

Human bite mark identification and DNA technology in forensic dentistry

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Received for publication: September 14, 2006

Accepted: December 15, 2006

Abstract

A significant field of study and analysis in Forensic Dentistry is the recognition and interpretation of marks and injuries produced for human bites in foods founded in crime scenes or in the human skin. In this way, the knowledge of the anatomical particularities of human dentition and distribution in the dental arcs can supply subsidies of real value to forensic scientist, sometimes, the only elements on which can count the expert. 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, due to the fact that dental impression can be adulterated easily and showing problems on expert analysis. This literature review aimed to stand out the importance of the recognition of these injuries in practical skillful of the dentist, being emphasized the use of the DNA technology in the briefing of crimes.

Key Words:

bite marks, DNA, saliva

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Introduction

Historically, the dental professional was organized as time passed by. It was first executed by healers and doctors and then it was relegated to charlatans, until it found a professional segment that would dedicate to it¹.

The emergence of Forensic Dentistry, as a discipline, in Brazil, just happened in curriculum edition established by Decree nº 19.852, edited in 1931²:

“1st Year – anatomy, physiology, histology and microbiology, metallurgy and applied chemistry.

2nd Year – dental practice (1st chair), hygiene and forensic dentistry, dental prosthesis, dental technique.

3rd Year – dental practice (2nd chair), pathology, applied therapeutics, bucco-facial prosthesis, orthodontics and pediatric dentistry.”

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

By the time, oral conditions analysis has been presented as a crucial tool to the forensic investigation team members when solving identification problems and it has been helpful to Criminal and Civil Justice³.

One of the possibilities 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 alive people, cadavers or unanimated objects with relatively softened consistence⁴.

Besides the agent identification, bite mark analysis, in a forensic investigation, can elucidate the kind of violence and the elapsed time between its production and the examination. It can show if the bite was produced *intra-vitam* or *post-mortem* and, in case of several bite marks, identify the sequence of them⁴.

Therefore, by observing, analyzing and interpreting, the bite marks constitute an important medical-judiciary proof in some cases of offense and help in suspects’ exclusion or point out the culpability elements⁵.

However, bite marks do not embody all the requisites of an ideal identification method (unicity, immutability, practicability, classificability), but it can represent, in some cases, the unique signs of real value to criminal investigation⁶. Fulfilling these requisites, we can state that the immutability characteristic is not much preserved in bite marks, especially when acting on human skin. Moreover, the practicability may not be so easily verified because of involved technical knowledge.

And, when referring to human identification, nowadays, there are three kinds of identification using oral characters. Two of them have been used a long time ago and behave as primary responsibilities of the expert. The first one is denominated comparative dental identification and involves a comparison between *intra-vitam* and *post-mortem* registers

(x-ray, clinical promptuary). The second one, which is composed by the reconstruction of *post-mortem* dental profile, is used in the cases in which there is no suspicion of the person or his/her descendents. The third kind works on the application of the modern techniques of DNA, in order to establish the identity⁷.

In this analysis, some obstacles are always present when working with human bite marks, which leads to a discussion on the analysis precision and the violation of citizen’s rights (proofs against yourself)⁸.

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 mechanism is the result of teeth pressure on skin, described as force combination. It starts with mandibular closure, followed by suction of skin (as a negative pressure) and action, in the opposite direction, thrust by the tongue; hence, we would have its projection on teeth incisor and lingual surfaces⁹.

In general, when a person bites an object, the superior teeth hold the object while the inferior ones cut it. The mark left by the superior teeth, however, is extremely relevant in order to provide information such as: dental alignment, size and shape of dental archs¹⁰.

Bite mark is, in general, circular or ovoid, and can have an appearance similar to sweet dough, like a doughnut or the dental arch may be registered as horseshoe shape patches¹¹. Moreover, human adult dentition consists of 32 teeth and each one of them has its own size, shape and features. Human dentition is unique and individual due to extractions, bad alignment, bad positioning, bad development, spaces, dental fractures, restorations and other numerous factors¹⁰.

The series of characteristics goes 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 collection¹².

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-cut¹³.

The evidence of a bite mark is usually crucial to establish that two subjects have been involved in a violent contact in a crime scene¹⁴.

The greatest challenge in Forensic Dentistry are bite marks found in human skin, because of the distortion presented and the time elapsed between the production and the analysis¹⁵.

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 teeth³. 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^{7,16}.

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, traumatism or autolytic processes¹⁷, 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 saliva¹⁸.

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 alive organisms has been essential to the development and application of the genetic technology¹⁹.

Thus, with the molecular biology advance, the DNA analysis in forensic samples has been increasingly used in human identification processes²⁰.

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 through a simple and fast method, excusing all the laborious stages of genic cloning²¹.

The method using PCR enables the distinction of a subject among the other ones with a high level of reliability, starting by 1 ng (nanogram), equivalent to a single part in a billion grams, of the DNA target^{16,22}.

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 hypervariable regions that present tandem repeats of fragment that have from two until nine pairs of bases (pb)²³.

The most valuable STR's to human identification present a higher polymorphism (larger alleles amount), smaller size, greater heterozygosity frequency (higher than 90%) and low mutation frequency²³.

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 degraded²⁴.

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 conditions²⁵. Its composition is 99% of water, has leukocytes (25 to 650,000) and sloughed off epithelial cells (6 to 600,000)²⁶.

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^{22,27-28}.

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 marks²⁹.

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 possible¹⁶.

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 application²⁷.

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%)²².

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 successfulness in amplification independent of the time after the deposit saliva, and absence of any case of contamination²².

Saliva, in contact with intact skin, maintains itself in stable conditions and can be recovered, at least, 60 hours after its deposit³⁰.

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 5,5 hour before being found, enough DNA was recovered from the bitten area, what enabled a genotypical contribution to identify the aggressor¹⁴.

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 submitted²⁷.

Bite Mark identification: DNA analysis and genotypical 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 profiles³¹.

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 buccal-involvement in the injury³².

In a study where 10µl 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 recovered³³. 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 genotypical 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 subjects' teeth responsible for the bite³². 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 crime³⁴.

In conclusions, the knowledge proceeding from Forensic Dentistry and Molecular Biology has great importance to the expert practice when we think of a dentist inserted in forensic investigation team in a bite mark case. 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 expert³⁵.

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