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# Evidence that does not lie - Implementation of raped victims and treatment algorithm within the oral surgery department: From ashes to truth

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**Abstract:**

Odontologists play a primary duty in the identification of individuals or missing persons in a scenario of a mass disaster, violent crime, child abuse, and elder abuse. When it comes to the identification of the victim or the suspect, their dental traits could turn out to a compelling proof and can help in slimming down the result of the investigating welfare work. Typically, it becomes necessary to use some least known and fewer widespread techniques in identification procedure such as lip prints, rugae patterns, and willing odontometrics can provide relatively valid conclusions referring to a person's identification. This review elucidates the importance of cheiloscopy, palatoscopy, and canine odontometry in a person's identification in relation to sex prediction and discrimination. This review article provides the newest information about the recent major advances and discoveries related to the classical and modern developed methods of dental identification that would enhance the knowledge and awareness among the professionals examining the youth victims of sex trafficking in urban and rural communities or identification of the rape or sexual abuse victims and the convicts, particularly in the Indian subcontinent when the rate of raped or sexually abused victims has risen. Various search engines such as Medline, PubMed, PsycINFO, EMBASE, and Web of Science were explored for scientific articles (original clinical research findings, case reports, and review articles) in the present subject area. A manual search strategy was adopted to obtain relevant literature on human trafficking, sexual violence, dental identification, and forensic odontology. There were no fixed inclusion and exclusion criteria before and after the literature search. Thus, the articles and items reviewed in this article were picked based on their relevance to the present topic, and an attempt was made to understand the application of various available methods of dental identification all over the world and its applicability to the forensic odontologists in the Indian subcontinent. The dental professionals who operate on the potential victims of human trafficking in secondary care units usually lack data and confidence. Coaching is required significantly for the dental employees who are involved in the identification of the victims and answering their demands, along with creating safe referrals.

**Keywords:**

Domestic trafficking, domestic workers, human trafficking, sex trafficking, sexual assault, sexual exploitation, dental identification

Forensic dentistry is a specialized branch of medical science and includes an element of odontology within the interests of justice. It deals with an accurate evaluation and presentation of dental findings based on the handling and examination of dental evidence. It is specifically helpful



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in the identification of raped victims as well as in the identification and confirmation of suspected convicts causing such heinous crimes.

The legal definition of rape in India varies from state to state. However, the foremost issues generally addressed throughout these states and typically required as evidence for successful prosecution includes lack of consent, the actual or threatened force within the commission of the act, and sexual penetration.[1] Medical evidence is crucial and often focuses on the presence of assailant DNA within the victim and documentation of anogenital injuries.[2] The examination of dental evidence by forensic odontologists can help the legal authorities in several situations. Each situation consists of three major fields of activity: civil or noncriminal, criminal, and research.[3,4] Human identification is also a universal process supported by scientific principles.[5] No two individuals within the planet look alike and are unique, and this idea of uniqueness is employed within the human identification procedures. Apart from DNA profiling, fingerprints, anthropometric data, and dental records are employed as standard methods. However, sometimes, it becomes obvious to use a variety of the smallest amount and unusually used ancillary methods, such as cheiloscopy and palatoscopy. When performed systematically, these methods along with other odontometric measurements can provide comparatively reliable results.[6]

Similarly, the patterns of palantine rugae can also provide reliable evidence, as these patterns exhibit racial and gender variations and are not subject to gross changes over time except the change in length during a person's growth. These are protected by the lips, cheeks, tongue, teeth, and bone against the extreme conditions like trauma and high temperature, and retain the identical position and shape throughout the person's life once formed.[7,8] Canines display sexual dimorphism and performance as a supplemental forensic tool in sex determination. They last long within the rima as they are least at risk of caries or periodontitis and also withstand vulnerable conditions.[9,10]

There are various methods employed in forensic dentistry for the identification of a victim or a suspect. These methods include a review of dental case records, their anthropological assessments, and analyses of their dentures or restoration of teeth, radiographs, bite marks, and intraoral photographs. It might also include cheiloscopy and rugoscopy. The most reliable source of DNA-based identification procedures is the dental pulp, as it is mostly preserved and resides in the protective environment inside the rima. Forensic odontologists are usually trained to handle victim identification in mass disasters along with individual cases.[11]

Bite-mark analysis relies on the principle that "no two mouths are alike." There are two assumptions on which the central doctrine of bite-mark analysis relies: (1) human teeth are unique and (2) sufficient detail of the distinctiveness is rendered during the biting process to facilitate identification.[12,13]

New technological facilities and techniques, such as three-dimensional (3D) optical laser scanners, surface scanners, intraoral cameras, and photogrammetry, are found to be reliable and accurate pathways for forensic studies.[14,15] These modalities were utilized specifically for the analysis of the dentition of subjects presenting similar dental traits and maxillofacial growth, such as orthodontically treated patients[16] and twins.[17] The observed dentitions are matched to each otherin order to investigate a similarity level, indicating whether or not human dentition is indeed unique for every person.

## Palatoscopy

Palatal rugae are considered relevant for human identification, thanks to its stability, and are just like the fingerprint, therein it is unique for each individual, it is called palatoscopy or palate rugoscopy [Figure 1].[7,18,19]

It has been shown that the entire number of rugae does not change throughout the time of life and adolescence, and changes that occur in rugae are only related to their length.[20] The various physical insults such as heat, disease, or trauma and chemicals are unable to alter the design and structure of these rugae. However, in case the palatal rugae are destroyed, they are reproduced exactly on the identical site.[21] Furthermore, the ability of palatal rugae to resist decomposition changes for up to 7 days after death has also been noted.[19] Calcorrugoscopy, or the overlaid print of palatal rugae in an exceedingly maxillary cast, is often employed to perform a comparative analysis.[22] Thomas and van Wyk mutually traced rugae patterns from antemortem and postmortem dentures onto clear acetate, then superimposed these tracings to photographs of plaster models.[23]

Prime accuracy rates in postmortem identification from palatal rugae are often obtained employing an easy visual comparison of antemortem and postmortem rugae

**Figure 1:** Representative picture of maxillary palatal impressions showing the different patterns obtained from three different individuals

patterns obtained from dentures, and it was noted that neither a classification protocol nor a computer-aided method is remitted.[24] A priority about palatal rugae that is voiced by many researchers is the chance of rugae patterns changing with age and other outside influences. Orthodontic movement,[25,26] extractions of adjacent teeth,[27] congenital defect surgery,[28,29] periodontal surgery, and a compelled eruption of impacted canines are just a few of the concerns.

## Role of DNA in Dental Identifications

Teeth represent an exquisite source of DNA material owing to the resistant nature of dental tissues in response to the environmental assaults such as incineration, immersion, trauma, mutilation, and decomposition of teeth.[30] This biological material can provide the mandatory link to prove identity in case the conventional dental identification methods fail [Figure 2].[31] The previously preserved DNA from an extracted teeth of an unidentified individual can be compared with the DNA obtained from an antemortem sample such as stored blood, hairbrush, clothing, cytosmear, and biopsy of a parent or sibling for confirmation of identification.[32]

Each individual has a unique DNA makeup which can be expressed as an encrypted set of numbers called DNA fingerprinting or DNA profile. The variable pattern of mini satellites and the stable inheritance in the usual Mendelian manner of the individual patterns can be detected by a probe that forms the premise of DNA fingerprinting. Polymorphisms are also used to differentiate and to correlate individuals as it involves variations in the DNA sequence.[33] An individual has teeth that differ in form and size, but all the teeth have similar histological structures. The dentin tissue forms the structural axis of the tooth, and it is rarely exposed to the oral environment. The enamel forms the roof of the dentin on the crown of the tooth. The enamel originated from ectoderm and is considered as a mineralized tissue with no vasculature or nerves. The inspiration dentin is roofed by the cement, another kind of calcified tissue. The odontoblasts, fibroblasts, and endothelial cells along with the peripheral nerve, the undifferentiated mesenchymal cells, and nucleated components of blood that are rich in DNA make up the soft tissue within the coronal and radicular pulp chamber. An odontoblastic process stretching into dentinal tubules or the soft tissues within accessory canals, cellular, adherent bone, and periodontal ligament fibers is also sometimes used for DNA extraction.[34] It has been revealed recently that dentine powder can be a source of mitochondrial DNA. It can be obtained by cryogenic grinding and dentine within the case of the root-filled tooth.[35] It can be also obtained by amplified fragment length polymorphism, a technique that came into practice during the early 1990s.[36] Single-nucleotide polymorphism detection technologies are accustomed to scan for fresh polymorphisms and to sort out the allele (s) of a known polymorphism in target sequences.[37] The arrival of DNA fingerprinting has revolutionized the concept of identification. It is reasonable to anticipate that future advances in DNA technology will reduce the time and value factor for the identification of unknown raped victims.

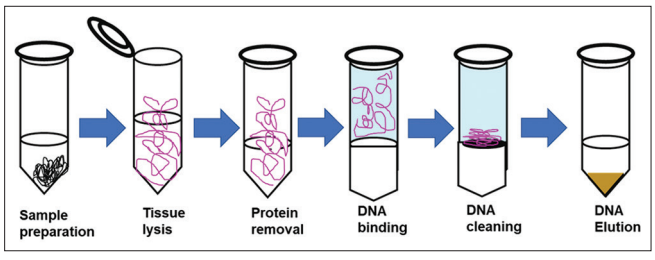


**Figure 2:** Representative picture showing steps of DNA isolation from dental tissue

## Legal Status of Bite-Mark Evidence

The comparison of the bite-mark pattern on the victim's body with the dental characteristics of the dentition of a suspect can be major evidence for the legal proceedings. Depending on the circumstances, a bite-mark pattern could even be deposited within foodstuffs, other objects,[38,39] or on the victim of an assault or homicide.[40] When a direct impression of the bite is left behind the physical characteristics such as the distance from the cuspid to the cuspid, the shape of the arch, evidence of malalignment, spacing, width and thickness of teeth, space created due to missing teeth, and wear patterns are considered for comparing bite-mark wound and suspect's teeth.[41] The bite mark made in human skin is that the realm during which bite-mark evidence may encourage to be valuable [Figure 3]. In 1975, the famous Marx case was seen with the bite mark on the

**Figure 3:** Representative picture showing the bite mark on the hand

nose and other cases where the 3D nature of the marks played a prominent role. The bite-mark analysis can provide greater assistance to examination and increase the worth of evidence in specific cases with the help of the advances in science.[42] Numerous techniques are utilized within the reproduction of the bite marks to return up with overlays, including hand tracing, photography, photocopying, scanning, and generating computer-assisted overlays.[43]

Guidelines for the analysis of bite marks: American Board of Forensic Odontostomatology established the following guidelines in 1986[44] to standardize the analysis of bite marks:

1. History – A history of any dental treatment succeeding, or in proximity to, the date of the bite mark should be obtained
2. Photography – A photograph of an extraoral view should include full face and profile views and that of intraoral should include frontal views, two lateral views, and an occlusal view of every arch. Often, it is useful to incorporate a photograph of maximal mouth opening. Photographs should be taken and preserved if foodstuffs or other insentient materials are used for test bites. A scale should be placed beside the bite mark while taking the photograph and the distance at which the photograph is being taken should be recorded. Ultraviolet light photographs capture the spacing, size, and shape of teeth and allow them to view the damage deeper into the tissue. A blood group determination is feasible in bite marks in human tissue further as in foodstuffs on account of saliva left in bite marks
3. Extraoral examination – It includes observation and recording of sentimental and hard-tissue factors which will influence biting dynamics. Maximal opening and any deviations on opening or closing should be measured and recorded. The presence of facial scars or evidence of surgery should be noted, further because of the presence of facial hair
4. Intraoral examination – It starts with the collection of salivary swabs. The tongue should be examined to assess size and performance. The periodontal status should be noted with particular relation to mobility. A dental chart can be prepared if possible
5. Impressions – A material that meets the American Dental Association specifications should be used to take at least two impressions of every arch. It is important to also record the occlusal relationship
6. Sample bites – Sample bites should be made into an appropriate material if possible similar to the one under the study
7. Study casts – Casts should be prepared using Type II stone in step with the manufacturer's specifications, using accepted dental techniques. The master casts should be duplicated into additional casts.

## Dental Prosthetics Identification

Certain features related to dentures such as previous or recent repairs, areas of relief, soft linings, the material used for its preparation, or the type of tooth and its arrangement can readily help in the process of identification [Figure 4]. However, sometimes, the label of the denture could be damaged if a denture wearer was involved in an accident, crime, or mass disaster and becomes invaluable for identification. Thus, the marker should ideally withstand such conditions. It should be acceptable to the patient and be easy and cheap to supply and provide identification.[45] The most common type of ownership identification is the inclusion or embedding of the patient's name or other personal information into the prosthesis. This can be often the best and least expensive approach; however, it provides no level of nonpublic security or background information. The dental prosthetics identification (DPid) system uses both an embedded code and an identification card (displaying the identical code) that provides another means of access.[46] There are two secure levels of DPid system. Tier 1 includes the patients' names; essential data to manufacture, repair, or remanufacture the dental prosthesis with photographs and the notes about the case as listed in the dental prosthetic categories; specific listing of the U.S. Food and Drug Administration Class II Dental Medical Device codes and numbers;[47,48] the date and point of origin of manufacture; the business name, address, phone, e-mail, and contact person of the dental laboratory; in case the dental laboratory is a licensed Dental Laboratory Technician (CDT [Certified Dental Technician]) on staff, Certified Dental Laboratory, Audit System Certified Laboratory (DAMAS [Dental Appliance Manufacturers Audit System]) of the audit device manufacturer, or a U.S. State-Registered Dental

**Figure 4:** Representative picture of different types of dental prosthesis which can be helpful in the identification of the raped victim and the accused as well

Laboratory; and the dentist's business name, address, phone, e-mail, dentist name, and dentist identification. The notification of health information associated with the patient's dental well-being to the manufacturing materials or the procedure of inserting the dental prosthetic is included in tier 2. The timely access to patient's identification and current dental records is extremely crucial for forensic dentists. Therefore, marked dental prostheses such as full or partial dentures, mouth guards, and other removable orthodontic appliances could be helpful in rapid identification in the event of accidents or disasters.[49]

## Mandibular Canine Index

The differences in size, stature, and appearance between males and females are referred to as sexual dimorphism. Dental identification is also a part of sexual dimorphism as the mouths of two different persons are not alike.[50] Various features like tooth morphology and crown size are characteristics of males and females [Figure 5].[51] In addition, a ramification of things influences tooth size, thanks to which its morphometric study is also a subject matter of great interest and provides significant results. Tooth size standards can be helpful in odontometric investigations and the determination of age and sex.[52] The identification of a missing person belonging to only one gender is simply considered when it comes to predicting the sex. However, in such a case, sex becomes an important determinant than age.[53]

Mandibular canines are found to exhibit the most effective sexual dimorphism.[54] The mean age of eruption of mandibular canines is 10.87 years. Canines are the last teeth to be extracted with relevance age; therefore, they are considered as the key teeth for personal identification.[55]

## Cheiloscopy

Lips of an individual contain unique characteristic patterns of grooves, furrows, wrinkles, and contours, similar to fingerprints.[56] The study of this lip-print pattern is understood as cheiloscopy [Figure 6]. The presence of furrows on the red part of lips was first described in 1902 by Fischer, an anthropologist. As referred by Sivapathasundharam *et al*.,[57] lip prints are relatively new forensic odontology tools in identifying individuals. A variety of classifications are proposed by various researchers to classify the lip-print patterns, the foremost commonly used among them being the Santos,[58] Suzuki, and Tsuchihashi[59] and Renaud's Classification.[60] A lip print found at the scene of a crime could lead to interpretations of the character of the event. It could also give an idea of the number of individuals involved, and their sexes or the cosmetics used, the behavioral habits of the individuals involved, their occupational traits, and the pathological changes of lips itself.[61] Lipstick stains on a suspect's clothing can show a link between the topic and also the scene of a crime. These prints are usually found as visible lipstick marks, even the latent lip prints are often used and may be lifted using aluminum and magnetic powder.[62]

## The Court of Law, Another Unfamiliar Place

Forensic dentists are termed to administer expert testimony during a courtroom, in both civil and criminal cases.[63] Concerning this context, the vital point to note is that forensic dentists have contact with the "dark side" of society. For example, the expertise in dentistry is additionally utilized in bite-mark analysis which constitutes the foremost common dental evidence presented in judicature. Victims of sexual homicide, rape, and child crime are often bitten by the assailants during the sexual attacks and leave bite marks as an expression of dominance and animalistic behavior.[64] The identification of bodies from the crime scene or suspicious death is additionally a part of the role. The dental team should bear in mind the chance of kid maltreatment and neglect and make referrals to a suitable agency if necessary,[65] but as praxis, a forensic dentist is understood on doing an examination followed by a political candidate report back to the court of law. Moreover, lip prints are considered to

**Figure 5:** Representative picture showing canine measurement

**Figure 6:** Representative picture showing the lipstick mark which can be used in victim/accused identification

be unique to each individual and are usually left at crime scenes.

## Age Estimation

Physicians with forensic experience and knowledge of auxology, radiology, dentistry, and legal medicine are usually consulted for the determination of the age of a suspect or a victim.[66] Dental and skeletal maturity are commonly used indicators for age assessment.[67] Dental structures are useful indicators of the individual's age.[68]

Following are the commonly used methods for age determination in children and adolescents:

- Schour and Massler method[69]
- Moorrees, Fanning, and Hunt method[70]
- Demirjian, Goldstein, and tanner method[71]
- Portigliatti Barbos–Robetti method[72]
- Nolla's method[73]
- Measurements of open apices.[74]

Clinically, the development of permanent dentition in adults is completed with the eruption of the third molar at 17–21 years, after which radiographic age estimation becomes difficult. The two commonly used methods are:

1. Volume assessment of teeth
   - Pulp-to-tooth ratio method of Kvaal *et al*.[75]
   - Coronal pulp cavity index.[76]
2. Development of the third molar
   - Harris and Nortje method[77]
   - Van Heerden system.[78]

## Geometric Structures Traced from the Human Face

The external part does not grow homogenously over time. Each of the various facial structures develops in several dimensions and directions.[79,80] Consequently, the facial anatomy reaches different proportions looking forward to age.[79,81,82] This phenomenon, named as allometry, is the rationale why a child's face does not correspond to a smaller version of an adult's face. Cattaneo *et al*.[83] contributed to forensic science with an innovative method that provided satisfactory age range information to support forensic investigations of pedo-pornographic material. This sort of evidence is common in cybercrimes involving ill-treatment. In these crimes, victims and perpetrators are additionally photographed[84] and their facial traits may contribute to crime characterization. Nevertheless, age estimation through facial photographs may be a challenging procedure.

Forensic dentistry has offered several avenues in the interest of justice since historical times. In the many more years to come, it will evolve as one of the most important identification methods of the accused in the rape case in the state capital, and justice to the victim cannot be denied anymore.

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There are no conflicts of interest.

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