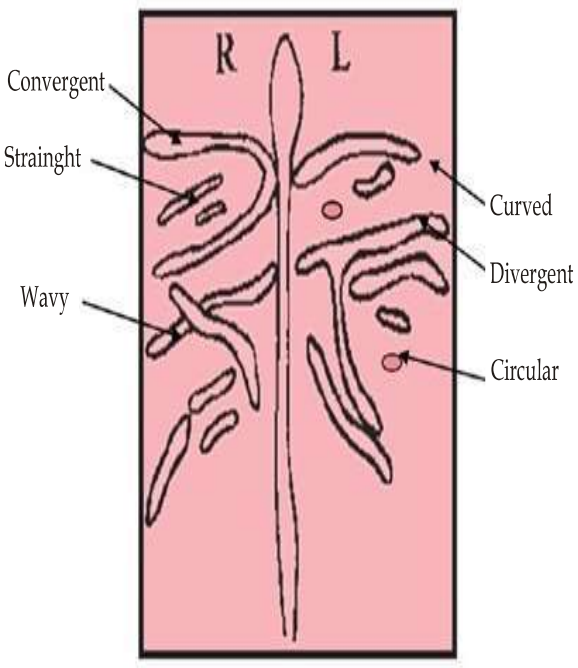

Fig. 2: Direct and Indirect Methods of Canine Distance Measurement[17]

Direct Indirect

Fig. 2: Direct and indirect methods of canine distance measurement[17]

List of Tables:

Table 1: Differences between human and animal bite mar.

Parametres	Human	Animal
arch size	25-45 mm	30-55 mm
arch shape	oval or elliptical	circular
incisor morphology	rectangular	oval to rectangular
canine morphology	triangle or trapezoid	oval/round
inter canine distance	29-39 mm	32-43 mm
tooth numbering system	FDI	modified Triadan system

Table 2: Methods of hand and wrist radiographs.

Sl No	Method and Year	Land Marks Use And Short Description	No. of Devolepmental Stages And Stage Indicating Puberty
1	Greulich and pyle (1959) 1. Atlas method 2. Bone specific method	Comparison of a hand and wrist radiograph with a standard done of same age and sex. Each bone is considered and given an age comparing to a standard X-ray and overall age is then calculated	–
2	Tanner and whitehouse method 1. Radius ulna and short bone score 2. Carpal bone method 3.Tw2 method	Rates of radius, ulna, metacarpals of 1, 3, 5 fingers and phalanges of 3 and 5 fingers are made Scoring of captitate, hamate, triquetral, lunate scaphoid, trapezium and trapezoid are made 20 Regions of interest are considered and given and a numerical score is given. Adding these scores will give an overall maturity score.	–
3	Bjork, grave and brown method (1976)	Relation between epiphysis and diaphysis in the carpal bone, phalanges and radius	9 Stages Stage 5 - peak pubertal growth spurt(mp3 cap, pp1 cap and radius capping)
4	Julian singers method (1980)	Characteristic features of 2 metacarpals and ulnar sesamoid along with relation of epiphysis and diaphysis of phalanges of second finger, third finger and radius was considered	6 Stages Stage 4 - pubertal stage (calcified ulnar sesamoid is seen and capping of epiphyses over diaphysis of middle phalanx of third finger)
5	Leonards fishman (1982)	4 Stages of bone maturation at thumb. Third finger, fifth finger and radius.	11 Stages Indicators of pubertal growth spurt-(smi 4 - appearance of adductor sesamoid, smi 5-dp5cap, smi6-mp3cap, smi7- mp5cap.)
6	Hagg and taranger	Ossification of sesamoid and 2 epiphyses at middle finger and epiphysis of radius.	5 Stages for middle phalanx of third finger (Peak high velocity is seen between mp3fg and mp3g stages) 3 Stages for distal phalanx of third finger 3 Stages for radius
7	Modified hagg and taranger (rajagopal et al. 2002)	One additional bone stage was included to the original	6 Stages for middle phalanx of third finger Mp3-g stage- maximum pubertal growth spurt (Epiphysis forms sharp distal edge, metaphysis show cupids bow appearance, moderate radiolucent gap between epiphyses and diaphysis)

References

1. Adams C, Carabott R, Evans S, et al. Forensic odontology: An essential guide. John Wiley & Sons; 2013 Nov 11.
2. Sorg MH, Haglund WD, editors. Forensic taphonomy: The postmortem fate of human remains. CRC Press; 1996 Dec 13.
3. Patidar. K A, Parwani R and Wanjari S, et al. Effects of high temperature on different restorations in forensic identification: Dental samples and mandible. Journal of forensic dental sciences; 2(1): p.37.
4. Prasad S, Sujatha G, Sivakumar G, et al. Forensic Dentistry: what a dentist should know. Ind J Multidisciplin Dent 2012 Feb;2(2):443–7.
5. women P, Yawn B, Yawn R, et al. American Medical Association diagnostic and treatment guidelines on domestic violence. Archives of Family Medicine 1992 Sep;1:39.
6. Cengel-Kultur E, Cuhadaroglu-Cetin F, Gokler B. Demographic and clinical features of child abuse and neglect cases. Turkish Journal of Pediatrics 2007 Jul 1;49(3):256.
7. Herschaft EE, editor. Manual of forensic odontology. CRC Press; 2011 Sep 26.
8. Rothwell BR. Bitemarks in forensic odontology: Fact or fiction? In Worthington P, Evans JR (ed) Controversies in Oral and Maxillofacial Surgery. pp .588–600.
9. Gupta S, Gupta V, Vij H, et al. Forensic facial reconstruction: The final frontier. Journal of clinical and diagnostic research. JCDR 2015 Sep;9(9):ZE26.
10. van der Linden FP. Changes in the position of posterior teeth in relation to ruga points. American journal of orthodontics 1978 Aug 1;74(2):142–61.
11. Muthusubramanian M, Limson KS, Julian R. Analysis of rugae in burn victims and cadavers to simulate rugae identification in cases of incineration and decomposition. J Forensic odontostomatol 2005 Jun;23(1):26–9.
12. Krishnappa S, Srinath S, Bhardwaj P, et al. Palatal Rugoscopy: Implementation in forensic odontology:A review. J adv med dent scie 2013;1(2):53–9.
13. Acharya AB, Prabhu S, Muddapur MV, Odontometric sex assessment from logistic regression analysis. Int J Legal Med 2011;125:199–204.
14. Patil MS, patil SB, Acharya AB, Palatal rugae and their significance in clinical dentistry: A review of literature. J Am Dent Assoc 2008;139:1471–78
15. Nayak P, Acharya A, Padmini A, et al. Differences in the palatal rugae shape in two populations of India. Arch Oral Biol 2007;52:977–82. 10.1016/j. archoralbio.2007.04.006
16. Pramod RC, Nupura V, Suresh KV, et al. Role of maxillary and mandibular canine indices in sex determination: Perspective of a forensic odontologist. CODS J Dent 2014;6:68–71.
17. Bakkannavar SM, Manjunath S, Nayak VC, et al. Canine et al. index–A tool for sex determination. Egyptian Journal of Forensic Sciences 2015 Dec 1;5(4):157–61.
18. Priyadarshini C, Puranik MP, Uma SR et al. Dental age estimation methods: A review. Lap lambert academic publ; 2015 apr.
19. Acharya AB. Age Estimation in Indians Using Demirjian's 8-teeth Method. Journal of forensic sciences 2011 Jan;56(1):124–7.
20. Cameriere R, Ferrante L, Belcastro MG, et al. Age estimation by pulp/tooth ratio in canines by peri-apical X-rays. Journal of forensic sciences 2007 Jan;52(1):166–70.
21. Star H, Thevissen P, Jacobs R, et al. Human dental age estimation by calculation of pulp–tooth volume ratios yielded on clinically acquired cone beam computed tomography images of monoradicular teeth. Journal of forensic sciences 2011 Jan;56:S77–82.
22. Flores-Mir C, Nebbe B, Major PW et al. Use of skeletal maturation based on hand-wrist radiographic analysis as a predictor of facial growth: A systematic review. The Angle Orthodontist 2004 Feb;74(1):118–24.
23. Premkumar S. Textbook of craniofacial growth. JP Medical Ltd; 2011.
24. Kamal M, Goyal S. Comparative evaluation of hand wrist radiographs with cervical vertebrae for skeletal maturation in 10–12 years old children. Journal of Indian Society of Pedodontics and Preventive Dentistry 2006 Jul 1;24(3):127.
25. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofac Orthop 1995;107:58-66.
26. Baccetti T, Franchi L, McNamara Jr JA. An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. The Angle Orthodontist. 2002 Aug;72(4):316–23.
27. Baccetti T, Franchi L, McNamara Jr JA et al. The Cervical Vertebral Maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. In Seminars in Orthodontics: 2005 Sep 1. (Vol. 11, No. 3, pp. 119–129). WB Saunders.
28. Kamal M, Goyal S. Comparative evaluation of hand wrist radiographs with cervical vertebrae for skeletal maturation in 10–12 years old children. Journal of Indian Society of Pedodontics and Preventive Dentistry 2006 Jul 1;24(3):127.
29. Soman BA, Sujatha GP, Lingappa A et al. Morphometric evaluation of the frontal sinus in relation to age and gender in subjects residing in Davangere, Karnataka. Journal of forensic dental

sciences 2016 Jan;8(1):57.

30. Badran DH, Othman DA, Thnaibat HW, et al. Predictive Accuracy of Mandibular Ramus Flexure as a Morphologic Indicator of Sex Dimorphism in Jordanians. International Journal of Morphology 2015 Dec 1;33(4).
31. Ali AR, Al-Nakib LH. The value of lateral cephalometric image in sex identification. Journal of baghdad college of dentistry 2013;25(2):54-8.
32. Hsiao TH, Tsai SM, Chou ST, et al. Pan JY, Sex determination using discriminant function analysis in children and adolescents: A lateral cephalometric study. International journal of legal medicine 2010 Mar 1;124(2):155–60.
33. Ali AR, Al-Nakib LH. The value of lateral cephalometric image in sex identification. Journal of Baghdad College of Dentistry 2013 Jun;325(2205):1–5.
34. Campomanes-Álvarez BR, Cordón Ó, Damas S,et al. Computer-based craniofacial superimposition in forensic identification using soft computing. Journal of Ambient Intelligence and Humanized Computing. 2014 Oct 1;5(5):683–97.
35. Lorkiewicz-Muszyńska D, Kociemba W, Żaba C, Łabęcka M, et al. The conclusive role of postmortem computed tomography (CT) of the skull and computer-assisted superimposition in identification of an unknown body. International journal of legal medicine 2013 May 1;127(3):653–60.
36. Aulsebrook WA, İşcan MY, Slabbert et al. Superimposition and reconstruction in forensic facial identification: A survey. Forensic science international 1995 Oct 30;75(2-3):101-20.
37. Gupta S, Gupta V, Vij H,et al. Forensic facial reconstruction: The final frontier. Journal of clinical and diagnostic research. JCDR 2015 Sep;9(9):ZE26.
38. Datta P, Datta SS. Role of deoxyribonucleic acid technology in forensic dentistry. J Forensic Det Sci 2012;4:42–6.
39. Gupta B, Gupta M. Sex identification in forensic odontology: A review of various methodology. International Journal of Forensic Odontology 2016 Jan 1;1(1):9.
40. Hinchliffe J. Forensic odontology part 1. Dental identification. British Dental Journal 2011; 210: 219 – 224.
41. Rajendran R. Shafer's textbook of oral pathology. Elsevier India; 2009.
42. Chomdej T, Pankaow W, Choychumroon S, et al. Intelligent Dental Identification System (IDIS) in forensic medicine. Forensic science international. 2006 Apr 20;158(1):27–38.