

The role of bite mark evidence in rape investigations: A forensic review

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Abstract—Human bite marks are a crucial and important type of forensic evidence, especially in sexual assault cases. Bite marks tend to be an essential connection between the victim and perpetrator. This review systematically addresses the definition, classification, mechanism, types of bite injuries, usual anatomical sites, and current collection techniques of bite marks in rape cases. Importance is laid on analysis and documentation protocol, such as the significance of photographic, swab, and impression methods. Modern developments such as 3D imaging, computer-aided analysis, and DNA identification using saliva smudges have added to bite mark analysis' reliability and credibility. A case study underscores practical application of such methodologies. The review also touches on significant advances in forensic odontology, supporting the changing standards in bite mark analysis. With an integrated approach, bite mark analysis continues to enhance the medico-legal investigation of sexual violence.

Index Terms --- Bite Mark Analysis, Forensic Odontology, Rape Investigation, DNA Profiling, 3D Imaging, Sexual Assault Evidence.

I. INTRODUCTION

Forensic Odontology, specialized branch of forensic medicine, plays a crucial role in criminal justice systems. Its significant is in the uniqueness of human dentition—like fingerprints, no two individuals share the same teeth configuration [1]. Such uniqueness allows forensic odontologists to provide significant input to investigations, particularly by analyzing bite marks and by providing expert testimony on such evidence in court [2]. Comparison of bite marks, like fingerprint comparison, is at the core of individual identification within criminal cases [3].

Forensic odontology has a wide application, which includes collection, analysis, and documentation of dental evidence for use in criminal and civil proceedings. The further advantages of forensic odontology are human and dental identification, estimation of age, sex determination cheiloscropy, palatoscopy, and bite mark comparison even plays a vital role in wildlife forensics. Also, forensic odontology enables individual identification using dental records and forensic comparison of bite marks—whether found on victims, suspects, or even objects like food—offering valuable clues that lead to criminal identification [4].

Bite mark analysis is particularly applicable to violent sexual crimes like rape, sexual homicide, and child sexual abuse. These marks are usually found or seen on areas of the body which are linked with sexuality. In females, they are most frequently found on the breasts, abdomen, thighs, buttocks, and pubic area, whereas in males, they are most commonly found on the back, arms, shoulders, chest, and genitals.[5]Also important in the identification of individuals in cases of fire accident, mass disaster, and sexual assault.

Bite marks are strong evidence in such crimes as violent rape, when they are often the product of teeth being used as weapons of aggression or control. The skin of victims of physical altercations is where bite marks are most frequently detected. Their distinctive patterns provide forensic experts with clues regarding the nature of abuse⁶. Bite marks can be found on almost any area of the body, from the face, neck, and arms to hands, shoulders, and even erogenous zones such as breasts and genitals [7,8,9].Bite impressions can also be found on common items—ranging from foodstuffs like cheese or fruit to everyday objects like pencils, cigarettes, and bottle tops—expanding the potential for evidence collection[10,11,12].

II. DEFINITION

According to the American board of Forensic odontology (ABFO), Bite-marks are the patterns that are created on the surfaces or tissues by the dental impression of animal or person [13].According to Mac Donald, the bite marks are the results of activity of tooth or development; it is either created by one factor or mixed up of other oral structures. It is believed that the size, shape, and details or uniqueness of the anterior teeth's biting surfaces in both dental arches are thought to be different for every individual As a result, a bite-mark displays a unique characteristics of an individual's teeth and can assist in ruling out suspects who are not the source of the mark[14].

III. CRIMES INVOLVED IN BITE MARKS

In life-and-death scenarios, the conflict between victim and assailant can involve the use of teeth as a means to inflict harm on the attacker, serving primarily as a defensive measure for the victim. Conversely, in instances of sexual assault, it is significant to note that perpetrators frequently bite their victims as an expression of dominance and anger. Different types of crimes associated with bite marks include violent offenses, cases of child abuse, and incidents at sporting events, homicides, self-inflicted injuries, and kidnapping cases, among others [15].

Violent crimes

In violent crimes, bite marks may be seen where the victim bites the assailant during protective retorts or where the attacker bites the victim. In sexual biting, teeth are employed for gripping, and petechiae, which may appear as central or peripheral suction marks, are observed[16].Sexual bite marks, which are typically present on exposed or sensitive parts of the victim's body, are a sign of dominance or struggle.

Child abuse cases

Bite mark in children occurs frequently and they are not recognized or accessed when appear to be suspicious. In older children, bite marks are typically associated with either sexual abuse or physical assault [17]. It is physical proof of abuse, particularly in young or nonverbal children who are unable to explain what happened.

Sporting events

At athletic events, bite marks have occasionally been seen, usually after intense contact or emotionally charged situations. Depending on their seriousness, these incidents frequently lead to disciplinary action and perhaps criminal prosecution. When a victim bites their assailant in sports like boxing, rugby, and soccer, bite marks are produced [18].

Self-inflicted bite marks

If the bite marks appear on a body portion that the subject can easily reach their mouth, it may be a self-inflicted bite. It frequently happens on children's forearms. This biting occurs at periods of extreme stress, panic, or annoyance. In certain situations, such as when someone is mentally ill, they may potentially harm themselves [19]. The bite marks could even show up while you're sleeping; they could be the result of unconscious or habitual behavior.

At the scene of crime

In some cases, the things that the criminals left at the crime scene which contain bite marks on it. Skin and soft tissues, as well as inanimate objects like food, fruits, clothing, etc., which contain bite marks [20].

Classification of Bite Marks

Bite marks can be classified in different ways based upon the cause of the bite, the location of bite that is where they appear, and severity or wounds created by the bite. The major classification systems are mentioned below

A. Cameron and Sims Classification

According to the reason for the bite and the location where it occurred, this classification scheme was developed

1. Depending on the biter
 - Human
 - Animal
2. Depending on the material bitten
 - Humanbody (i.e. skin and body muscles)
 - Food or other materials which is edible
 - Objects or non-food material

B. MacDonald's Classification

Bites based on the nature of the force used and the manner in which the mark was produced

1. Tooth pressure marks - developed when teeth actually press into tissue, typically by the biting surfaces of front teeth.
2. Tongue pressure marks - when the human tongue is pushed into the mouth, it presses tissue against the roof of the mouth or teeth, causing tongue pressure marks. Of the mouth following being introduced into the mouth.
3. Tooth scrapes marks - developed when teeth rub across the surface, resulting in scratches or superficial abrasions.
4. Complex marks - combination of the above forms, sometimes further complicated by multiple bites in one area [21].

C. Webster's classification (applied mostly for food bites)

This system takes into account the extent to which a food item is bitten or penetrated

1. Type 1 – Food is easily fractured with minimal tooth penetration.
2. Type 2 – Teeth bite deeper into food, tearing off some of it (e.g., apples or other solid fruits).
3. Type 3 – Teeth penetrate almost all the way through the food, often leaving drag or slide marks (e.g. cheese)[22].

D. Classification according to depth or severity of bite

This classification is based on how far the bite penetrates the tissue

1. Obviously defined – deep impressions due to heavy pressure.
2. Clearly marked – pressure with clear marks.
3. Quite obvious – forceful biting with strong pressure.
4. Lacerated – severe bites in which the skin is torn [23].

Note: The severity of the wound can also reflect the psychological or emotional condition of the person who bitten. Injuries may show faint signs of contusion or bruise, scraping (abrasion), tearing (laceration), removing skin (avulsion), or mimic trauma due to something else other than a bite (artifact).

IV. MECHANISM OF BITEMARK

The reason behind formation of bite-mark is caused by the process of pressure of teeth on the skin, which typically involvement mandibular closure and negative pressure – induced suction. During the process of bite the upper jaw holds the skin in place while the lower jaw is mobile and delivers most of the biting force. The injury resulting from a bite mark often present as oval in shape exhibiting clear dental features. The presence of 'C' shaped impression indicates the lower jaw was used for the biting action. These injuries can range upto (in diameter) 25 to 40 millimeters. As the teeth press the tissue inward, leading to bruising that develops within the bite-mark [25].

According to MacDonald's classification the three main mechanisms involved in the creation of bite mark

- Tooth pressure mark
- Tongue pressure marks
- Tooth scrape marks [25,26].

V. TYPE OF INJURY

Injuries can be divided into four types according to the degrees of impression levels and also there are seven different types of injuries which can be observed in bite marks are

According to injuries

- 1) Petechial hemorrhage is a tiny area of bleeding.
- 2) Contusion is ruptured blood vessels.
- 3) Abrasion is an undamaged mark on skin.
- 4) Avulsion is a pulled off skin.
- 5) Laceration is a skin that is close to being punctured.
- 6) Incision is neatly pierced or torn skin.
- 7) Artifact is a piece of body that has been bitten off [27].

According to degrees

Clearly defined - marks which result from applying a significant pressure.

Obviously defined - because of light pressure.

Quite noticeable - as a result of intense pressure.

Lacerated - a severe cut or rip in skin which is very deep [28].

VI. LOCATION

The Anatomical location of bite marks or injury will vary accordingly. Depends upon the type of crime and age and sex of the person involved in the crime. Crimes like homicide, rape, sexual assault, robbery, and child abuse are most frequently linked with biting offenses. The study revealed that the females were four times more probable to experience a bite wound than the males and that the injuries, which were most common on breasts, arms and legs, were the least severe. On the other hand while taking female children; the bite marks are typically experienced on the parts of the body like face, legs and arms. Males are statistically more likely to experience bites on the arms, back, and hands compared to other areas of the body it can also be possible that a victim may have more than one bite mark on one or more various anatomical sites.

Bite marks can appear on different areas of the body and are generally categorized into non-sexual and sexual types. Arms, legs, hands, fingers, chest, and ears are common places to find non-sexual bite marks. Conversely, bite marks associated with sexual activity are typically found on areas such as the breasts, neck, thighs, genital region, armpits, buttocks, upper back, arms, and cheeks, it is known as sexual bite marks. The occurrence of bite marks differs by body area, with frequent sites being the breasts, arms, genitalia, back, thighs, legs, nipples, hands, buttocks, abdomen, waist, face, and neck. (In rape cases the bite marks can often be found on body parts like Breasts and chest Shoulders Neck Arms Thighs Back Face Genital areas (rare but possibility is high). The occurrence of bite marks are also based on the force, struggle and domination).

VII. COLLECTION OF BITEMARK FROM RAPE VICTIM

Photography

Images with or without an ABFO No.2 scale Taken in color and black & white photography with and without the camera flash

Overall body images to document the location of the bite Close-ups views (scaled 1:1) Ultraviolet photography, if needed

Additionally, photograph the various body positions to examine movement effects; especially for bites on mobile anatomical location [29]. To avoid distortion, photographs should be captured with the camera angled at 90° to the injury. It is advised that bite marks be observed at 24 hours' intervals in both living and deceased victims, as the appearance of bite mark may evolve or become more pronounced [30].

Salivary swab

Hence, double swab technique is suggested for effective collection because of frequent saliva deposition during the process of is one inevitable [31]. The collection process remains effective even if the skin has been washed. Using distilled water the area of bite mark is swabbed and gently rubbed on the location of bite mark in circular form and using dry swab collect remaining residual moisture and left it to dry at room temperature [32].

Impression of bite injury

Records any imperfections or injuries like cuts or abrasions that left on the surface of bitten area. The vinyl polysiloxane impression materials are the best method suited for this purpose. Once taken, the impression can later be cast in plaster to preserve for the permanent record of the injury. The victim's consent is mandatory for the collection of evidence [33].

Collection of bite mark from suspect

Collecting dental evidence tends to be invasive process, and suspects are often unwilling to give their physical exhibits during the collection method [34].

- History & dental records – The dental records sourced from the suspect's dentist are extremely valuable and serve an essential purpose in verifying the suspect's identity.
- Photographs – Taking photographs of the suspect is an important step; make ensure that both intraoral and extra oral photographs had taken. The extra oral images should consist of both profile and full face views, whereas intraoral images must capture frontal, lateral, and occlusal perspectives of both arches. Capturing the maximum inter-incisal opening is essential and photos should be taken with and without scale.
- Impressions and study cast – The process of taking and fabricating the dental study casts of the suspect's dentition are the crucial steps in the evaluation of bite marks analysis.
- Test bites – This technique is used to identify the suspects position, shape, and alignment of the incisedges. The materials like base plate wax, aluwax, coprwax, silicone etc are often used to take these sample test bite.

- DNA samples – For DNA extraction, saliva is used as a non-invasive method, while whole blood collection is considered an invasive method; both samples can subsequently be analyzed against biological evidence from the scene of crime [35].

VIII. RAPE CASES WHERE BITE MARK'S PLAYED A MAJOR ROLE

Jogeshwari case (Mumbai, 2014)

Shrinivas saryadu, a 45-year-old man, abducted, assaulted, and raped a six-year-old girl in Mumbai in 2014. The incident took place when the girl left her home to purchase a paan for her grandmother and did not return. Her family reported her missing. The following morning, a woman on her way to work found the girl at aaray. She found the child unclothed, crying, injured, with swollen lips and bleeding. The child received a medical examination after being sent to a trauma center. Upon her father's arrival, she recounted the details of the attack. In court, she testified that the accused had approached her near the paan shop, stolen 10 rupees from her, and taken her into the woods, where he bit and assaulted her. The accused had been reported missing by his brother at the same police station. Although the child could not identify him due to his covered face during the crime, medical and dental evidence ultimately led to saryadu's conviction by a special court under the pocho act. A computer-based comparison technique confirmed that the bite marks on the victim's lips matched the teeth of the accused. The verdict was made; the saryadu was sentenced to 20 years imprisonment.

Nirbhaya case (Delhi, 2012)

On December 16, 2012, in Delhi, India, a 23-year-old woman named nirbhaya was subjected to multiple rapes while traveling on a private bus. She passed away on December 29, 2012, as a result of the terrible injuries she sustained during the vicious attack. Within twenty-four hours, the suspects were located. Six males, including a minor, were convicted. The accused's dental models were matched with the several bite marks found on the victim's body. Using computer tools, Dr. Ashit b. Acharya examined the bite marks and made the hypothesis that two of them were the same for two suspects. After approving the evidence presented, the court rendered a verdict in which the juvenile received a three-year jail sentence, one of the accused committed suicide, and the other four adults were given the death penalty.

Thane case (Maharashtra, 2019)

In 2019, a 48-year-old man named lakhan dekar sexually assaulted a 50-year-old woman in the thane region of Maharashtra. The incident occurred when the woman was returning home alone; the perpetrator dragged her to a secluded area and raped her. Following the attack, the woman was taken to a local hospital and subsequently filed a police report. During the investigation, authorities reviewed CCTV footage from the area and conducted inquiries at various local establishments, slums, and labor colonies. The police identified the suspect in several video clips and called him for questioning. Upon examination, they discovered bite marks on his chest, which he claimed were inflicted by the victim as she attempted to resist. The accused was taken into custody and charged with a number of offenses, including criminal intimidation and rape.

Powai case (Mumbai, 2014)

On January 23, a 28-year-old woman was sexually assaulted by a security guard outside her residence shortly after being dropped off by a friend. The victim, who lives in powai with her siblings, had spent that evening out with two friends, a girl and a boy. After dropping the female friend off, they returned to powai. As she approached her building after being dropped off, the guard, upadhyaya, 32, confronted her, forcibly dragged her across the street, and assaulted her. Her brother found her in the early morning, in unconscious and partially clothed and her sister took her to the hospital. They reported the incident to the police. The victim sustained multiple injuries, including a head contusion, bruises on her arms and legs, and bite marks on her breasts. A forensic examination carried out at kem hospital verified that the dental impressions of the security guard matched with the bite marks found on the victim. Following the evidence presented, the accused was sentenced to 10 years in prison by the trial court.

Perumbavoor case (Kerala, 2016)

In April 2016, jisha, a law student, was tragically raped and murdered in her home in iringol, near perumbavoor. While waiting for her mother, the perpetrator, ameer ul islam, forcibly entered her residence, intoxicated and armed with a bottle of liquor and a knife, intending to commit sexual assault, which ultimately led to her murder. After the crime, he escaped to his home state of Assam. The postmortem examination revealed two distinctive bite marks on the victim's left shoulder, indicating that the assailant had a gap of over three millimeters (diastema) between his front teeth. One bite mark was located approximately 6 cm below the shoulder, while the other was 12 cm from the base of the neck. Later the accused was arrested and he was sentenced to life imprisonment.

IX. DOCUMENTATION

Bite samples

It is recommended to get a sample bite using materials which is approved by the american dental association for example copra, aluwax can be used accordingly these samples are subsequently photographed and used for future comparative analysis. The above documentation procedure should be taken while taking bite marks in live and deceased people as follows

Documentation of history

It is necessary to compile a thorough medical history of the person, including any dental procedures. Assessing the influence of decomposition, embalming, contamination, or cleaning on the bite mark is also crucial.

- Demographics: demographics details such as name, age, sex, race of the person and case number, date of examination, and name of the examiners should also be included.
- Location of the bite mark: the anatomical position, show the surface's shape (flat, curved, or uneven), and describe the tissue's condition. The underlying tissues include bone, cartilage, muscle, or adipose tissue.
- Shape of the bite marks: if its shape is irregular, or it takes on a spherical, oval, or crescent form, it can be classified as such.

- Colour and size of the mark: the metric system should be used for recording both vertical and horizontal dimensions.
- Type of injury: bite marks can cause a variety of injuries, including laceration, abrasion, contusion, incision, avulsion, artifact, and petechial hemorrhages. One should see whether the skin's surface is smooth or indented[36].

Photographing the bite mark

This is a crucial stage in the investigation since an exact bite-mark photo needs to be taken. The orthodontist can lower the margin of error by using a digital camera rather than a traditional one. After that, a life-size version of the picture is made. Alternative photographic techniques employing ultraviolet light can be utilized to create photos of the tips of the penetrated area if a significant amount of time has passed after the mark was formed[37]. photography is crucial for recording bite marks and gathering proof. Since skin markings can change over time, photos provide reliable documentation. Images should be taken at a 90° angle to the injury, ideally every 24 hours, for both living and deceased subjects, as their appearance may vary[38]. The American board of forensic odontology (ABFO) established ABFO scale no.2, a standard for documenting sequential photographs of bite mark injuries, utilizing both traditional photography and video imaging. In addition to traditional color and monochrome films, ultraviolet photography is advised during the initial meeting and for several days thereafter[39]. Additional oral photos include profile and full-face shots. A close-up shot of the teeth in their natural occlusion, with maximum opening and edge-to-edge biting, as well as two lateral views and frontal views, should be included in the intraoral examination. it important to eliminate any unwanted shadows. To achieve these outcomes, digital single lens-reflex cameras are used.

Impressions

Two impressions of each arch are obtained, and type ii stone master casts are created using material recommended by the American dental association (ADA). Recording the interocclusal relationship is necessary. You can get duplicate castings from the master cast. One set of castings is utilized for direct proof, while the other set is used for comparison. If there is a detachable prosthesis, both the prosthesis and its absence are captured in the imprints. It is not appropriate to cut, carve, or otherwise modify teeth or soft tissue records. Sample bites that mimic the sort of bite being examined are created using the proper material[42].

Impression and model

Making stone models requires taking imprints of the bitten region in order to maintain its three-dimensionality. Both silicone-based and rubber-based imprint chemicals are utilized to capture the biting marks at the location.

The two techniques for making an impression:

- Method i - the impression material is applied to the bite region. They put wire gauze on it and inject more material over it.
- Method ii - applying cold remedy an impression is taken after a customized tray is built according to the bite mark's shape. Stone should be type IV and which is used while performing master casts. Additionally, duplicate castings must be made. To create a hard model, either transparent epoxy resin or visible light curing can be utilized [42].

X. BITE MARK ANALYSIS

The very first phase of bite mark analysis is to verifying whether the injury is caused by a bite to check whether it is caused by human teeth. The consistency of the marks in relation to the time of the crime should be determined, followed by an assessment of its forensic relevance. The procedure for looking at bite marks is as follows

Shape, Size and Arrangement of Teeth

Bite marks may manifest in different forms, such as crescent, oval, circular, or irregular shapes. The cross-section of human incisors creates rectangular impressions, while canines produce triangular ones. The bite mark's horizontal and vertical measurements are recorded, ideally in metric units. Key dental characteristics such as tooth size and arrangement, along with secondary features like gaps or broken teeth, are analyzed for comparison. To be called a match, a bite mark must have both primary and secondary dental traits in alignment. Furthermore, it is crucial to record tooth numbers, identify any missing teeth, and note the placement of the tooth marks [43].

Size of Dental Arch

The correlation between the dimensions of bite marks, as determined by the dental arches, may indicate whether the bite belongs to a child or an adult. These arches are U-shaped and feature a gap in the center where bruising typically occurs. The typical diameter of adult arches, measured from canine to canine, ranges from 25 to 40[44].

Suction Mark and types of injuries

Suction marks, commonly known as hickeys, consist of small punctuate hemorrhages. They feature a central ecchymotic region encircled by linear abrasions that radiate outward, resembling a 'sun-burst', typically observed following sexually motivated offenses. These bruises occur due to suction or negative pressure, which causes blood to leak from capillaries[45]. The seven types of injuries are linked to bite marks are Contusion, Abrasion, Avulsion, Laceration, Incision, Artifact, and Petechial Hemorrhage and Colour of the wound the color should be defined, for example, red, purple, and so on.

Methods of Analysis -

Odontometric Triangle Method

Three locations are revealed using the objective odontometric triangle approach, which tracks bite marks and tooth models. Two points are placed at the outermost convexities of the canines, while the third point is positioned at the midline between the maxillary central incisors. When these points are joined, a triangle is created. The three angles and lines are computed and contrasted. The upper and lower tooth models are used for this, and their markings are compared to those of the specimen. Following an in-depth analysis, the outcomes have been obtained [46].

Comparison Technique

- Direct method/cast on photo technique this method compares photos and models directly, or uses a fingerprint powder lift model. For illustration reasons, this approach allows replicas of the suspect to be placed immediately over a life-sized photograph of the bite mark[47].The fingerprint powder lifting method involves dusting the bitten flesh with a brush and appropriate powder, then transferring the impressions onto an acetate sheet using fingerprint tape. Investigators must exercise caution during the development of the print to avoid damaging it.
- The indirect method-overlay technique involves capturing a suspect's sharp edges by making a transparent overlay. To do this, a dental model's occlusal or incisal surfaces are manually traced onto an acetate sheet, which is then placed over scaled 1:1 photos for comparison. However, the use of transparent overlays is often viewed as subjective, easily altered, and not consistently reproducible. In contrast, overlays produced by a photocopier are regarded as a superior option for accurately matching bite marks to the appropriate models, eliminating the need for freehand tracing [48]. Bite mark overlays can be made in four different ways.

Computer based

- Radiopaque wax method
- Xerographic
- Hand traced [49].

Other Special Methods

- Stereo metric graphic analysis
- Vectron
- Scanning Electron Microscopic analysis
- Image perception technology
- Experimental Marks[50]

In order to aid standardize bite mark assessment; the American Board of Forensic Odontology (ABFO) developed criteria in 1986.

Impression

Two impressions of each arch should be taken using materials that comply with the American Dental Association (ADA) specifications, ensuring that the occlusal relationship is accurately document. A sample of suspects' bites in centric occlusion is taken using a base plate wafer made of silicone putty or wax. The sample is photographed right away for future reference and comparison. Study casts are created using type II stone [51,52].

XI. RECENT ADVANCEMENT :

Image perception software procedure

Using a picture of a bite mark, the imaging software selects a certain region. Different shades of grey are given specific colors, allowing the forensic dentist to choose areas with similar grey shades. By deleting specific pixel regions, you can draw attention to the area of the picture that displays the bite mark. The bite mark is meticulously replicated. Then, the colored image of the bite mark is placed over the original photo using Photoshop [53].

Automated dental identification system (aids)

This is a computer program that helps examine victims after death by looking at their mouth features. Comparing to traditional methods it is very fast and accurate. The program analyzes digital x-rays and dental images, which are hard to check just by looking at them. It also finds many digital dental records that match the victim's records [54].

3d reconstruction of bite marks

Using 3d-cbct instead of the traditional method has advantages. It requires less handling of the sample, which means the original bite mark at the crime scene changes less. It's also easier to save and retrieve the information, produces better images of the bite marks, reduces angle distortions, and keeps records for a long time [55].

Odontosearch

It offers a way to objectively determine how frequently a dental code occurs. Based on the dentist's clinical background, the degree of correspondence between a post mortem and ante mortem dental code is determined. Data bases of criminals and missing persons are compared. It enables the odontologist to assess if a patient's exact filling arrangement is unique⁵⁶.

Computer-assisted analysis (CAI)

This CAI technique is software which helps in comparing bite marks more precisely. This program has in-built function such as measuring tooth width, spacing, angles, and arch patterns which automatically reduces the human bias.

XII. CONCLUSION

Though difficult, human bite marks remain a useful kind of evidence in rape cases. Bite marks can be used to precisely identify and prosecute offenders using meticulous documentation, proper collection techniques, and advanced analytical tools. Skin elasticity and post-injury changes cause problems even for forensic experts using newer, scientifically validated methods in spite of these obstacles. Recent advances such as DNA recovery from saliva, computer-aided analysis, and 3D digital imaging have significantly boosted the validity of bite mark evidence. Forensic odontology is still developing; keeping high standards of analysis and careful interpretation will help to guarantee the bite mark evidence stays acceptable under legal review. Improving multidisciplinary collaboration among forensic odontologists, medical examiners, and investigators will help to clarify the situation.

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Case study references

Case 1 : Jogeshwari Case (Mumbai, 2014)

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Case 2 : Nirbhaya Case (Delhi, 2012)

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Case 3 : Thane case (Maharashtra, 2019)

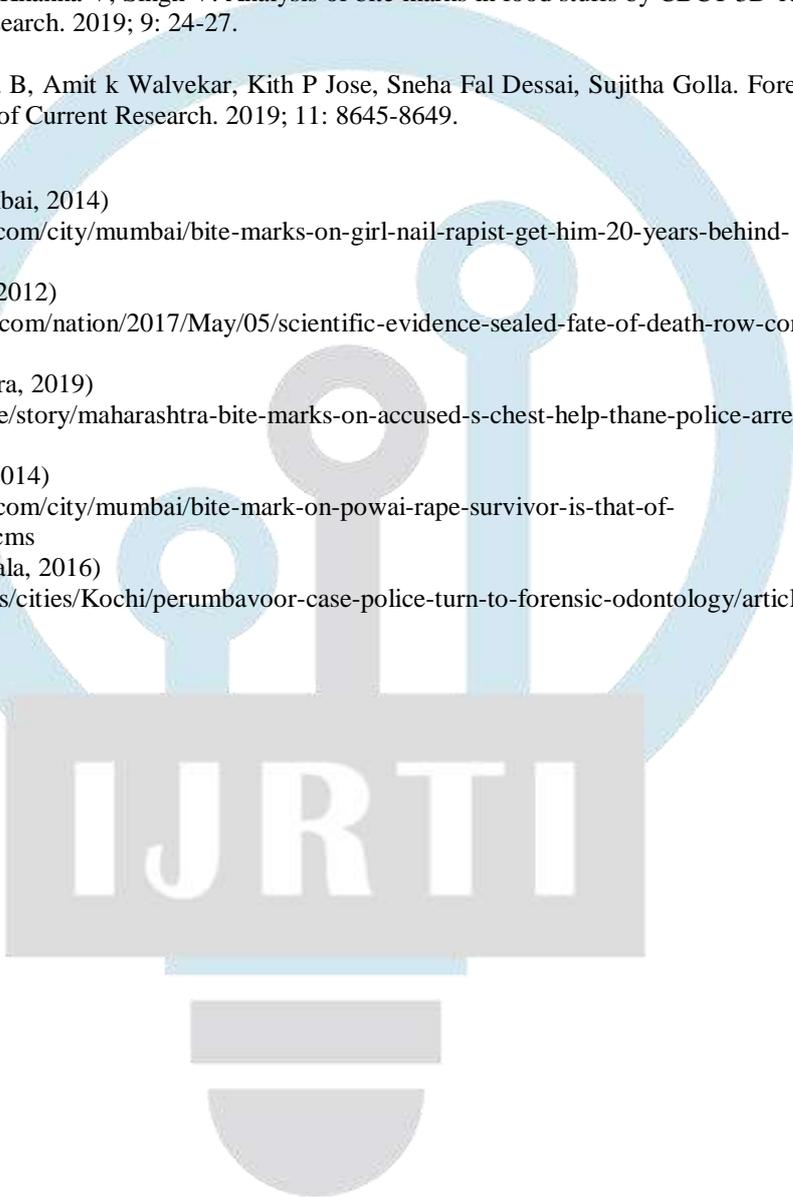
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Case 4 : Powai case (Mumbai, 2014)

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Case 5: Perumbavoor case (Kerala, 2016)

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