ORIGINAL RESEARCH PAPER

Oral Medicine

BITE MARKS- A NOVELTY IN ANALYSIS

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ABSTRACT

In Forensic dentistry, dental knowledge is used for the civil and criminal laws, which are imposed by police agencies for the criminal justice system. Forensic dentistry is a field of forensic science that deals with the justice assistance in the cases of person identification. Since 49 AD Identification techniques applications was registered throughout our history. Bite marks serves as a main source in crimes such as child abuse, sexual abuse and murders, where the criminal uses the teeth as weapon, thereby teeth marking will be present neither on victim's skin nor on the objects present at the crime scene. Bite marks investigation are an intricate technique that carries subjectivity, various isolating opinions and generating arguments. This article consists of a narrative literature review and discusses various ways in the identification of bite marks performed with highlighting its recent advanced methods, their importance and also pointing out the role of the dentist.

INTRODUCTION:

Forensic Odontology is a branch of dentistry in which, dental evidences are used for justice.[1] Forensic Odontology play a vital role in person identification in mass disasters, for crime investigations and in recognition of disfigured, decomposed bodies. The other methods used in forensic Odontology for person identity includes tooth prints, rugoscopy, bite marks, cheiloscopy, photographs, radiographs and through molecular methods.

Bite Marks

Forensic dentistry uses the dental knowledge for criminal and civil cases. In 1962, for first time bite mark identification is recorded for Salem Witch Trials.[3],[4] In a robbery case in America, bite marks are registered from a cheese piece became an important evidence in identifying thief.[2] Person identity is derived through comparing antemortem and postmortem bite mark records which serves as forensic dental evidence by use of the distinctive features noticeable on a person bite marks captured from skin of victims or even through their radiographs. Thereby, bite mark investigation plays a significant role in criminal justice system. Due to advancement in technologies like scanning electron microscopy, laser scanning and cone beam computed tomography are used by forensic odontologist to identify minute details in bite marks.[5]

Furthermore, techniques for enhanced bite marks identification includes the use of electron microscopy, computer enhancement technique, ABO blood groups determination derived from saliva on the bite marks, through identifying bacteria and other microorganisms present in the bite marks. Shape and precision of bite marks present on the victim's skin changes in ten to twenty minutes duration in both live and dead, so it necessitates bite marks recording at earliest as much as possible. 3-dimensional bite marks in a 2- dimensional photograph shows color changes and its spatial relationships. Rawson has investigated, the distinctiveness in human dentition measurement mathematically through a precise method [6],[7],[8] The distinctiveness in a bite mark, is not seen clear-cut because human skin is a poor type of registration material for recording bite.[9] Bite marks can reveal individual tooth marks. It can appear in double arched pattern or in a homogeneous bruise condition.[10] Bite marks distortions can happen by elastic properties in the skin, through anatomical locations, bite pressure, position of the human body and through angulations of maxilla and mandible.[11]

Due to advancements, forensic odontology benefited from digital imaging of low dose 3D computed Tomography (CT).[12] Through 3D CT digital data 3D simulations are assessed to plan accurately and to follow up their clinical decisions.[13] 2D digital camera with the software of photo editing is currently accepted technique for bite marks image acquisition.[14] Cone beam CT used as a radiographic diagnostic tool. Appropriate use of advanced techniques results in greater precision for forensic identifications.[15]

Classifications of Bite Marks:

Camerons and SIMS classifed bitemarks into two, they are: the agents that produced the mark, the materials and substances that have exhibited the marks.

McDonald's Classified bite marks as tooth pressure marks, tongue pressure marks, Tooth scrape marks and complex marks. Tooth pressure marks are marked by incisal edges of anterior teeth, it may be stable with minimal distortion. Tongue pressure marks are by tongue pressure on palatal surfaces of the teeth, cingulae or palatal rugae which causes distortion of marks. Tooth scrape marks are caused due to irregularities in teeth due to fractures, restorations, etc. Complex marks are combination of above marks.

Webster's classified bite marks into 3 types. In Type I, bites in chocolate which fracture easily with limited depth of penetration. Most prominent areas are incisal edges of upper and lower anterior teeth. In type II, good grip of material obtained by teeth and then bitten piece is fractured from main material. Example, in a apple; the outline of labial aspect of upper and lower incisors are recorded. In type III, bite mark produced by biting through cheese. It indicates relative position of upper and lower incisors in centric occlusion.[16]

Collection of Bite Mark Evidence

To collect bite mark evidences vital information to be recorded in both in the living and deceased victims.

Demographic details to be recorded, they are date of examination, name, age, gender, race, case number and name of the examiners. Location of the bite marks to be recorded to illustrate the anatomical location, to indicate the surface contour, to state the tissue characters and underlying structures such as tissue-bone, cartilage, muscle or fat. The shape of bite marks like round, ovoid, crescent or irregular in shape to be recorded. Colour of the mark to be recorded. The size of the bite mark to be recorded in both vertical and

horizontal dimensions in metric system. Type of bite marks injury to be recorded. Injuries like petechial haemorrhage, contusion, abrasion, laceration, incision, avulsion and artefact to be recorded.[17]

Methods of Examination

There are various methods to collect the evidences from the bite marks are photography, saliva swabs, impressions, salivary DNA recovery and bacterial genotyping and through computerized techniques.

Photography

To record bite mark evidences the photographs are to be taken at 90° with the camera to the site of injury and photographs are to be taken at 24 hour intervals on deceased as well as on living victim for the improvement in appearance. Forensic Dentistry facing greatest challenge in analyzing bite marks present in human skin, due to the distortions present and due to the elapse of time in between the production and analysis. Photography provides safest mode of recording permanent marks. Stereoscopic photography generates greater definition of details, but it has some inherent problems. Infra-red, ultra-violet illumination is required under various circumstances to get out some details which may not be obvious in the usual positive print.[17]

Saliva swabs

Saliva deposited in the skin while biting, sucking actions were obtained to investigate, the goal is to collect the cells for DNA. Amount of saliva deposited in a bite mark is about 0.3ml and it is distributed over a area of 20 cm. Swabs are to be taken as early as possible after the bite is inflicted and prior to the area is cleaned or washed. If the bite was inflicted by clothing, attempts to be made to take hold of the clothing for the purpose of DNA analysis. This technique will maximize the quantity of DNA recovered. Saliva collected from swab is to determine ABO blood group antigen through neither absorption-elution nor absorption-inhibition technique. Saliva identification is done by indicating its amylase activity through hydrolysing a starch substrate. Oral swabs are also taken for semen analysis.[18],[19],[20]

Impressions

After photographing the evidences, extra oral and intraoral examinations should be carried out. Next step is to make impressions in both upper and lower arches. If the person, wears a dental prosthesis impressions are to be taken along with prosthesis and another impression to be made without prosthesis.[22] Two sets of models should be prepared, one set for direct evidence and the other set for comparison purpose. If the bite marks have penetrated the skin, an impression of the marks should be made.[20] Nowadays, silicon based impression compounds are used for making quality impressions.[21] Acquisition of 3D images of the bite mark is collected for bite mark evidences from bite mark victims. 3D images are acquired through software, Lumin IQ and enabled for evaluation of grey scale levels, to produce a three dimensional version of standardized images. 3D images are useful for indicating the depth of an injury which is done without the use of impression materials.[23]

Salivary DNA Recovery and Bacterial Genotyping

DNA analysis in the field of forensic odontology, gain its significance while conventional identification methods fails due to heat, trauma, autolytic process, and distortions complicates in analysis. Biological materials like bones, teeth, blood, saliva, hair and semen can be utilized for accomplishing DNA typing. Polymerase chain reaction allows enzymatic amplification for specific DNA sequence done even in a negligible quantity of material source. Forensic identifications through DNA analysis are becoming popular among investigators. In the field of forensic sciences, genomic and mitochondrial DNA (mtDNA) is utilized. Genomic DNA found in the nucleus of a cell in the human body. Teeth are a rich source of genomic DNA. mtDNA obtained from skeleton tissues, while the obtained DNA samples are too less or degraded.[24][25] Amplified DNA is compared with the ante mortem samples like clothing, stored blood, hairbrush, cervical smear, and with biopsy specimens.[26] Currently performed DNA profile tests were reliable in providing information about physical characteristics, place of origin, ethnicity and in determining the sex of the person. In court, all these test reports were accepted legally as proofs for investigating paternity and in human identification cases.[25] DNA profiling are done by Short Tandem Repeat (STR) Analysis, Restriction Fragment Length Polymorphism Typing, X-Chromosome STR, Y-Chromosome Analysis, mtDNA Analysis, Single Nucleotide Polymorphism Analysis, Gender Typing and by DNA methylation analysis.[26] Furthermore, an abundant of DNA are extracted from the teeth. Saliva collected in painless and non-radical way. In that, double swab method is effective, because DNA recovery rates are significantly higher with double swab method than single swab or filter paper method. Double swab method for saliva, cryogenic grinding for teeth, chelex extraction and polymerase chain reaction for both types are used in the forensic. Though DNA analysis proven its value in forensic dentistry, ethical and juridical considerations are still in debate and criticism.[27]

Computerized Techniques

Computerized techniques are used for the precise fabrication process for the demonstration of rotations and biting edges area. Computer programmes like CAT scans, adobe photoshop and 3-D/CAD photogrammetry are useful in demonstrating the bite marks. 3D cast depiction with 3D type topographic teeth is characteristic and interactions with the 3D documented skin can be visualized for study on the computer screen. Thereby it represents the succession of biting action and also represents the successive injury pattern. Bite marks identification are based on dentition uniqueness, so comparing the match for a bite mark in a suspected perpetrator is commonly performed method. Matching is done by arch to arch comparison and by tooth to tooth comparisons by use of parameters like teeth size, shape and its alignment. Most usual method to analyze the bite mark is in 2D space. Thereby, 3D information preserved through two dimensional aspect with distortions.[27][28] The features collected in the bite marks are depth, length, width of the tooth, inter canine distance, overall size of the bite mark, space between the tooth marks and rotation from the normal arch form. Computerized system advantages are accurate measurement of evidences with physical parameters, results in minimum photographic distortions, to reduce examiners subjectivity, for quality image visualization, for standard comparison procedures and for results reproducibility.[29] For standardized photographic procedures, xeroradiography and contrast radiography provides valuable information. Xeroradiographic technique uses a layer of radiographic contrast material, radiograph marks are taken and is applicable for indentations.

In deceased person identification, post-mortem computed tomography (PMCT) is used to overview the teeth condition without opening corpse bags. Use of CBCT in forensic odontology is to estimation dental age, in the role of dentists for forensic witnesses, in analysis of bite marks, for investigating trauma cases and in determination of sex and race.[30] Advantages of digital CBCT includes the speed at which radiographs retrieved, radiograph display directly on a computer screen and advantages through CBCT digital radiograph software applications for options to adjust the contrast, density, sharpness, image, and color. These advantages are important in forensic identification checks, especially in odontology and skeletal cases.[31] Sachidanand et al. analyzed bite marks in students using 3D CBCT for reconstructions, the bite patterns of the students were made on apples. A very significant analysis was better using CBCT

radiology in the identification of bite patterns than in the usual analysis.[32] Marques J et al. also support the prior results, using CBCT for the analysis of the relative density of bite marks on food ingredients such as chocolate, cheese, apples, gum, pizza, and tarts. Using CBCT pictures, the analysis can be very accurate, especially for the pattern of bitemarks, and matched to the previously obtained dental model.[33] It is also seen from this study that 3D CADCAM is a very promising modality to explore in the bite mark identity studies. These modalities if explored and utilized well could be of greater assistance in legal and judicial aspects. In this study, it was shown that CBCT was efficient in yielding images with the finer level of detail needed to detect and compare human bite marks. CBCT imaging was shown to be more resourceful in bitemark imaging and thus if used wisely, CBCT 3D imaging could replace the conventional 2D bite mark imaging as an efficient forensic tool.

CONCLUSION:

Science of bite mark analysis is relatively and potentially valuable for person identification. Dentition is subjective to genetic and environmental factors to determine the teeth position in the arch. Due to its novelty, researches are focused in recent advances for more objective methods in bite mark analysis, such as in salivary DNA recovery and in bacterial genotyping, which have become a main stay in investigation of such crimes. Evidences are proving that Cone Beam CT method is reliable and reproducible for estimating dental age. The quantitative metric and volumetric analysis is performed for better prediction in estimating chronological age than staging it. We here forth conclude that future studies will explore the population in specific variability in age estimation with the quantitative metric and volumetric cone beam CT analysis for fruitful result.

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