Original Article

Indian Journal of Forensic Odontology
Volume 6 Number 2, April - June 2013

Using Human Bite as a Modern Tool in Forensic Dentistry

Anvesha Gupta*
Aditi Garg**
Neeraj Chaurasia***
Pankaj Datta****

*Reader, Department Of Prosthodontics, Inderprastha Dental College & Hospital, Sahibabad, UP, India.
**Sr. Lecturer, Department Of Prosthodontics, Inderprastha Dental College & Hospital, Sahibabad, UP, India.
***Sr. lecturer, Department Of Prosthodontics, Inderprastha Dental College & Hospital, Sahibabad, UP, India.
****Principal, Prof & Head, Department Of Prosthodontics, Inderprastha Dental College & Hospital, Sahibabad, UP, India.

Abstract

A significant field of study and analysis in Forensic Dentistry is the recognition and interpretation of marks produced by human bites in human body, foods and other articles founded in crime scenes or in the. The knowledge of human dentition and unique features in the dental arches can provide substantial value to forensic experts. Particularly, in bite marks found in the skin, generally resultant of rapes, fights, assaults, abuses and child violence, this evidence can mean the crime resolution, assuming a decisive role in the criminal identification. In this direction, the DNA technology can be used in the recovery of the genetic material, through the saliva deposited in the skin, after the production of a bite mark. This literature review aimed to stand out the importance of the recognition of bite mark injuries and emphasizing the use of the DNA technology in the briefing of crimes.

Keywords: Human bite marks; Molecular biology DNA; Forensic dentistry; Saliva.

Introduction

Since, Dental specialty has been in continuous development and it has shown, lately, a remarkable professional and scientific maturity.

Oral conditions analysis is a crucial tool to the forensic investigation team members when solving identification problems and it has been helpful to Criminal and Civil Justice.[1]

One of the biggest challenges in Forensic Dentistry field is related to the human identification process, such as in cases which involve the study of bite marks. Bite can be defined as the mark made by human or animal teeth in the skin of living people, cadavers or unanimated objects with relatively softened consistence.[2]

Bite mark analysis can help the forensic team in identifying the agent, elucidate the kind of violence and the time elapsed between its production and the examination. It can also show if the bite was produced ante-mortem or *post-mortem* and, in case of multiple bite marks, identify the sequence of their production.[2]

Therefore, observing, analyzing and interpreting, the bite marks constitute a important medical-judiciary evidence in some cases of offense and help in suspects' exclusion or point out the culpability elements.[3]

However, bite marks do not embody all the requisites of an ideal identification method (immutability, practicability, classification), but it can represent, in some cases, the unique

Corresponding author: Dr. Pankaj Datta, Principal, Prof & Head, Department Of Prosthodontics, Inderprastha Dental College & Hospital, Sahibabad, UP, India.

E-mail: pankajdatta97@gmail.com

signs of real value to criminal investigation.[4]

Immutability is not much preserved in bite marks due to various reasons, especially when acting on human skin. Moreover, the practicability may not be very high due to lack of technical knowledge involved in making use of it as a forensic tool.

In order to achieve human identification, commonly used methods in forensic dentistry involve; comparative dental identification and involves a comparison between ante-mortem and *post-mortem* registers (x-ray, clinical procedures), reconstruction of *post-mortem* dental profile and latest method involves application of the modern techniques of DNA, in order to establish the identity.[5]

There have been doubts raised concerning the precision and validity of human bite mark analysis.[6]

Therefore, the present work intends to display some applications of DNA technology in human identification by studying the bite marks in Forensic Dentistry.

Bite Mark Production Mechanism

The bite mark is produced as a result of pressure caused by teeth on the skin. It starts with mandibular closure, followed by suction of skin (negative pressure), in the opposite direction, caused by the tongue and peri-oral musculature.[7]

In general, when a person bites an object, the upper incisors hold the object while the lower incisors cut it. The mark left by the incisors is extremely relevant in order to provide information such as: dental alignment, size and shape of dental archs.[8]

Bite mark is, in general can have an appearance as, circular or ovoid.[9] Moreover, human adult dentition consists multiple teeth and each one of them has its own size, shape and features. Human dentition is unique for every human being due to extractions, malalignment, malformation (developmental defects), interdental spacing, dental fractures, restorations and other numerous factors.[8]

The clinical picture at the site of crime ranges from benign wastage, observed just after the injury, up to a picture of infection observed days or weeks later. The signs and symptoms include laceration, erythema, lymphadenopathy, fever, pain and purulent collection.[10]

Therefore, the action of the dental arch on the skin may produce many kinds of lesions, as the dental elements act as incisive instruments or even incisive-cut.[11]

The evidence of a bite mark is usually crucial to establish that two subjects have been involved in a violent/sexual contact in a crime scene.[12]

The greatest challenge is Forensic Dentistry are bite marks found in human skin, because of the distortion presented and the time elapsed between the production and the analysis.[13]

Moreover, many factors can affect the structure of the lesions produced by bite marks, which include: applied force, bite duration and movement between tissues and teeth.[1] However, our main focus in this paper is the possibility of DNA recovery through saliva deposited on skin after a bite mark or from object surface.[5,14]

Using DNA in Bite Mark Identification

Techniques involving DNA in Forensic Dentistry offers a new tool when traditional identification methods fail due to the effects of heat, trauma or autolytic processes,[15] as well as in distortions and difficulties in analysis.

There are many biological materials that can be used to execute DNA typing, being the most common blood, semen, bones, teeth, hair and saliva.[16]

The field of human genetics was revolutionized when Watson and Crick described the DNA structure as a double helix in 1953. The acknowledgement of the genetic code universality in living organisms has been essential to the development and application of the genetic technology.[17]

Thus, with the modern advancement in

molecular biology, the DNA analysis in forensic samples has been increasingly used in human identification processes.[18]

Due to this abundance of material, the use of the technique based on PCR (Polymerase Chain Reaction) has acquired great importance in DNA *post-mortem* analysis in forensic cases.

Polymerase Chain Reaction is an enzymatic amplification of a specific DNA sequence, aiming millions of copies production from this sequence in a test tube, which was first described by Kary Mullis, in the late 1980's, and enabling a new strategy of gene analysis though a simple and fast method, excusing all the laborious stages of genetic cloning.[19]

The method using PCR enables the distinction of a subject among the other ones with a high level of reliability, starting by 1ng (nanogram), equivalent to a single part in a billion grams, of the DNA target.[20]

When treating of forensic samples, the DNA study is usually done through the analysis of regions of short tandem repeats (STR), which can be defined as DNA hyper-variable regions that present tandem repeats of fragment that have from two until nine pairs of bases (pb).[21]

The most valuable STR's to human identification present a higher polymorphism (larger alleles amount), smaller size, greater hetero-zygosity frequency (higher than 90%) and low mutation frequency.[22]

In order to perform human identification, it is more interesting to use the molecular markers that have great variability within the population. In other words, high level of polymorphism, enabling that the probability of two people that present the same alleles gets smaller.

And, when we wish to identify a subject that comes from a certain population, the study of different markers in that population is necessary, in order to know what the present alleles are and how often they appear, with the purpose of defining the best markers to be used.

Besides the genomic DNA, inside the cell nucleus, it is possible to use mitochondrial DNA. This organelle has a number that ranges from 100 to 10,000 copies per cell, enabling the material analysis with limited amounts and also DNA samples partially degraded.[22]

Saliva is a very useful DNA source due to the fact of being collected by painless and non-evasive way, able to be used even when it is stored in the most different conditions.[23] Its composition is 99% of water, has leukocytes (25 to 650,000) and scaled off epithelial cells (6 to 600,000).[24]

The amount of saliva deposited on the skin is generally very little in bite mark cases, making it necessary to use methods for collecting, whose result in the recovery is the maximum possible amount of saliva and minimizes any contamination through the victim's skin cells.[20,25,26]

When checking the DNA analysis reproducibility of collected saliva on the skin, simulating cases that involve bite marks in 20 samples, the double swab technique showed to be sensitive and efficient in criminal cases when there is presence of saliva in bite marks.[27]

There are studies where 40 µl of saliva were deposited on the skin of 27 corpses and 100 µl of saliva on the skin of five corpses, making the DNA analysis of all samples possible.[14] Studies compared the DNA extraction results in saliva samples deposited on human skin in a simulation of bite marks from three different techniques (Organic, Classic Chelex and Modified Chelex), being the last one more efficient than the others, but all of them with possibilities of application.[25] Comparing saliva collection methods, there is significant difference between the DNA recovering capacity in three different techniques: filter paper (17, 4%), the single swab technique (35, 3%) and the double swab technique (44, 6%).[20] In another research using bite marks simulated situations in two experimental series, deposited three samples of saliva (40 µl) on the skin of 27 corpses (in 33 different places) and three samples of saliva (100 µl)

on the skin of five corpses (in 12 different places). Saliva was collected using the double swab technique in times of five minutes, 24 hours and 48 hours, having proven a decrease in concentration in the first 24 hours and stability between 24 and 48 hours, showing success in amplification independent of the time after the deposit saliva, and absence of any case of contamination.[20]

Saliva, in contact with intact skin, maintains itself in stable conditions and can be recovered, at least, 60 hours after its deposit.[28]

In another study, using the DNA analysis by PCR in a bite mark located in a body that had been submerged in a river for a 5 hour before being found, enough DNA was recovered from the bitten area, what enabled a genotype contribution to identify the aggressor.[12]

However, it is not always possible to recover DNA from a bite mark, due to the fact that it will be subject to a series of modifications, such as contamination, degradation and putrefaction, depending on the circumstances the body and/or object were submitted.[25]

Bite Mark Identification: DNA Analysis and Genotype Composition of Oral Bacteria

The human oral cavity has a large and varied bacterial community, many of which are unique for this habitat. There is wide evidence that oral bacteria are transferred during the human bite act and, in some cases, survive and multiply, creating infections. Besides, there are evidences that individuals shelter unique bacterial species stocks in the oral cavity and that those stocks can be identified by techniques such bacterial typing and protein profiles.[29]

It is important to note that the oral *Streptococcus* recovery from the skin or objects seems to imply the contact with oral surfaces or deposit saliva which can lead to evidences of oral-involvement in the injury.[30]

In a study where 10 µl fresh saliva sample was collected without stimulation and applied to areas of the upper left quadrant of the thorax, so that the loss rate of units that make up the colony and its recovery ranged from 45 to 50% per hour. They have also noticed that 6, 25 hours after the saliva deposition, oral viable streptococcus could be recovered. [31] In another research, volunteers bit their own arms firmly and the bite marks were sampled in time intervals to recover isolated viable *streptococcus*, in order to make a genotype comparison with bacteria from the oral cavity. It was concluded that it is possible to recover bacteria up to 24 hours after the production of the bite, but identification assertiveness is only possible when compared to samples acquired from the subject's teeth responsible for the bite.[30] Isolated *Streptococcus* from recent bite marks can be listed by PCR and compared to the teeth that were responsible for the bite. Moreover, they claim it is preferable to recover the subject's DNA, but such strategy is not always possible, the recovery of the bacteria derived from the subject's tooth may enable the link with the suspect of a crime.[32]

In conclusions, the knowledge proceeding from Forensic Dentistry and Molecular Biology has great importance to the expert practice when we think of a dentist involved in forensic investigation team for a bite mark analysis. It's necessary to broaden the pertinent studies of the theme, in order to establish protocols to allow additional tools in criminal investigation.

It is stated that, in judicial proceedings involving Dentistry, being Civil or Criminal, it is extremely necessary the presence of a professional that militates in Forensic Dentistry as a judicial expert.[33]

References

1. Syrjänenn SM, Sainio P. Forensic dentistry recent development towards on independent discipline in modern dentistry. *Proc Finn Dent Soc.* 1990; 86: 157-70.
2. Melani RFH. Identificação por marcas de mordida. In: Silva M. Compêndio de odontologia legal. Rio de Janeiro: Medsi; 1997.
3. Ramirez AIC. Estomatologia forense. México:

Trillas; 1990.

4. Arbenz GO. Medicina legal e antropologia forense. São Paulo: Atheneu; 1988.
5. Sweet D, Pretty IA. A look at forensic dentistry Part 2: teeth as weapons of violence identification of bitemarks perpetrators. *Br Dent J.* 2001; 190: 415-8.
6. Stimson PG, Mertz CA. Forensic dentistry. New York: CRC Press; 1997.
7. Beckstead JW, Rawson RD, Giles WS. Review of bite mark evidence. *J Am Dent Assoc.* 1979; 99: 69-71.
8. Dinkel-Junior EH, Captain MS. The use of bite mark evidence as an investigative aid. *J Forensic Sci.* 1974; 19: 535-47.
9. Vale GL. Dentistry, bite marks and the investigation of crime. *J Calif Dent Assoc.* 1996; 24: 29-34.
10. Liston PN, Tong DC, Firth NA, Kieser JA. Bite injuries: pathophysiology, forensic analysis, and management. *N Z Dent J.* 2001; 97: 58-63.
11. Gomes E de M, Melani RFH. O estudo das marcas de mordidas e a identificação humana. [monografia] São Paulo: Fundecto; 1999.
12. Sweet D, Shutler GG. Analysis of salivary DNA evidence from a bite mark on a body submerged in water. J Forensic Sci. 1999; 44: 1069-72.
13. Sheasby DR, MacDonald DG. A forensic classification of distortion in human bite marks. *Forensic Sci Int.* 2001; 122: 75-8.
14. Sweet D, Lorente JA, Valenzuela A, Lorente M, Villanueva E. PCR-based DNA typing of saliva stains recovered from human skin. *J Forensic Sci.* 1997; 42: 447-51.
15. Pötsch L, Meyer U, Rothschild S, Schneider PM, Rittner C. Application of DNA techniques for identification using human dental pulp as a source of DNA. *Int J Leg Med.* 1992; 105: 139-43.
16. Butler JM. Forensic DNA Typing. 2nd ed. Burlington: Elsevier; 2005.
17. Santos CF, Sakai VT, Machado MAAM, Schippers DN, Greene AS. Reverse transcription and polymerase chain reaction: principles and applications in dentistry. *J Appl Oral Sci.* 2004; 12: 1-11.
18. Remualdo VR, Oliveira RN. Potencial de análise forense do DNA de diferentes amostras biológicas. *Rev Assoc Paul Cir Dent.* 2005; 59: 421-4.
19. Farah SB. DNA no diagnóstico das doenças humanas. In: Farah SB. DNA: segredos & mistérios. São Paulo: Sarvier; 1997, 103-40.
20. Sweet D, Lorente M, Lorente JA, Valenzuela A, Villanueva E. An improved method to recover saliva from human skin: the double swab technique. *J Forensic Sci.* 1997; 42: 320-2.
21. Galante-Filho H, Figini AL, Reis AB, Jobim LF, Silva M. Identificação humana. Porto Alegre: Sagra Luzzatto; 1999.
22. Allen M, Engström AS, Meyers S, Handt O, Saldeen T, Von Haeseler et al. Mitochondrial DNA sequencing of shed hairs and saliva on robbery caps: sensivity and matching probabilities. *J Forensic Sci.* 1998; 43: 453-64.
23. Koh D, Ng DPK, Choo SGL, Ng V, Fu Q. Effect of storage conditions on the extraction of PCR-quality genomic DNA from saliva. *Clin Chim Acta.* 2004; 343: 191-4.
24. Cate T. Oral histology: development, structure and function. Saint Louis: Mosby; 1988.
25. Sweet D, Lorente M, Valenzuela A, Lorente JA, Alvarez JC. Increasing DNA extraction yield from saliva stains with a modified Chelex method. *Forensic Sci Int.* 1996; 83: 167-77.
26. Sweet D. Why a dentist for identification? *Dent Clin North Am.* 2001; 45: 237-51.
27. Anzai-Kanto E, Hirata MH, Hirata RDC, Nunes FD, Melani RFH, Oliveira RN. DNA extraction from human saliva deposite don skin and its use in forensic identification procedures. *Braz Oral Res.* 2005; 19: 216-22.
28. Smith BC, Holland MM, Sweet D, DiZinno JA. DNA and the forensic odontologist. In: Bowers CM, Bell GL. Manual of forensic odontology. 3rd ed. Colorado Springs: American Society of Forensic Odontology; 1997, 283-98.
29. Elliot TR, Rogers AH, Haverkamp JR, Groothuis D. Analytical pyrolysis of streptococcus salivarius as an aid to identification in bite-mark investigation. *Forensic Sci Int.* 1984; 26: 131-7.
30. Borgula LM, Robinson FG, Rahimi M, Chew KEK, Birchmeier KR, Owens SG et al. Isolation and genotypic comparison of oral streptococci from experimental bitemarks. *J Forensic Odontostomatol.* 2003; 21: s23-9.
31. Brown KA, Elliot TR, Rogers AH, Thonard JC.

The survival of oral streptococci on human skin and its implication in bite mark investigation. *Forensic Sci Int.* 1984; 26: 193-7.

32. Rahimi M, Heng NCK, Kieser JA, Tompkins GR. Genotypic comparison of bacteria recovered from human bitemarks and teeth using arbitrarly primed PCR. *Soc Appl Microbiol.* 2005; 99: 1265-70.
33. Silva RHA. Atividade ilícita profissional em odontologia: análise do conhecimento de acadêmicos, magistrados e entidades promotoras de cursos de aperfeiçoamento e/ou especialização, no município de Bauru-SP [dissertação]. Bauru: FOB-USP; 2005.

Instructions to Authors

Submission to the journal must comply with the Guidelines for Authors.

Non-compliant submission will be returned to the author for correction.

To access the online submission system and for the most up-to-date version of the Guide for Authors please visit:

http://www.rfppl.org

Technical problems or general questions on publishing with IJFO are supported by Red Flower Publication Pvt. Ltd's Author Support team (http://ww.rfppl.org)

Alternatively, please contact the Journal's Editorial Office for further assistance.

A Lal
Publication -in-Charge
Indian Journal of Forensic Odontology
Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II
Mayur Vihar Phase-I
Delhi - 110 091
India
Phone: 91-11-22754205, 45796900, Fax: 91-11-22754205
E-mail: redflowerppl@gmail.com
Website: www.rfppl.org