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Review Article

Biochemical Properties Of Skin Hide Its Culprit

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ABSTRACT

A bite mark as defined by Clark 1992 is 'a pattern produced by human or animal dentitions and associated structures in any substance capable of being marked by these means. A bite mark can be distorted because of the biomechanical properties of skin and underlying tissue. Distortion can occur in different stages of the causation and the analysis of a bite marks. The two types of distortions are explained primary and secondary distortion. Primary distortion occurs at the time the bite is inflicted. It is also termed as dynamic distortion or tissue. The degree of deformation can be influenced by anatomic location, thus affecting tooth relationships within an arch, arch size, and shape. Skin is highly elastic in nature and as soon as pressure is removed from its surface, it will start reverting back to its original form. The phenomenon of stretching and relaxing thus causes a considerable tissue distortion and may also cause oedema. A phenomenon known as 'tenting' may also be present, which changes the dimensional stability of the skin. Secondary distortion is basically time related distortion, postural distortion and photographic distortion. Aim of this article is to focus on the degree of distortion in bite mark analysis by different factors and basically due to biochemical property of skin.

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INTRODUCTION

A bite mark has been defined as 'a pattern produced by human or animal dentitions and associated structures in any substance capable of being marked by these mean's[1]. The manual of American Board of Forensic Odontologists (ABFO) defines the bite mark as a physical pattern left in an object or tissue by dental structures of human or an animal. The manual also describes the bite mark as a circular or oval patterned injury consisting of two opposing symmetrical, U shaped arches separated at their bases by open spaces[2]. Whereas Mac Donald described it as a mark caused by the teeth either alone or in combination with other mouth parts[3] Bite mark evidence has slowly gained acceptance as a Forensic tool. The earliest recorded bite mark case in the United States was Ohio vs. Robinson in 1870[3]. Bite marks analysis is based on the principle that 'no two mouths are alike'. Bite marks are thus, considered as valuable alternative to fingerprinting and DNA identification in forensic examinations[4]

Classification of Bite Marks

Bite marks can be broadly classified as in table 1

Based upon agent	1. Non human (animal bite marks) 2. Human
Based upon manner of causation	1. Non-criminal (such as love bites) 2. Criminal • Offensive (upon victim by assailant) and • Defensive (upon assailant by victim)

Variation in bite mark[4]

1.Additional bite marks
2.Partial bite marks
3. Faded bite marks
4.Superimposed bites
5 Avulsive bites

Biomechanical properties of skin

Distortion of bitemark is because of the biomechanical properties of skin and underlying tissues. The degree of deformation can be influenced by anatomic location, and tooth relationships within an arch, arch size, and shape. Skin has physiological properties like heterogeneous, nonlinear, visco-elastic, anisotropic. It also exhibits hysteresis, which affects how long an indentation remains. The issue is compounded by variability between and within individuals and from site to site on the body. These properties also differ with age, weight, and physiologic condition.

Biomechanical properties dictate how a material deforms in response to applied force. When teeth engage skin, a complex interaction takes place. The skin may be pulled and compressed. Although the overall bite may be considered as being a compression injury, locally, where the tooth contacts the skin there is tension. As a bite force is applied, skin strains under tension until either tissue is released or lacerating rupture occurs[5].

Visco-elastic properties of skin is contributed by interaction among its constituents like collagen, elastin, and ground substance. These properties dictate how an indentation formed and why it subsequently disappears. The collagen fiber network comprises 75–77% of the fat-free dry weight of skin and elastin fibers range from 0.5–0.8 um in width and up to 50 l in length, are interwoven among the collagen fibers, and compose 4% of fat-free dry weight [6,7]. Mucopolysaccharides present as ground substance present between fibers. During mild stress skin behave elastically thus quickly restoring skin to its original position, however with increasing stress collagen fibers begin to stretch as it exhibit both elastic and viscous properties so, termed as visco-elastic property. As stress is released, the ground substance slowly regain its original topography. This is the hysteresis effect of skin.

Nonlinear property of skin is described by a ''J'' shaped stress–strain curve. In this Y-axis

represents stress, expressed in Pascal units (force per unit area) and X-axis is strain expressed as a fraction derived from the change in length divided by the original length. There are three phases in the curve as shown in fig 1 and table 2, this help in understanding of how applied stress affects skin during biting.

Fig. 1—Stress / strain curve for skin.

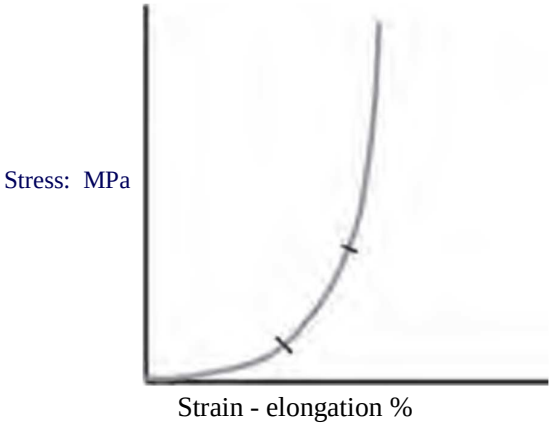

Table 2 : phase of skin during stress and strain

Phase I	•Represents the elastic phase. The elastin fibers reorient and straighten in the direction of the force and the collagen fibers are not extended
Phase II	Represents stiffening of the skin. As the elastin fibers have already been stretched, the collagen fibers begin to orient in the direction of the stress, straighten, and the skin stiffens. At the end of this phase collagen fibers are straight and oriented in the direction of stress and subcutaneous haemorrhage also occur
Phase III	In this phase all collagen fibers straightened and laceration occur.

Anisotropy means that skin possesses different properties in different directions. Tension lines not only vary between regions of the body, but also with movement[7]. Hence anatomic location, skin tension, and movement are linked, and play a role in bitemark distortion. Knowledge of skin response to the movement and the areas susceptible to distortion may help the forensic odontologist to better predict and even anticipate bitemark distortion.

Bite mark recording and analysis

The collection of evidence associated with the bite mark is important to review and document over time as healing of the bite mark occurs in a living victim and degradation occurs in a deceased victim.

The ABFO set forth the following guidelines for the analysis of bite marks. First, the analysis is broken into four distinct sections[8]:

1) The description of the bite mark;
2) The collection of the evidence from the victim;
3) The collection of evidence from the suspect; and
4) The analysis of the evidence.

Steps in the recording of bite marks are

Photography: for the photographic documentation a reference scale such as a ruler should be placed in the same plane as the bite injury, this can be used for future measurements of the bite marks. The ABFO no.2 scale is the most commonly used reference scale [9.] For registering the three dimensional features of bite use of side lighting and by low level positioning of the flash is important otherwise it cause splitting the bite. The UV light is used to capture the bite as it does not penetrate the

skin surface and hence produces a detailed image of the surface of the skin.

There are two techniques that utilize ultraviolet light in photography. In **ultraviolet imaging**, the bite mark is flooded with ultraviolet light. Here an ultraviolet filter is used on the camera to block out all light to which the film is exposed, with the exception of the UV rays. This creates an ultraviolet image of the wound. The second technique is called **fluorescent ultraviolet imaging**, and it too is accomplished by flooding the bite mark with ultraviolet light. Tone line photography is also used to produce a transparent overlay with a photographic outline of the mark. Tone line, also referred to as "line print," utilizes common and readily available film products and darkroom equipment to produce a thin, black outline of the bite mark.Video camera, with the capability of intensifying an ultraviolet image over 70,000 times, enables investigators to immediately become aware of unseen injuries without waiting for film development.

Collection of swabs: saliva is one of the various body fluids from which DNA can be extracted. It also contain ABO antigen. Different methods and techniques have been described to collect the saliva from the bite site, but the most commonly used is the Sweet's double swab technique which uses two cotton swabs to collect the saliva. It should be air dried for about 45 minutes before they are sent for DNA analysis.

Impression and models: There are two methods for making impressions:

Method I: Pour the material covering the bite area. Place wire gauze and inject additional material over it.

Method II: A special tray is constructed using cold cure confining to the shape of bite mark and impression is made.[10]

According to the guidelines of American Board of Forensic Odontology (ABFO) taking dental impressions of the bite site; the impression materials used should have American Dental Association specifications and must be prepared according to the manufacturer's instructions. The common impression materials listed are hydrocolloids and light-body vinyl polysiloxane (VPS). Polyether, has been reported to have excellent accuracy, long-term stability, good elastic recovery, and excellent tear resistance.[11]

Methods of analysis of bite marks

There are two methods for analysis of bite;

Odontometric triangle method: In this objective method, a triangle is made on the tracing of bite marks and teeth models by marking three points, two on the outer most convex point of canines and one in the centre of the upper central incisors. Three angles of the triangles are measured and compared. By comparing bite mark width, bizygomatic and bigonial width from a given bite mark impression, the facial dimensions of a person who is responsible for the mark can also be determined.[12,13]

Comparison technique: Model from the suspect can be directly placed over the photograph of the bite mark to demonstrate concordant points. Videotape can be used to show slippage of teeth producing distorted images and to study dynamics of the bite marks.14

Other methods of bite mark analysis are

- •Vectron –used to measure distance between fixed points and angles.
- •Stereometric graphic analysis – This can be used to produce contour map of the suspect‘s dentition.
- •Experimental Marks –may be produced on pig skin, baker‘s dough or rubber for analysis.
- •Scanning Electron Microscopic analysis of bite mark wounds
- •Image perception technology[10]

Alteration in bite mark analysis

Accuracy of the bite imprint: The impression may not be accurate due to irregularity of the bitten areas, poor quality of the materials, duration between infliction of the bite mark and creation of the model. Only one impression from the bitemark should be taken to avoid unnecessary manipulation, distortion, and loss of evidence. A monophase technique was performed according to the manufacturer's recommendations to minimize the distortion.

The densite type IV die stone was chosen for its good physical properties. The physical properties like powder/water ratio (100 gr/20 ml), working time is approximately 6–8 min, while the setting time is 12 min shows the quality of material. Furthermore, its compressive strength increases from 55 to 117 Mpa in just 48 h. These properties ensure dimensional stability and durability[11]

Care must be taken to reinforce the impression material by a rigid material like acrylic, orthopedic mesh, dental stone or silicone putty before the impression material is removed from the skin. This reinforcement will prevent the inaccuracies being developed in the impressions due to physical distortion. Two stone casts must be made. One is used for analysis purpose and the second cast is preserved for presentation in the court.[9]

Permanency: The character of the bitten surfaces or actual position of the individual's teeth is changed by various restorative materials, caries or periodontal diseases. So these alteration leads to errors in recording, comparison, analysis and interpretations of bite marks.

Alteration due to photography:

There are four types of photographic distortions as in table3

Non visible light photography can also be used which includes ultraviolet (UV) photography and infrared photography. The UV light good for capturing the bite marks. . It also captures the bleeding pattern below the surface of the skin. whereas the infrared light does penetrate the surface the skin and creates an image of the bite mark injury as it appears below the surface of skin.[9]

Table 3; photographic distortion

Type I	it occurs when the scale and the bite mark are on the same plane, but the camera is not parallel to them.
TYPE II	it occurs when the scale is not on the same plane as the bite mark
Type III	it occurs when one leg of the two dimensional scale has a perspective distortion, but the other leg does not
Type IV	it occurs when scale is itself bent or skewed

DNA from salivary swab: salivary DNA is used for investigational. However due to the presence of nucleases within the saliva whose activity is accelerated due to the ambient temperature of the skin of a living victim, there is degradation of the salivary DNA. Collection and preservation of saliva is important. If there is a lot of time delay from collecting the salivary swabs till they are sent for analysis then the cotton swabs should be stored properly in a box that allows air to circulate between the swab tips.[9]

The American Board of Forensic Odontology provides a range of conclusions to describe whether or not an injury is a bite mark[15]. These are describe in table 4

Table 4: showing bite mark according to ABFO

Exclusion	The injury is not a bite mark
Possible bite mark	An injury showing a pattern that may or may not be caused by teeth, could be caused by other factors but biting cannot be ruled out. Probable bite mark – The pattern strongly suggests or supports origin from teeth but could conceivably be caused by something else
Definite bite mark	There is no reasonable doubt that teeth created the pattern

Preservation of bite mark for prolonged study, a procedure have been developed for removing the bitten tissue from the body of a deceased victim. This is done by the use of the

Acrylonitrile-Butadiene-Styrene plastic ring (ABS ring). The ABS ring supports the configurations and contours before and after removal from the body

CONCLUSION

Biochemical properties of skin and how it responds to applied stress can be a valuable adjunct to bitemark analysis. Skin is elastic and is stretched during the bite infliction, and the surface itself is almost always curved to some degree. Shrinkage of the skin due to water-loss, and putrefaction can also change the shape and appearance of the mark. With recent advances in research, more objective methods of bite mark analysis like salivary DNA recovery and bacterial genotyping have become the main stay of investigation in such crimes. Although bite mark comparisons will not always reveal crucial findings, bite mark evidence can potentially be an invaluable tool in both the conviction of the guilty and the vindication of the innocent.

REFERENCE

1. Verma K, Joshi B, Joshi CH, Reject Paul MP (2013) Bite Marks as Physical Evidence from the Crime Scene-An Overview.
2. N Kausha, Human Bite Marks In Skin: A Review The Internet Journal of Biological Anthropology; 21(4)
3. Yadav N, Srivastava PC, Bite Marks: An Indispensible Forensic Odontological Evidence in Rape Cases, J Indian Acad Forensic Med. July-September 2014;36(3)
4. Kaurs K, Krishan K, Chatterjee PM and KanchanT, Analysis and Identification of Bite Marks in Forensic Casework, OHDM - 2013;12(3)
5. Bush MA, Raymond G, Peter M, Bush J B and Dorion RBJ, Biomechanical Factors in Human Dermal Bitemarks in a Cadaver Model, J Forensic Sci, 2009; 1:54.
6. Hendriks FM. Mechanical behaviour of human skin in vivo: a literature review. Koninklijke Philips Electronics N.V., Nat. Lab. Unclassified Report 2001, 1–46.
7. Millington PF, Wilkinson R. Skin. Cambridge: Cambridge University Press, 1983.
8. Clure MM. Odontology: Bite Marks As Evidence in Criminal Trials, Santa Clara High Technology Law Journal,1995;11(2): 269-285
9. Kaushal N . Human Bite Marks In Skin: A Review . The Internet Journal of Biological Anthropology (2010); 4(2): 1-9.
10. Bhargava K, Bhargava D, Rastogi P, Paul M, Paul R, Jagadeesh HG, Singla A. An Overview of Bite mark Analysis, J Indian Acad Forensic Med. (2012); 34(1): 61-66.
11. Fonseca GM, Farah MA, Orellano-Blaskovich SV. Bitemark analysis: Use of polyether in evidence collection, conservation, and comparison. Journal of Forensic Dental Sciences(2009); 1(2): 66-72.
12. Chhatpar S and Sabane VS. Role of bite mark analysis in identification of a person in forensic odontology. J. Ind. Dent. Asso, 1989; 60: 173-179.
13. Singh M, Das R and Rao KTS. Bite marks an index for identification in crime (An experimental clinico-anthropological study). J. Ind. Acad. Foren. Med, 1988; 10: 21-25.
14. West MH and Friar J. The use of videotape to demonstrate the dynamics of bite marks. J. Foren. Sci, 1989; 34: 88-95.
15. Pretty, I.A: Forensic Dentistry: 2 Bitemarks and Bite Injuries. Dent Update; 2008; 35:48-61.

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