HUMAN BITE MARK ANALYSIS: A DIAGNOSTIC TOOL IN FORENSIC ODONTOLOGY

DISSERTATION

Submitted to The Tamil Nadu Dr. M.G.R Medical University in partial fulfillment of the requirement for the degree of

MASTER OF DENTAL SURGERY

BRANCH IX

ORAL MEDICINE AND RADIOLOGY

2012 - 2015

CERTIFICATE

This is to certify that this dissertation titled "HUMAN BITE MARK ANALYSIS: A DIAGNOSTIC TOOL IN FORENSIC ODONTOLOGY" is a bonafide record of the work done by Dr. VINEETHA VIJAYAKUMAR under our guidance during her post graduate study during the period of 2012-2015 under THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI, in partial fulfillment of the degree of MASTER OF DENTAL SURGERY IN ORAL MEDICINE AND RADIOLOGY, BRANCH IX. It has not been submitted (partial or full) for the award of any other degree or diploma.

Dr. TATU JOY. E M.D.S
Professor and HOD and Guide
Department of Oral Medicine
Medicine and Radiology

Dr. Shashi Kiran M M.D.S
Reader and Co-Guide
Department of Oral
and Radiology

SREE MOOKAMBIKA INSTITUTE OF DENTAL SCIENCES, KULASEKHARAM

ENDORSEMENT BY THE PRINCIPAL / HEAD OF THE INSTITUTION

This is to certify that this dissertation titled "**Human bite mark analysis: A diagnostic tool in forensic odontology**" is a bonafide research work done by **Dr. Vineetha Vijayakumar** under the guidance of Dr. Tatu Joy. E MDS, Professor and Head, Department of Oral Medicine and Radiology, Sree Mookambika Institute of Dental Sciences, Kulasekharam.

Dr. Elizabeth Koshi MDS
PRINCIPAL
Sree Mookambika Institute of Dental Sciences.
V.P.M Hospital Complex,
Padanilam,
Kulasekharam,
KanyaKumari District
Tamil Nadu - 629 161

ACKNOWLEDGEMENT

First and foremost, I thank God Almighty for His abundant blessings, wisdom, health and strength to complete my research work and for gifting me a wonderful family- My Parents **Mr. S. Vijayakumar** and **Mrs. Hemalatha.M.S** , Brother **Mr. Vishnu Vijayakumar** ,Grand Parents **Mr. P.Muralidharan Nair** and **Mrs. Sathyabhama** ,Uncle **Mr. Suresh Kumar** and Aunt **Mrs. Ashalatha**. I am extremely grateful to all of them who encouraged and helped me at every stage of my personal and academic life, and longed to see this achievement come true.

I am extremely grateful to my Guide, **Dr. Tatu Joy E ,MDS** , Professor and Head , Department of Oral Medicine and Radiology, Sree Mookambika Institute of Dental Sciences ,for his valuable guidance, scholarly inputs and constant support and all helps in the academics and for igniting the researcher in me. I consider it as a great opportunity to do my postgraduate programme under his guidance.

I extend my profound sense of gratitude to my Co-guide, **Dr. Shashi Kiran M MDS**, Reader, Department of Oral Medicine and Radiology, for his valuable guidance and encouragement I received throughout the dissertation work. Thank you Sir, for all your help and support.

I would like to extend my deepest thanks to the Chairman **Dr. Velayuthan Nair M.B.B.S, M.S** & the Director **Dr. Rema V. Nair M.B.B.S, M.D, DGO**, Sree Mookambika Institute of Medical Sciences, for the academic support and the facilities provided to carry out the dissertation work. I am thankful to the Administrative Officer **Mr. J.S Prasad** for his timely involvement and encouragement throughout

the course. I express my gratitude to Principal **Dr. Elizabeth Koshi MDS** who has been encouraging and supportive.

I am thankful to **Dr. P.G Agnihotri MDS**, Professor for suggesting me the topic, **Dr. Eugenia Sherubin MDS**, Reader, **Dr. Hema MDS**, **Dr. Kavitha MDS**, Senior Lecturer , **Dr. Raghupathy L P MDS,** Senior Lecturer,for their support.

I am extremely thankful and words would be inadequate to express my gratitude to **Dr. Jejo Mathew**. Without his continuous, tireless help and support this feat would not have been possible.

I am extremely thankful to my professional role model **Dr. Ashith B Acharya**, Professor and Head , Department of Forensic Odontology, SDM, Dharwad for his priceless suggestions and final refinement in the study which made it to completion of the study.

My sincere thanks to **Dr. Arun Sadasivan MDS**, Professor, Department of Periodontics, for his endless encouragement and mental support throughout.

I duly acknowledge and extend my sincere thanks to **Dr. Singi Yatiraj, MD, Associate Professor, Department of Forensic Medicine,** Sree Mookambika Institute of Medical Sciences for sharing all his knowledge in the topic and helping me through out with his valuable suggestions.

I am also thankful to **Dr .George P John MDS**, Department of Prosthodontics, Anoor Dental College, Muvattupuzha, **Mrs.Prathi**, DentCare Lab, Muvattupuzha and all the others in the Lab for their valuable suggestions, help and support throughout the study period.

I am extremely grateful to my friend **Dr. Anandhu.V.Krishnan**, and **Mr.Sarath Babu K**. for helping me in the statistical analysis of my study.

I am thankful to **Mr. Satheesh** and **Mr. Rajeev** for their tireless support in carrying out all the DTP works.

I thank my department fellow Post Graduates **Dr. Meera Mathai, Dr. Redwin Dhas Manchil, Dr. Indu Krishna, Dr. Melbia Shiny** for their suggestions , co- operation and support during my study.

I thank all my friends especially**, Dr. Sarah , Dr. Rajkumar, Dr. Nissy , Dr. George Jacob , Dr. Karthika.V.Kumar , Dr. Varun Babu , Dr. Sandeep** for their prayers and constant mental support.

Last but not the least, I am extremely indebted and thankful to **Mrs. Usha,** Aunt who has protected ,cared and supported me like her own daughter throughout.

I thank them all with all my heart for being with me throughout my ups and downs.

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LIST OF ABBREVIATIONS

FDI	-	Federation Dentaire International
DNA	-	Deoxy Ribo Nucleic Acid
ABFO	-	American Board of Forensic Odontology
3D	-	Three Dimensional
UV	-	Ultraviolet

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ABSTRACT

BACKGROUND

Forensic odontology generally addresses the problem of identifying individuals based on the properties of teeth or bite mark impressions. It is legally relevant to accurately and reliably match a bite mark impression to convict a criminal. Therefore, a system which minimizes human interaction to conduct the comparison would be beneficial to ensure accuracy and reduce human bias. This study describes experiments with a method to compare 3D dental models taken from human volunteers and bite mark impression images in the apple and also to evaluate which level of the labial surface matches the indentations. Once the compound overlays were generated, the best match is identified by performing an interobsrver analysis.

AIM

To ascertain if the depth of penetration in a bitemark would require alterations in the assessment of layers in the digital compound overlay technique.

MATERIALS AND METHODS

The study was carried out on 30 volunteers. All of them were made to bite on to apples and the bitemarks were photographed immediately. Upper and lower arch impressions were obtained and 60 dental study casts were made and scanned using 3D scanner. Compound overlays were generated from the dental casts using Adobe Photoshop software and compared with the bite impression images. Statistical evaluation included descriptive and Kappa analysis.

RESULTS

All the samples matched positively. Also in maxillary bite pattern, percentage of level 3 cross section was found to be the highest followed by level 2,level 4and level 1 and in mandibular bite pattern, percentage of level 2 and level 3 cross sections were found to be the same and highest followed by level 4 and level 1.

CONCLUSION

Comparison techniques used in bite mark analysis are many and varied. The choice of technique depends largely on personal preference. So to overcome these problems more recently three dimensional scanning and Adobe Photoshop Software are used to produce bite mark comparison overlays. Hence, with the use of three dimensional scanners and advanced softwares, it is possible to make bitemarks a highly reliable evidence. Also it is recommended that labial surfaces of the teeth rather than incisal edges be looked in for the comparison of bite marks in food substances.

KEY WORDS

Forensic, bitemark, compound overlay

INTRODUCTION

Introduction

Forensic science is the scientific method of gathering and examining information about the past which is then used in a court of law. The word forensic is derived from the Latin word ***forēnsis*** **,** meaning **"of or before the forum".** It refers to the areas of endeavour that can be used in a judicial setting and accepted by the court and the general scientific community to separate truth from untruth.[1, 2]

Federation Dentaire International (FDI) defines forensic odontology as *that branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings.*[3]The forensic odontologist analyses various aspects of dental evidence including dentition of the victim(s) or the suspect(s) radiographic or photographic recordings of dental arches, bite marks on victim or suspect and analysis of human products like blood, saliva, semen etc. Forensic dentist plays a major role in identification in manmade or natural disasters-events that result in multiple fatalities that may not be identifiable through conventional methods such as finger prints.

Forensic dentist play an important role in the following areas of practice:

1. Identification of retrieved human remains
2. Identification in mass fatalities
3. Age estimation
4. Assessment of bite mark injuries
5. Assessment of physical abuse(child, spousal, elder)
6. Lip print identification
7. Palatal rugae pattern identification

8. Identification from dental DNA
9. Civil cases involving malpractice (Medical negligence)

Human identification can be done by:

1. Comparative identification: By comparing antemortem and postmortem records
2. Reconstructive identification/ Dental profiling: By extracting a triad of information-Race, Gender and Age.

According to statistics 50-60% of all physical trauma associated with abuse occurs in the head and neck regions and dentists play an important role in the assessment of abuse.

The most intriguing, complex and sometimes controversial challenge in forensic dentistry is the recognition, recovery and analysis of bite marks. Bite marks may be caused by humans or animals. It is as unique as finger print and characteristic and specific for each individual.

Bite mark injury is a contusion by rupture of small blood vessels as the individual teeth compress the tissue. It is generally accepted that the arrangement of teeth is unique and no two dentition are identical in regard to the size, shape and alignment of the teeth. *Bite mark analysis* is an important subdivision of forensic dentistry in solving most challenges in identifying living or deceased person involved in medico-legal cases. Although bite and biting have been around as long as animals with teeth inhabited the Earth, the science of bite mark identification is comparatively new and potentially valuable.

The scientific basis of bite mark analysis is rooted in the premise of the individuality of the human dentition because often crime investigators have only a few suspects who had access to the victim. It has been estimated that two persons with all teeth, producing identical bite marks are 2.5 billion to 1.This means in India, with a population of approximately 1 billion no two persons will have identical bite marks. In the world with a population of approximately 6 billion only two or three people will have identical bite marks.[5]

If the teeth leave definitive marks it should be possible to individualize them to a particular person. Contusions tend to leak in to the surrounding tissue, however making the mark blurred or fuzzy. Despite this blurring the forensic examiner often can narrow down the number of potential biters by excluding those who could not have made the bite because of definite differences(eg: type of dentition: primary/ secondary, maxillary/ mandibular arch, arch size, arch contour, missing teeth etc)

In 1984, the American Board of Forensic Odontology (ABFO) established guidelines for bite ,mark analysis.[6] Additional workshops of the board, held in 1993 and 1994, provided further insight into the techniques available to recover, store, analyze, and evaluate bite mark evidence based on the guidelines.

The biological and physical evidence from the bite mark begins to deteriorate soon after the bite is inflicted. So the knowledge of the general principles of evidence collection is required such as description of bite mark, collection of evidence from victim, collection of evidence from suspect.[4]

This is followed by the comparison of the bite mark with the suspect's dentition. The comparison techniques have been divided into two categories- Life sized comparisons and Assisted comparisons. The *life-sized comparisons* include direct and indirect methods. In direct method, the models are placed directly over the life size 1:1 photographs and the concordant points are demonstrated. The indirect comparisons are made using transparent overlays on which the biting surfaces of the teeth are recorded. The *assisted comparison* involves the use of microscopes of varying types of electronic, histological, radiographic and specialized techniques including the use of experimental bite marks.[6]

Bite mark investigation includes the physical and metric analysis of a suspect to a bite injury. The physical comparison of the suspect to the bite requires a comparison of the unknown mark found on skin or objects to known exemplars (*Latin: Exemplare*, *to show*) of the suspect's teeth. These exemplars are typically plaster casts derived from dental impressions or a reproduction of the teeth obtained by other means.

More recently, the computer-based method is used as a gold standard for bite mark analysis and other commonly used methods are compared to it.[7] In this method, transparent overlays are fabricated from images generated by scanning the suspect's dental casts. If the evidence sample is too large to be scanned or too fragile to be moved, conventional or digital photography can be used to capture the image.

When the bite mark image and the overlay are completed, a *metric* or non-*metric analysis* can be carried out. The *non-metric analysis* involves superimposing the overlay onto the bite mark injury and investigating points of concordance or discrepancy. A typical bite mark comparison image includes, the bite mark image as the background layer, the maxillary arch overlay layer, and the mandibular overlay layer. Each of these layers can be enhanced or moved individually.

More information from the outlines of the biting teeth can be gathered from the suspect's scanned dental casts. Individual features like, chipping, wear facets, unusual anatomy and dental erosion of the teeth can be visualized and recorded using Photoshop and the digital image. This type of overlay is referred to a *compound overlay*. The compound overlay contains not only the perimeter outlines of the teeth, but also images of the individual features within the outlines.

A compound overlay provides three-dimensional topography of the teeth surfaces, when a partial bite mark exists and identification is otherwise difficult, the compound overlay can be valuable. In these cases, identification comparisons can be made based on these individual features of a single tooth. The comparison processes can be recorded on videotape and create digital video clips on the desktop that can be played back on a data projector during a presentation of the evidence.

The use of digital imaging allows the examiner to establish physical data parameters for bite mark cases. The application of certain Photoshop tools and functions provides the dental examiner with concise physical evidence data that create

linear and angular information useful to support the final conclusions regarding a case.

Bite marks can be classified as [8]

1. Non-human (animals)

2. Humans

a) In foodstuffs (e.g. in partly-eaten food stuffs abandoned by offenders at scene of crime).

b) In human skin

b (1) Non-criminal (erotic bites).

b (2) Criminal (ordinary and sexual assaults) which may be

- Offensive (upon victim by assailant)

- Defensive (upon assailant by victim)

Bite marks are usually associated with sex crimes, violent fights, child abuse and theft etc. Matching the bite marks to a suspects dentition may enable law enforces to implicate the suspect in the crime.

The terms victim and perpetrator are also used to describe the recipient of the bite mark and the person that caused the bite mark, respectively. Bite marks may be found on either or both the victim and perpetrator of the crime and on examination should include all alleged participants.

This is a very reasonable conclusion and courts will not hesitate to prosecute a criminal on bite mark evidence, its recording is therefore an important aspect of dental evidence in forensic dentistry.

Identification of bite mark on victim is generally difficult because of (1) lack of awareness of the importance of bite mark (2) other severe injuries on victim, (3) many bite marks at one particular place making difficult to identify and (4) avulsion of tissues in the bite region.

AIM AND OBJECTIVES

AIM

To ascertain if the depth of penetration in a bitemark would require alterations in the assessment of layers in the digital compound overlay technique.

OBJECTIVES

- To obtain Webster type II bitemark(food item fractures with considerable penetration of teeth) photographic images from volunteer bitten apples and dental study models from the volunteers.
- To determine the level of tooth which actually creates the bite marks by using cross sections made from 3-D scanned casts and generation of compound overlays using Adobe Photoshop software.
- To assess whether a new technique can be developed to assist in the development of Forensic Science

REVIEW OF LITERATURE

Historical background of bitemarks:

Odontologic evidence is second only to fingerprints as the best and most accurate means of identification. The dental profession has both an ethical and a moral responsibility in identification procedures.

Identification of a person by teeth goes back as far as 49 A.D. at the time of Nero. As the story goes, Nero's mother, Agrippina, had her soldiers kill Lollia Paulina, with instructions to bring back her head as proof that she was dead. Agrippina, unable to positively identify the head, examined the front teeth and on finding the discolored front tooth confirmed the identity of the victim.

The first treatise on Forensic Odontology as a subject in its own right was written in 1898 by Dr. Oscar Amedo who is generally recognized as the Father of Forensic Odontology. In India, the first reported case of dental identification was that of Raja Jaichandra Rathor of Kannouj, who died in the battle field in 1193 whose mutilated body was identified by his false anterior teeth. Around 900 years ago, the tooth impressions were deliberately utilized for legal personal identification.[9]

It is reported that William the Conqueror validated royal documents by biting into a wax seal with his characteristic dentition. Debtors coming from Britain or

Europe to America to work as servants verified their agreements by biting the seal on the pact, in lieu of a signature and become known as 'indentured' servants.[10]

In 1692, Reverend George Burroughs was convicted of and was subsequently executed for the crime of soliciting young women into witchcraft. The accusers in this case displayed tooth marks on their arms. The trail judges examined Burroughs dentition and compared it to those of others in the courtroom and were sufficiently satisfied of his guilt.[11]

Paul Revere, a coppersmith had been taught dentistry by an English surgeon, John Baker. Paul Revere's close friend Dr. Joseph Warren was killed in battle and buried in an unmarked grave. 10 months after Joseph Warrens' death in 1776, his brothers and friends including Paul Revere, disinterred the body to confirm the presence of the silver wire and ivory bridge replacing the upper left canine and first premolar and identified Joseph Warren. The bridge was constructed by Paul Revere early in 1775.[12]

One of the first crimes to attract the attention of America was the Webster-Parkman case in 1840. Dr. B. W. Webster was a Harvard professor and borrowed money frequently from Dr. George Parkman. Professor Webster dismembered Parkman's body putting the head and some organs in the furnace. Professor Webster denied that the remains belonged to Dr. Parkman. But the recovered portions of

charred teeth fused to gold were identified by Dr. Nathan Cooley, who had made Parkman's denture and Dr. Lester Nobel, who testified that the study models of Dr. Parkman's teeth had been marked by him with the date Oct 1846 and fitted the recovered portion of porcelain denture accurately on the marked model of Dr. Parkman's lower jaw. The jury was convinced that the dental evidence positively established the identity of the victim and Professor Webster was convicted. [12]

The earliest recorded bite mark case in the United States was Ohio vs. Robinson in 1870. In which Robinson was charged with the murder of his mistress. His teeth were matched with the bite marks on the victim's arms, but Robinson was acquitted of the charge.[13]

In 1906, two colliers were charged with breaking into a store and stealing. During examination of the premises, some cheese which had been bitten out leaving marks of the teeth was found. The impressions of the suspects were taken and the teeth on the models fitted the marks in the cheese. This case is another landmark in forensic dentistry since it was the first recorded instance where expert guidance was given. [14]

Several authors consider Sorup as the first investigator of bite marks. The method developed by him was known as '*Odontoscopy'*. In his method tooth marks on the body were photographed. Plaster casts of the teeth of the suspect was made,

dried and varnished. The incisal edges and occlusal surfaces of the teeth were coated with printers ink and an impression of the marked teeth was taken on a sheet of moistened paper and this impression was compared with the life size photograph of bite marks of the victim's body.[15]

In 1942, a workman lifted a stone slab set into the cellar floor under the vestry of a bombed Baptist church and found a skeleton, which he assumed, was just another victim of the blitz. The neat burial under the slab and absence of bone damage precluded a blitz victim. The skeleton could have been on the site for 12 -18 months. The body was dismembered. The calculated height of the victim was *5* feet, *1/2* inch and age estimation revealed between 40 - 50 years. The lower jaw was missing, the upper jaw presented extensive dental treatment. Mrs. Rachel Dobkin, wife of a firewatcher at the church had been reported missing 1*5* months earlier. She was similar in height. A dental surgeon Dr. Barnet Kopkin had kept precise record of Mrs. Dobkin's treatment. They were able to sketch a picture of the lady's upper jaw. Further investigations resulted in the arrest of Harry Dobkin, her husband.[16]

The first case involving the admissibility of bitemark evidence was a Texas case, Doyle vs. State in 1954. In this case a piece of cheese found at the crime scene had tooth marks. The defendant, Doyle was asked to bite on another piece of cheese and a firearms examiner, not a dentist compared the marks. At the trial this examiner

and a dentist testified that the same teeth made the marks. The court allowed the evidence because it appeared similar to finger prints.[10]

In a landmark l975 case, People vs. Marx, the California court of appeals concluded that bitemark analysis was generally acceptable in the proper scientific community and thus admissible. It was bitemark evidence back in 1975 that gave the *Marx* standard of admissibility, and it's probably worth quoting that standard at length (People vs. Marx, California 1975) : *"in making their pains taking comparisons and reaching their conclusions, the experts did not rely on untested methods, unproven hypotheses, intuition or revelation. Rather, they applied scientifically and professionally established techniques — x rays, models, microscopy, photography — to the solution of particular problem, which, though novel, was well within the capability of those techniques. In short, in admitting the evidence, the court did not have to sacrifice its independence and commonsense in evaluating it".*[17]

Dental identification was used on Adolf Hitler and Eva Braun at the end of World War II, the New York city World Trade Centre bombing, the Waco Branch Dravidian siege, and numerous airplane crashes and natural disasters. The late president of Pakistan General Zia-Ul-Haq, who died in plane crash in 1988, was identified from his dentition.

ABFO Bitemark guidelines are the result of a collective effort of the participants of the bitemark workshop of the American Board of Forensic Odontology assembled in Anaheim, California, February 18th to 20th 1984. These guide lines are considered dynamic, not static, and are modified as significant developments evolve. In 1993, the ABFO bitemark Workshop No. 2 Committee distributed a questionnaire on bitemark terminology. About half of the members responded and provided the basis of the bitemark terminology survey reviewed at the three day Bitemark workshop in San Antonio on February 12 - 14, 1994. Suggestions for modifications were made at that time and these were incorporated into the finished work product that was accepted by the Diplomats of the ABFO on February 13th 1995, in Seattle, Washington.

CLASSIFICATION OF BITEMARKS

1. *Cameron and Sims classification*

This is based on the type of agent producing the bitemark and the material exhibiting it.

AGENTS

Humans

Animals

MATERIALS

Skin, body tissue

Food stuff

Other materials

2. *Mac Donald's classification*[18]

This classification is based upon the etiology and is pertinent to human bitemarks

i) Tooth pressure marks

Marks produced on the tissue as a result of direct application of pressure by teeth. These are generally produced by the incisal /occlusal surface of teeth.

ii) Tongue pressure marks

When sufficient amount of tissue is taken into the mouth, the tongue presses it against rigid areas such as lingual surfaces of teeth and palatal rugae. The marks thus left on the skin are referred as 'sucking'. Since there is a combination of sucking and tongue thrusting involved.

iii) Tooth scrape marks

These are caused by scraping of teeth across the bitten material. They are usually caused by anterior teeth and present as scratches or superficial abrasions.

iv) Complex marks

Combination of above types of mark

3. *Webster's classification*[19]

He classified bitemarks on food stuffs

i)Type 1:- the food item fractures readily with limited depth of tooth penetration. E.g.: Hard chocolate

ii)Type 2 :- Food item fractures with considerable penetration of teeth E.g.: Apple and other firm fruits

iii)Type 3:- complete or near complete penetration of the food item with slide marks. E.g.: Cheese

TYPES OF BITEMARKS[20]

i) Sexually oriented bitemarks

Sexually oriented bitemarks are often sadistic and typically appear to have been inflicted slowly and deliberately with suction applied to the tissue. The resultant injury exhibits central and/or peripheral suck marks and linear radiating abrasions caused by the incisal edges of anterior teeth with good identification of both the gross and individual characteristics of the teeth. The amount of distortion allows an opinion as to whether the person being bitten was active or passive when the bite was being inflicted.

ii) Child abuse bitemarks

Bitemarks nearly resemble tool marks in child abuse victims and represent the primal rage by the attacks by the victim.

iii)Self inflicted bitemarks

Mostly found on forearms of children by themselves. Sometimes may be pushed into child's mouth to stop crying or due to intense pain, children may bite themselves because of fear. Mentally retarded and psychologically disturbed people may also inflict bite on themselves. Self inflicted bitemarks also seen in Lesch - Nyhan syndrome, an X - linked recessive disease with loss of sensation to pain.

FORMS OF BITEMARK [21]

There are seven forms of bitemarks:

1. *Hemorrhage:* Small bleeding spot
2. *Abrasion:* Undamaging mark on skin
3. *Contusion:* Ruptured blood vessel, bruise
4. *Laceration:* Punctured or torn skin
5. *Incision:* Neat puncture of skin
6. *Avulsion:* Removal of skin
7. *Artifact*: Bitten-off piece of body

Contusions are the most common type of bitemark and incisions offer the best three-dimensional images of the teeth.

LOCATION OF BITEMARKS [20]

In sexually oriented bites, the marks are generally found in characteristic location according to the type of sexual relationship,

1) Non sexual assaults: Extremities ,Thorax , Chest
2) Sexual assaults:

a) Heterosexual

Female victim- Breast, Thigh, Anterior shoulder , Pubic area ,Neck ,Arm, Buttocks

Male victim - Abdomen ,Chest, Arms

b) Homo sexual

Female victim - No documented cases

Male victim - Upper back, Axilla, Posterior shoulder, Penis, Scrotum, Breast, Arm

RANGE OF BITE MARK SEVERITY THE BITEMARK SEVERITY & SIGNIFICANCE SCALE [7]

1. Very mild bruising, no individual tooth marks present, diffuse arches visible, may be caused by something other than teeth - *Low forensic significance*

2. Obvious bruising with individual, discrete areas associated with teeth, skin remains intact - *Moderate forensic significance*

3. Very obvious bruising with small lacerations associated with teeth on the most severe aspects of the injury, likely to be assessed as definite bite mark - *High significance*.

4. Numerous areas of laceration, with some bruising, some areas of the wound may be incised. It is unlikely to be confused with any other injury mechanism - *High forensic significance.*

5. Partial avulsion of tissue, some lacerations present indicating teeth as the probable cause of the injury - *Moderate forensic significance.*

6. Complete avulsion of tissue, possibly some scalloping of the injury margins suggested that teeth may have been responsible for the injury. May not be an obvious bite injury - *Low forensic significance*

This scale shows that **medium severity** cases have high forensic significance.

Fearnhead. R.W (1960) concluded that "evidence which involves the identification of a person by tooth marks left as bruises in flesh should never be admitted, and evidence involving bitemarks in, for example, food stuffs should be examined extremely critically". Along with his colleague Mr. A. Boyde, he performed a simple experiment which relates the models of a dentition with well defined freshly made bitemarks in suitable foodstuffs. It was one of the first paper to question the use of bitemark evidence based upon the reliability of the technique.[22]

Taylor D. V (1963) was dual qualified dentist and lawyer. He described all aspects of forensic dentistry, including bitemarks. He stated that "bitemarks.... are unlikely to establish convincing proof in most cases".[23]

Ferdinan strom (1963) described the evolution of bitemark investigation. He also gave credit to Sorup, who was the first to publish analysis of bitemarks. His method odontoscopy was explained. The method of using dia positives was mentioned. The dynamics of the bite action in human tissue as presented by Korkhaus was described. Research on bitemarks in foodstuffs was also described. He pointed that all bitemark cases should be handled by a highly trained odontologic expert. [7]

Osterberg J. W (1967) According to Osterberg , the gross features, class features and individual features are identified in each bitemark case.

GROSS FEATURES, Human bitemarks present as a circular or elliptical pattern injury, and frequently this general shape is divided into 2 distinct halves, representing maxillary and mandibular arches. Bitemark injuries usually are seen as a pattern of bruising, as a series of individual or linear abrasions, or a combination of two. Lacerations, punctures, erythema and avulsions may be seen as well but when present usually are concurrent or superimposed, with the bruise or abrasion appearance. Commonly there is an area of ecchymosis contained within the defining shape of the bitemark due to sucking action or negative pressure created by mouth.

CLASS FEATURES, are more obvious, distinguishable, features in an object with an evidence involving impressions. The general dimensions, design and contour, of the imprint constitute the class characteristics. Class characteristics allow the dentist to ascertain an adult versus a child biter and to determine which teeth are present in the pattern. The injury pattern in tissues is generally caused by incisal / occlusal portions of the teeth. These class patterns are incisors- rectangles; canines- triangles with some variation; premolars- single or dual triangles, diamond with some variations; molars- rarely leave marks, but when present refer the shape of making area. Via class characteristics we can differentiate the human bite from animal bites.

INDIVIDUAL FEATURES, are features, traits that represents an individual variation rather than an expected finding within a defined group. Examples are rotated tooth, fractured tooth. An individual feature helps to differentiate between individuals and helps to identify the perpetrator. The individual arches most frequently are produced by the anterior 6 teeth but may be created by all teeth present in the respective arch. Sometimes only a partial arch of teeth present was observed. Occasionally, a double bite, the marking of the same dental segment twice in close proximity, was observed.[24]

John Furness (1968) introduced a new method of bitemark analysis, in which he described the inking of the occlusal surfaces of the teeth, which are then

photographed and placed on white board. Lines of comparison are drawn with photographs of the injury. This technique is still used today for court exhibits depicting bitemark comparisons.[9]

T. J Stoddart (1973) described a method for producing accurate permanent models of bitten material for forensic purposes. He recommended using two commercial silicone impression materials. The technique described is still applicable today.[25]

Mac Donald D G (1974) described a method of classification of bitemarks based on their etiology.[18]

Whittaker. D. K (1975) studied bitemarks in wax and on pig skin. He found that those on pig skin were less reliable than those on wax in terms of biter identification. He extrapolated that bites on human skin may be similarly unreliable and warned that more research is required. This is a highly cited paper, often regarded as one of the first attempt to validate the science of human bitemark analysis.[26]

Goodbody R. A. et al (1976) described bitemark identification in a murder case. The case demonstrates that a full dental evaluation is mandatory in any case of wounding where a toothed cause is suspected. They discussed the differences between bite injuries and 'toothed' injuries such as those made by a saw. The value of the acetate film technique for speedy and accurate reproduction of bitemarks illustrated.[27]

Lester. L. Luntz (1977) gave a brief description of history of forensic dentistry. He mentioned Paul Revere & Dr. Joseph Warren, Bazaar De La Charite - disaster in Paris, Webster - Parkman case, and Johwlkes booth case.[28]

Rudland. M (1982) described the method for preserving a variety of apple types. He used a pre-defined mark, which was examined over ten years using a preservative known as FFA (Formol Acetate Alcohol mixture consisting of Formaldehyde, Acetic acid, Ethanol). He noted very little distortion. He also stated that bitemarks can be used as supportive evidence in identification.[29]

Sognnars R.F et al (1982) using computer terminology and radiographic bitemark analysis, concluded that occlusal arch form and individual tooth portions, even in identical twins are in fact unique, after conducting a study on 5 homozygotic twin pairs.[30]

Webster. G. (1982) stated that bitemarks have been reported in flesh, food stuffs, and intimate objects. The terminology used to describe food bitemarks is very varied and a classification of food bites has been formulated in an effort to bring a degree of uniformity to the analysis of such marks.[19]

Burnstein. Mark. L (1983) described the importance of photography in forensic dentistry. He stated that all photographs intended as evidence should be labelled with the location, date, time, subject and photographer's name and

information of the camera such as lens, film, shutter speed, flash setting etc. He also described the photographic method of bitemark analysis.[8]

Dorion RB (1984) described a method for removing and preserving human skin exhibiting bite injuries. The author used acrylic, which was placed on the skin and cyanoacrylate glue, which was used to stick the acrylic ring to the skin and the tissue was excised. It was noted that three year preservation achieved little or no post fixation shrinkage. However, the author did not discuss how the lack of shrinkage was assessed.[31]

Krauss TC (1984) advised the use of a rigid ruler for scale, proper camera positioning in relation to the scale, and a method to evaluate the distortion in a two-dimensional print that records a three-dimensional object is suggested. The author suggests that disregarding these factors makes metric bitemark analysis inappropriate.[32]

Rawson RD etal (1984) conducted a study in which a general population sample of bitemarks in wax was used to determine how unique bites are. Author concluded that the analysis confirm the unique nature of human bites.[33]

Rawson RD etal (1984) also conducted a study of the frequency of bitemarks among sheltered children. He found an incidence of 1,545 bitemarks per 100,000

populations. Analysis of age, sex, and location of bitemarks is presented in his paper.[34]

Drinnan et al (1985) mentioned the uniqueness of human bitemark. He quotes the twin study as support for this and was supported by Rawson et al. They also mentioned the difficulties in interpreting and various techniques for comparison. Although the techniques for evaluating bitemark evidence are extremely sophisticated it is important to that the courtroom presentation of such evidence should be as simple as possible.[11]

American Board of Forensic Odontology (1986) gave guidelines for bitemark analysis. These guidelines are the result of a collective effort of the participants of the bitemark workshop of American Board of Forensic Odontology assembled in Anaheim, CA, Feb 18-20, 1984.[6]

Rawson RD et al (1986) stated that some degree of distortion is found in all bitemarks. That distortion can be caused by photographic methods of recording the mark, by the dynamics of the bite or by artifact complicating the bitemark analysis. A method of analyzing photographically distorted bite patterns was presented (90°angle), future research directions are suggested.[35\]

Norman Sperber (1986) in their article describes the current methods available for dental identification and a brief description of human bitemarks and their shape and their usual locations on the victim's body. [36]

West, Michael H et al (1987) described the attempt to standardize a technique for ultraviolet photography of bitemarks on human skin. It also deals with a technique for producing clinical bitemarks on living human subjects and a review of the equipment, lighting source, scanning technique, filters, films and recommended camera exposures and film development for reflective U.V photographs for bitemarks on human skin.[37]

Barsley RE et al (1990) in their article discussed the photographic techniques involved in reflective and fluorescent UV light. Documentation of skin wounds via still photography and dynamic video photographic techniques, which utilize various methods of UV illumination were covered. The use of advanced photographic techniques has been questioned in courts.[38]

Wood. R. E et al (1994) presented a case in which a homicide victim bit his assailant. Scale photographs of the injury were compared to the dentition of the deceased using digitized computer images for superimposition. The different approaches for comparison with bitemark photograph, radiograph, transparent overlay. A review of these techniques as they apply to computerized bitemark analysis was presented. [39]

Thompson IO et al(1994) reported a case in which the bite patterns of two suspects were compared to a bitemark on the breast of a murder victim. Each suspect had sufficient concordant features to have been found guilty of producing the bitemark. The irony in this case was that the bitemark was not inflicted by the murderer.[40]

Rothwell BR (1995) in his article explored the legal and scientific basis of bitemark evidence. He also described steps in data collection for bitemark evidence and problems in bitemark analysis when present on human skin.[10]

Nambiar P et al (1995) in their article an interactive shape analysis computer programme (SCIP) has been employed in an attempt to derive experimentally a quantitative comparison, in the form of Similarity Index (SI) between the offender's teeth and bitemark produced on a standard flat wax. They recommended this technique as a simple, accurate, and objective means of comparing bitemarks.[41]

Nambiar P et al (1995) stated that SCIP was employed in an attempt to quantify the comparison in the form of similarity index between the offender's teeth produced on food stuffs and on human skin. The use of SCIP and S.I was recommended to eliminate suspects in bitemark cases.[42]

Naru A S et al (1996) stated that criminal cases occasionally involve the analysis of bitemark injuries. This paper presents a method of digital image

enhancement of an injury and an overlay production method to improve the comparison between the dentition of a suspect and the image of the injury. A comparison method entirely within the digital image software is also illustrated.[43]

Naru AS et al(1997) described the production of a complex computer program for assessing bitemarks and a series of experiments to validate the system.[44]

Wright Franklin.D (1998) described a case involving multiple bitemarks. The bitemarks were photographed over a 31 day period to document the injuries and preserve their evidentiary value. This case demonstrates the difficulty of attempting to record images in non visible light, specifically the UV photographs of the injuries on the day of the assault. There was no problem with the technique or the equipment utilized in taking the UV photographs taken on days 8 and 31. The review of this case demonstrates the value of photography in the recovery and preservation of bitemark and patterned injuries as the means of documentation for evidentiary purposes in future legal proceedings.[45]

Whittaker D. K. et al (1998) compared adult and child human bitemarks using Receiver Operating Characteristic (ROC) analysis. Fifty colour prints of human bitemarks were sent to 109 observers who were asked to decide using a six point rate scale, whether the marks had been produced by the teeth on an adult or a child. The observers consisted of accredited senior forensic dentists, accredited junior forensic

dentists, general dental practitioners, final year dental students, police officers and social workers. The results were compared against a 'gold standard' which was the actual verdict from the case. Comparison of the results between the groups of observers and the standard was made using ROC methodology. The best decisions were made by senior/junior experts and final dental students. General dental practitioners and po lice officers were least able to differentiate correctly between adult and child bitemarks. Then he concluded that training is important and its effects need to be assessed in more detail in future studies.[46]

Sweet. D et al (1998) described a computer based production of bitemark comparison overlays. They described the importance of bitemarks found on skin or objects in forensic dentistry. They suggested this technique to enable the Odontologist to produce high quality accurate comparison overlays without subjective input. In this method they generated accurate hallow volume overlays using Adobe Photoshop. They also stated that photographic, xeroradiographic, radiographic methods were more subjective in nature.[47]

Sweet D J et al (1998) in their study compared five common overlay production methods using digital images of dental study casts as a reference standard. Two physical characteristics of dentition, viz., area and angle of rotation, were analyzed. The computer based overlay production technique was found to be the most

accurate. The second best methods in terms of area and angle of rotation were found to be the radiographic method and xerographic method respectively. Hand-traced methods from either wax impressions of teeth or directly from study casts were determined to be inaccurate and subjective. The authors recommended the discontinuation of the hand traced overlays. [48]

CM Bowers and RJ Johansen (2001) described the importance of digital photography its advantages and disadvantages. They gave a detailed description of the fabrication of computer generated overlay from suspect's dentition and bitemark analysis using adobe photoshop.[49]

Franklin D. Wright and J. Curtis Dailey(2001) gave a brief description of how to recognize bitemark, its appearance, composition, evidentiary value, and their changes over time and evidence collection from the suspect and bitemark analysis. Also described photocopy technique for overlay production. They stated that in 1986, Daily published this technique as the first accurate, reproducible and inexpensive transparent overlay technique because this technique uses a conventional office photocopy machine.[50]

lain A. Pretty and David Sweet (2001) stated that the most of the bitemark analyses use analytical techniques. Their study defines quantifiable variables for transparent digital overlays. A series of ten simulated, postmortem bites were created

on pigskin and, with accompanying overlays, assembled into cases. Using two separate studies with four examiner groups the study conducted and the defined values of intra- and inter-examiner reliability, accuracy, sensitivity, specificity, and error rates for transparent overlays were studied. It was concluded that the weak inter-examiner reliability values explain the divergence of odontologists' opinions regarding bite mark identifications often stated in court. The authors conclude that further research is required so that the results of the current study can be placed into context, but this represents a significant first step in establishing the scientific basis for this aspect of forensic dentistry. [15]

Mac Donald. D. G and Sheasby. D. R (2001) has given a classification which is based upon the causative factors and their inter-relationship. The terms primary distortion and secondary distortion were introduced and described. The objective of the classification was the need for a scientific approach to the recognition and interpretation of the types of distortion found in human bitemarks. The relationships between distortion, distinctive features and superimposition techniques in the bitemark analysis were discussed.[51]

Stella Martin-de las Heras et al (2005) in their study presented a new software package, DentalPrint R that generates different comparison overlays which is entirely automatic from 3D dental cast images depending on the pressure of the

bite or the distortion caused by victim-biter interaction. They stated that method avoids observer bias and makes it impossible for third parties to manipulate or alter the 3D images, making DentalPrint suitable for bite mark analyses to be used in court proceedings. Different biting edges could be obtained from the dental casts depending on selected depth (mm) and angulation (degrees) with the software.[52]

lain A. Pretty (2006) has assessed aspects of bitemark analysis including the crucial issue of the uniqueness of the human dentition, the application of transparent overlays and the application of statistical probabilities in bitemark conclusions. He also stated that there are numerous barriers to undertaking high quality research in the field of bite mark analysis, the most important of which is the use of a gold-standard that is acceptable both in terms of diagnostic research but is also forensically relevant. He concluded that if bite mark analysis is to continue to play a role in the judicial process then there is an urgent need for high quality studies that meet the levels of forensic and scientific scrutiny applied to other disciplines within the criminal justice system.[53]

lain. A. Pretty and Sweet .D.J (2006) mentioned a review of appellate court rulings from the United States and identified trends of objections to bitemark testimony. Nine major trends identified within the cases assessed were: bitemark evidence not sufficiently reliable or accepted, arguments regarding the uniqueness of

the human dentition, constitutional arguments, inflammatory photographs, inaccuracy of techniques and errors in protocol, use of historical bitemarks and previous biting behaviour, funds for defence witness and objections pertaining to witness credibility. In summary it stated that historically bitemark evidence has been generally accepted within the forensic field and the admission of such evidence on this principle is correct within the definitions provided by Frye and the Federal Rules of Evidence (Rule:702). Indeed within the U.S. evidence of positive identification of bitemark suspects has been admitted in all states with the single exception of Oklahoma, where Odontologists conclusion level was limited to "probable bitemark".[54]

James H. (2006) reported a good bitemark evidence in a 25 year old female who was sexually assaulted. Digital overlays were produced using the techniques described by Johansen & Bowers and compared with the injury. This bite mark case demonstrated quality evidence of good probative value which could confidently be presented in a court of law.[20]

van der Velden. A, Spiessens. M and Williams. G (2006) described a new method bitemark analysis using image perception technology. With this technology it is possible to artificially colour areas with equal intensity values and depict a 2-D image as a pseudo 3-D surface object. The use of image perception technology allows visualization of a degree of detail unavailable with any other method.[55]

Rai. B. and Anand et al (2007) stated that bitemark analysis is a vital area within this highly specialized field and constitutes the commonest form of the dental evidence presented in criminal court. In their study, identification of the person was done through bitemark by different techniques using life size photographs, transparent overlays from study dental cast models in different materials such s clay and cheese.[56]

Kouble. R. F and Craig. G.T (2007) stated that missing teeth is one of the characteristics that could implicate or exclude a suspected biter. [57]

John D. McDowell (2009) stated that whenever performing a bitemark analysis scientific method must be used. Each scientist should recognize and report any potential errors, distortions, deviations and variations when collecting data.[58]

lain. A. Pretty and David Sweet (2010) described a paradigm shift in the analysis of bitemarks. They provided an update on the current context status of bitemark analysis. Given the present combination of critical elements and a new level of caution that includes the use of a careful scientific approach to case work, increased reproducibility of conclusions by independent analysts. He also mentioned examples of two bites on cadaver tissue from Bush et al and example of a comparison of dentitions from the grouped suspects from miller et al.[59]

Michael J. Saks (2010) in his article reviews the fundamental assumptions of forensic identification science and notes the lack of empirical evidence or theory supporting its typical strong claims. They also discuss three general research strategies for placing these fields on firmer scientific ground. They are the DNA model, the black box model, the basic research model. It concludes by suggesting what forensic identification science experts can do while awaiting that scientific foundation.[60]

Avon S. L. and Victor. C et al (2010) conducted a study on analysis of dermal bitemarks recruiting 30 volunteers. They are dentists with no experience in forensics, dentists with an interest in forensic odontology and board certified diplomats of ABFO. Error rates were calculated for each of the three suspect dentitions. This study demonstrates that even under carefully controlled conditions errors in interpretation may occur.[61]

Thais Torralbo Lopezn et al (2010) described their study on the frequency of missing anterior teeth in the Brazilian adult population and its potential importance in bitemark analysis. They have conducted a study on 13431 people. They found that missing teeth were more frequent in the upper arch than lower and females were 1.61 times more likely than males to present missing teeth. They suggested that further

research should also include an analysis different age groups and that would increase the potential of applying this kind of information to bitemark analysis.[62]

Richard Siderits et al (2010) on their study on three-dimensional laser scanning of crime scene gum as a forensic method illustrated a method for quickly and inexpensively scanning crime scene gum by using a desktop, compact, automated 3-D laser scanner (Next Engine), creating a virtual tooth imprint model using the true Space CAD program and using an online rapid prototyping service for obtaining solid models of the scanned objects and concluded that combination of these techniques may support a wide range of uses in criminal investigations. [63]

G.S. Golden(2011) in his paper on standards and practices for bite mark photography focused on standard technique, macrophotography, visible light imaging, alternate light imaging, infrared photography, reflective ultraviolet photography, stated that not all situations will require all of these techniques. He also stated that frequently the evidentiary value of the bite mark is of such low quality that neither advanced nor visible imaging protocol will be of use to the investigator. Sometimes the best option in those inferior cases is to disregard the bite mark evidence completely and rely on the DNA results instead. [64]

Saritha Maloth et al (2011) in their study on comparison between five commonly used two-dimensional methods like hand tracing from study casts, hand tracing from wax impressions, xerographic method, radiopaque impression method ,2D computer-based method for human bite mark overlay production from the dental study casts concluded that hand tracing methods, from either wax impressions of teeth or directly from study casts, were determined to be inaccurate and subjective. They also recommended that forensic odontologists discontinue the use of hand tracing overlays in bite mark comparison cases as there is lot of scope for manipulation and observer bias. [65]

Kalyani Bhargava et al (2012) Analysis of bite injuries should only be undertaken if unique or, in certain circumstances where class characteristics exist. 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. [66]

MATERIALS AND METHODS

MATERIALS FOR OBTAINING CASTS

1. Alginate impression material
2. Dental stone
3. Upper and lower perforated stainless steel impression trays
4. Rubber bowl and spatula
5. Disposable gloves and mouth masks

PHOTOGRAHY MATERIALS

1. Sony Cyber-shot DSC-W730 with 16.1 megapixel and 8 optical zoom
2. ABFO No. 2 bite mark standard reference scale
3. Customized photographic box

COMPUTER AND SOFTWARE MATERIALS

1. Hewlett Packard Computer with

Intel Pentium CORE i5

Windows 7 Home Premium

6 GB RAM

Hard Drive with 500 GB

CD ROM Drive

ATI RADEON Graphics

Adobe Photoshop 7 software

3-D-Tool-Free software

METHODS

Study Setting

The study was conducted in the department of the Oral Medicine and Radiology, Sree Mookambika Institute Of Dental Sciences, Kulasekharam , Tamil Nadu

Inclusion criteria

30 subjects with complete set of natural upper and lower anterior teeth were selected for the study.

Exclusion criteria

Subject's with orthodontic appliances, impaired mouth opening .

PROCEDURE

(A)OBTAINING OF STUDY MODELS:

Each of the 30 subject's was made to sit comfortably on the dental chair and the upper and lower alginate impressions were taken. The impressions were then thoroughly disinfected with 2.4% glutaraldehyde base formulations and alginate impressions were made as per the manufacturer's recommendations since alginate material satisfies the court stipulations in the collection of evidence.[67] The dental stone was poured promptly according to the manufacturers recommendations as soon as the impressions were made, as they tend to lose dimensional stability via syneresis. Dental stone was used since it is a strong

gypsum product and for accurate details of the impression obtained. They were poured in dental stone using the standard pouring techniques. The models were then trimmed of the excess stone and serially numbered. They were then placed carefully in cotton-lined boxes and stored. All the volunteers were asked to bite on apple with instruction that not to shear away the bitten piece. Force of the bite was not calibrated as this was an overlay study.

(B)PRODUCTION OF COMPOUND OVERLAYS

The following procedures were followed.

Procedure 1: Scanning subjects casts using 3-D model Scanner

60 casts-30 maxillary and 30 mandibular casts were scanned using 3-D model scanner

Procedure 2: Photographing of bitten objects (apple)

A box with a height of 20 centimeters (from the camera lens up to the base where the apple is placed) and a flat surface was customized for proper placement of the camera. ABFO NO: 2 scale was used as standard reference for photographing the bitten apples. Upper and lower bites were photographed with flash separately for each subject.

Procedure 3: Cross sectioning of the casts using 3-D tool

3-D scanned casts were obtained as STL (Stereolithography) which were obtained using 3-D-Tool-Free software. Each cast was opened individually with this software and four levels of cross sections were made for each maxillary and mandibular casts.

FOR MAXILLA

Level 1 cross section: made at the incisal levels of central incisors and canine.

Level 2 cross section: made at the incisal levels of central incisors, lateral incisors and canine,ie,2mm above occlusal level.

Level 3cross section: made at 1 mm apical to level 2.

Level 4 cross section: made at 1 mm apical to level 3.

FOR MANDIBLE

Level 1 cross section: made at the occlusal plane of central incisors, lateral incisors and canine.

Level 2 cross section: made 1mm below level 1.

Level 3cross section: made at 1mm below level 2.

Level 4 cross section: made at 1mm below level 3.

Procedure 4 :Analysis of bite marks

> Open image of bitten object (apple) in Adobe Photoshop 7.

Using > **Marque tool**, image of apple with ABFO NO:2 Scale is selected and cropped and this cropped image is **saved** as new file

Select this image using **Ctrl + A > Edit > Transform >Scale.** The selected image is made life size . > **Save** this image as **Scaled upper or lower**

Each level of cross section is individually opened with photoshop. **Select** canine to canine from > **Magic Wand** tool. Open **Scaled image** in the photoshop. Using > **Move** tool, **select** the selected canine to canine portion. This is dragged and moved to the **Scaled image.** This is compared with the bite mark on the apple.

The final superimposed image is saved .

The same procedures are followed for all the levels of cross sections of maxillary and mandibular casts**.**

Procedure 5: Interobserver Analysis

After the compound overlays were generated for each level cross section of all the 30 samples, all the images were given to five observers and all of them were asked to determine which level of cross section matched with the bitten apple. The following guidelines were given to all the observers before the analysis:

1. Shape and arrangement should be assessed based on the upper and lower borders of the indentations seen on the apple skin.
2. Best fit should be assessed with the axial levels which fits into the flesh of the apple.
3. An axial level should not be considered best fit if it covers the indentation completely.
4. If two or more axial levels fit in almost similarly ,number of tooth which matches also should be considered, i.e. shape and arrangement and best fits should be assessed simultaneously.

FIGURE 1: Materials used in the study

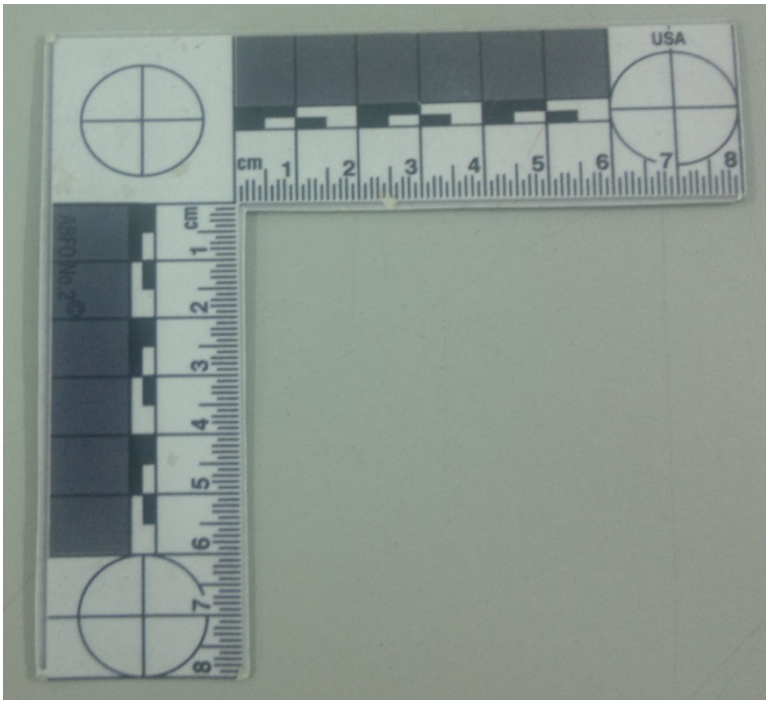

FIGURE 2 : ABFO Scale NO:2

FIGURE 3: Study M odels

FIGURE 4: Life size images of maxillary and mandibular bitemark

FIGURE 5: 3D (D900) Scanner

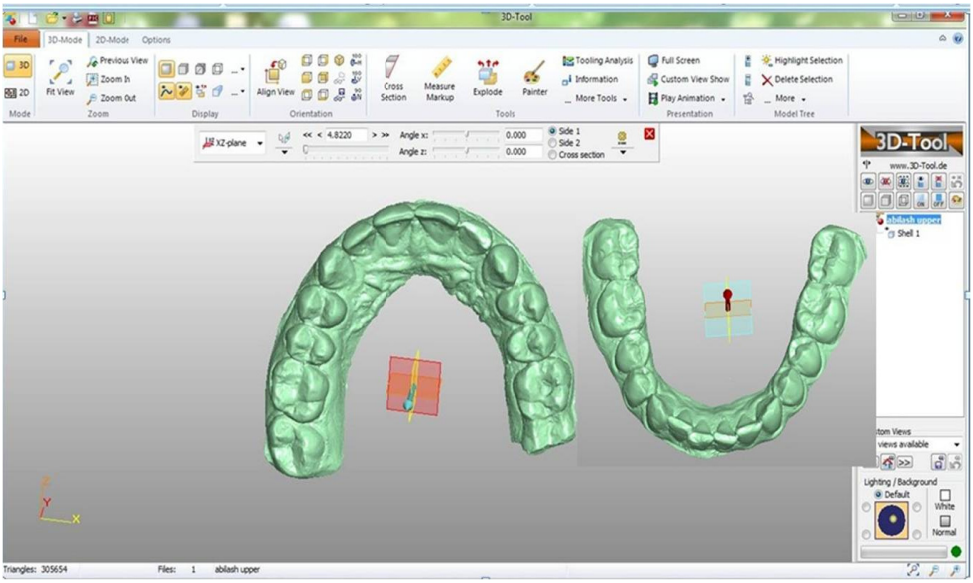

FIGURE 6: Scanned casts opened with 3d tool software for various levels of cross section

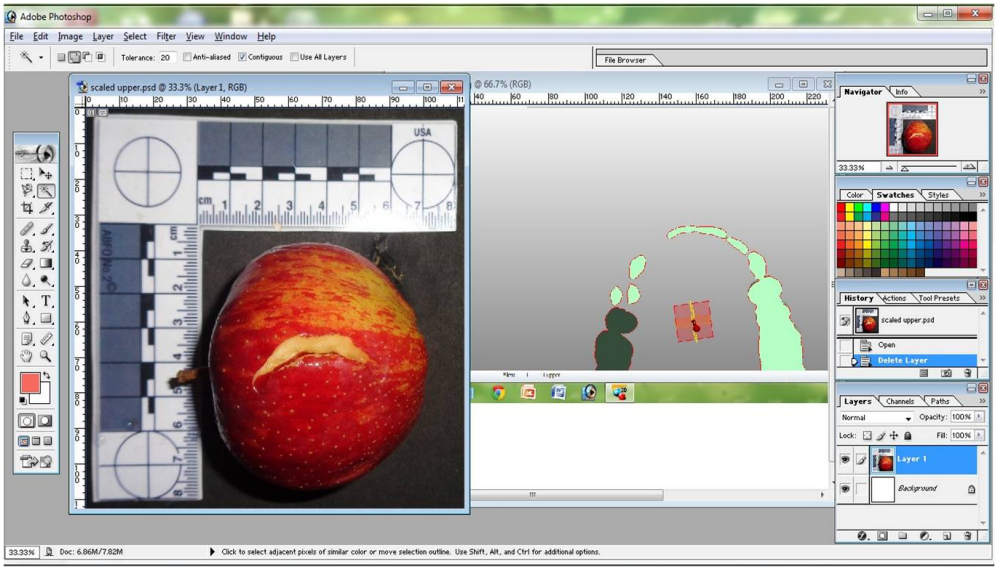

FIGURE 7: Step 1-Open the image of bitemark and cast in Adobe Photoshop

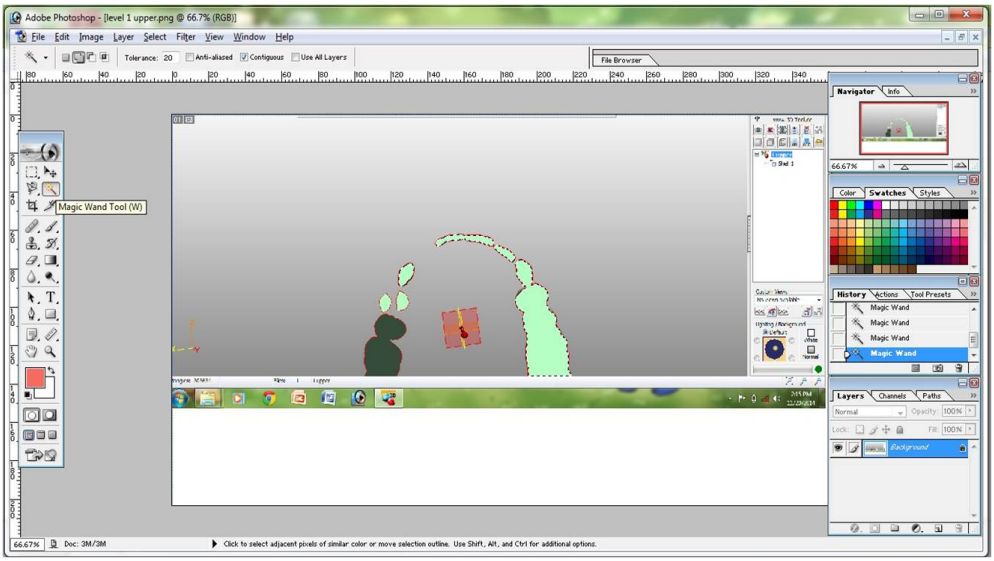

FIGURE 8: Step 2-Selection of biting edges using magic wand tool

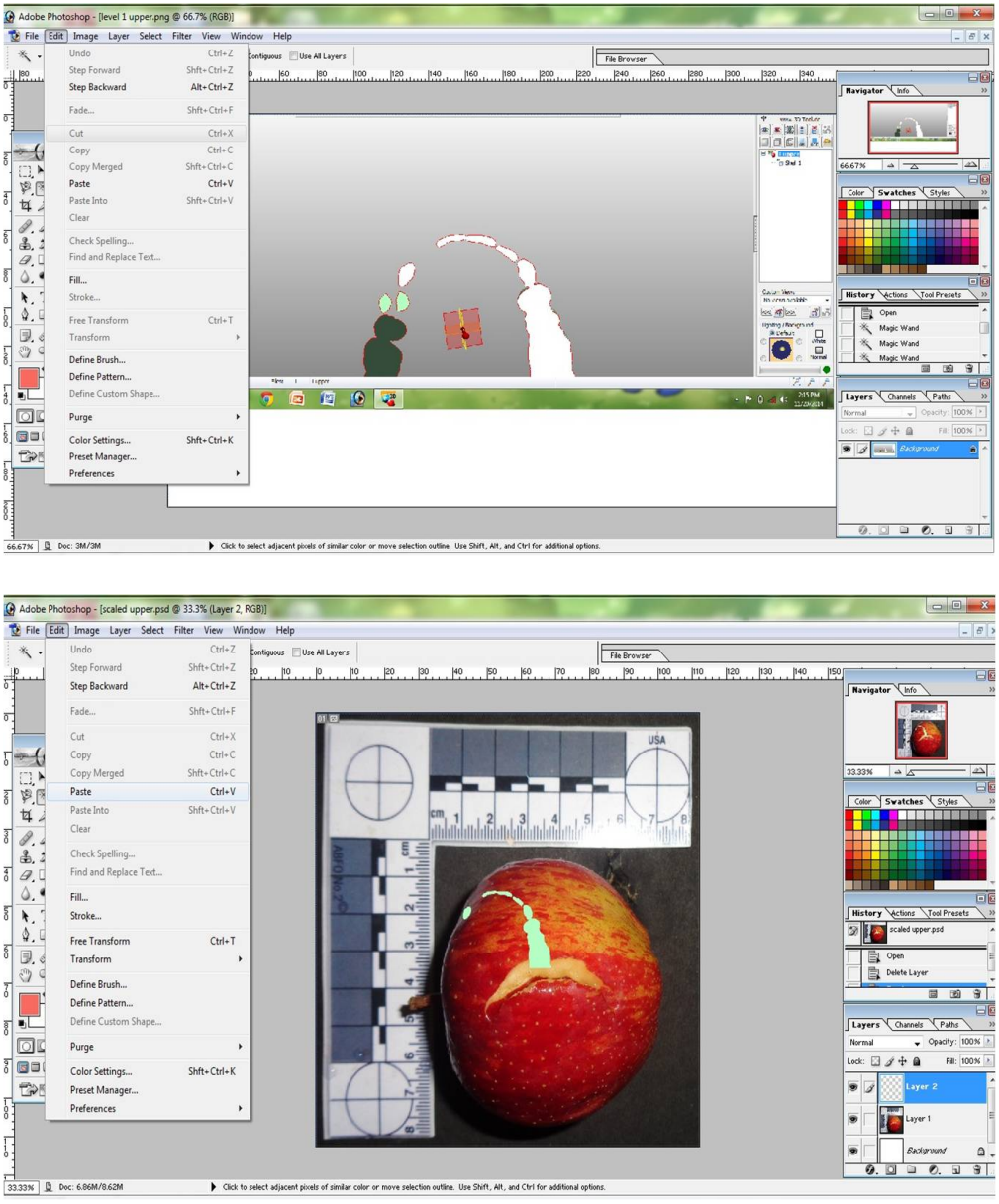

FIGURE 9:STEP 3-DRAGGING THE SELECTED LEVEL OF CROSS SECTION

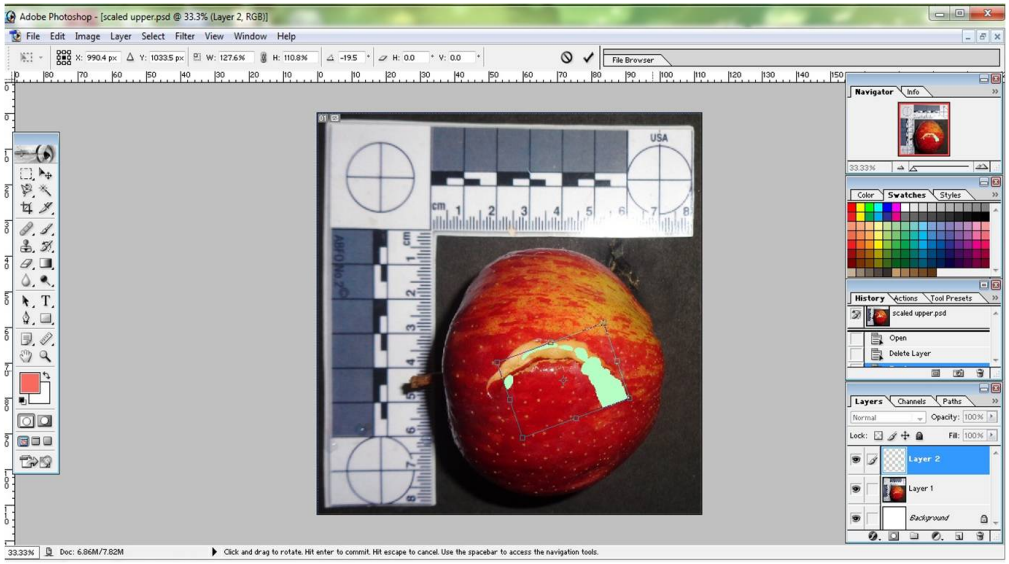

FIGURE 10: STEP 4-COMPARING THE COMPOUND OVERLAY WITH THE LIFE SIZE IMAGE OF APPLE

RESULTS

The characteristics of each bite mark such as shape and arrangement of the bitemark pattern and the level of the tooth -whether incisal edges or various levels of the labial surfaces actually make the indentations were analyzed.

Each bite mark sample constituted teeth marks created by the six upper and six lower anterior teeth of 30 subjects. For statistical analysis, frequency of distribution of four levels of cross sections obtained from 3D scanned casts were calculated in percentage separately for maxillary and mandibular levels.(Table 1 & Table 2) And an inter observer analysis which included five observers was done to minimize the possibilities of subjective error. Interobserver variation is measured because five independent observers are evaluating the same thing. For statistical evaluation of the inter observer analysis, Kappa statistics was used to prove the validation of the procedures followed during the comparison of various compound overlays as kappa is the most commonly reported measure in the medical literature. Interpretation of Kappa is as follows:

Kappa	**Interobserver Agreement**
< 0	Less than chance agreement
0.01–0.20	Slight agreement
0.21– 0.40	Fair agreement
0.41–0.60	Moderate agreement
0.61–0.80	Substantial agreement
0.81–0.99	Almost perfect agreement

Results show that there was 100% positive match for all the 30 samples. Also ,results derived with the descriptive analysis and Kappa analysis shows that in maxillary bite pattern, percentage of level 3 (46.6%) cross section was found to be the highest followed by level 2(30%),level 4(13.3%) and level 1(3%) and in mandibular bite pattern, percentage of level 2 and level 3cross sections were found to be the same (43.3%) followed by level 4(10%) and level 1(3.3%).On an average a fair agreement was obtained with the Kappa analysis.(Table 3 & Table 4)

GRAPH 1

Graph showing Frequency distribution of upper levels

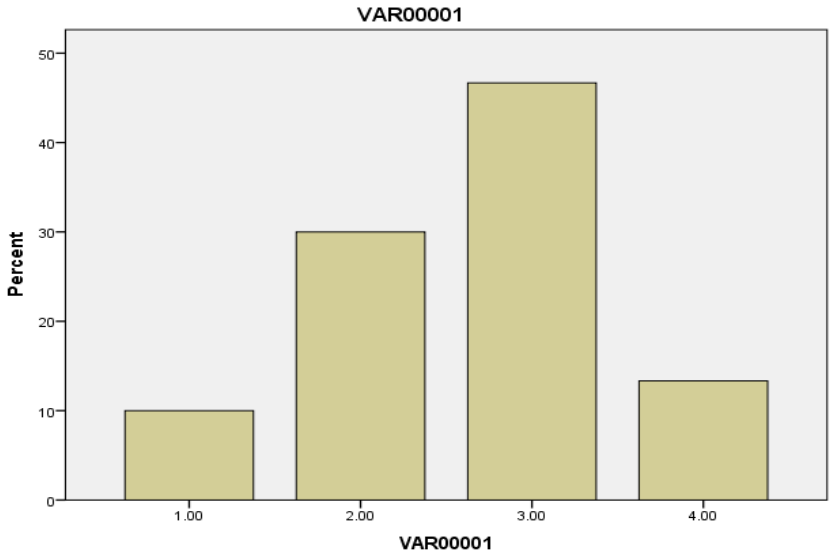

Table 1

Table showing Frequency distribution of upper levels

VAR00001

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	10.0	10.0	10.0
	2.00	9	30.0	30.0	40.0
	3.00	14	46.7	46.7	86.7
	4.00	4	13.3	13.3	100.0
	Total	30	100.0	100.0	

GRAPH 2

Graph showing frequency distribution of lower levels

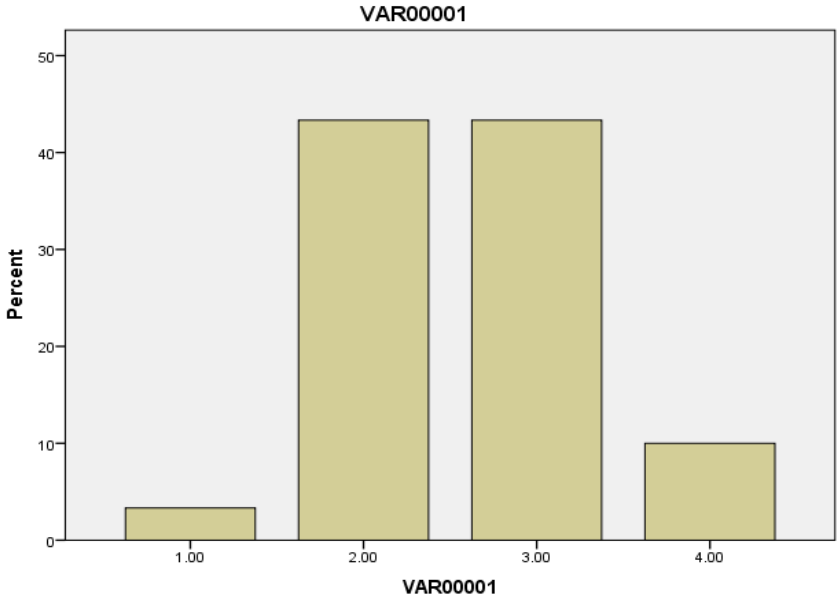

Table 2

Table showing frequency distribution of lower levels

VAR00001

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.3	3.3	3.3
	2.00	13	43.3	43.3	46.7
	3.00	13	43.3	43.3	90.0
	4.00	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

TABLE 3

MAXILLARY KAPPA ANALYSIS

UPPER	ex1	ex2	ex3	ex4	ex5
ex1	nil	0.347	0.174	0.309	0.085
ex2	o.347	nil	0.193	0.139	0.214
ex3	0.174	0.193	nil	0.106	0.103
ex4	0.309	0.139	0.106	nil	0.175
ex5	0.085	0.214	0.103	0.175	nil

TABLE 4

MANDIBULAR KAPPA ANALYSIS

LOWER	ex1	ex2	ex3	ex4	ex5
ex1	nil	0.013	0.257	0.263	0.054
ex2	0.013	nil	0.008	0.216	0.181
ex3	0.257	0.008	nil	0.177	0.246
ex4	0.263	0.216	0.177	nil	0.218
ex5	0.054	0.181	0.246	0.218	nil

DISCUSSION

"The criminal may lie through his teeth though the teeth themselves cannot lie" - Furness[9]

The role of a forensic odontologist in the investigative process of crime solving involves has numerous roles, one of which is to match the bitemark impressions on a victim to the tooth structure of suspects. The fact that the bite marks are unique in size and alignment and can be attributed to specific individuals has long been recognized.

From the onset of human hostility, man has used his teeth as a weapon, to bite his victim. In mortal combat situations, such as the violence associated with life and death struggles between assailants and victims, the teeth are often used as a means of defense which indeed may be the only available defensive method for a victim. Assailants in sexual attacks, including sexual homicide, rape and child sexual abuse, often bite their victims as an expression of dominance, rage and animalistic behavior. The teeth are a significant component of our natural arsenal. Bitemarks may be caused by humans or animals. They may be on tissue, food items or other objects. There are significant differences between a human bite and that of an animal. Human bitemarks are broad, 'U'- shaped and somewhat oval or circular where as animal bitemark is narrow in anterior aspect and is 'V'-shaped and elongated. The morphology of anterior teeth varies in humans and animals. Human bitemarks have broad centrals and relatively narrow lateral incisors and are blunt. Bitemarks caused by animal's exhibit broad laterals, narrow centrals with sharper & deeper canine marks. Two

terms which are commonly used in bitemark analysis are *victim*, is the recipient of the bitemark and *perpetrator*, is the person who caused the bite mark. [9,4]

UNIQUENESS OF BITE MARK

It has long been recognized that bitemarks are unique and can be attributed to specific individuals. A study in 1991 has established dental uniqueness beyond a reasonable doubt. Even the dentition of identical twins is not identical. [33,56]

It has been well documented that owing to factors such as size, shape, wear, rotations, restorations, missing teeth, fractures, no two sets of teeth are exactly alike. The arrangement and alignment of the human teeth are accepted as being unique to each person. This is mainly caused by the sequence of eruption of anterior posterior teeth. Canines must force their way into the dental arch, which often results in bodily movement, rotation and displacement of the teeth.

Often, these factors help to distinguish one set of bitemarks from another. These factors provide the forensic odontologist with specific and characteristic information about the person who has inflicted the bitemark and can be used to positively identify a suspect. When a biting incident occurs involving the human dentition, these unique characteristics of the biter's teeth are transferred to the object or person bitten. Using this bitemark it is possible to establish the identity of the person responsible for the biting.

INCIDENCE OF BITEMARKS

Bitemarks can be found in tissues, food and inanimate materials. They can be of human or animal origin. Human bitemarks may be associated with assault, homicide, child abuse and or sexual assaults. They are found on virtually all areas of the body, most often found on the skin of the victims with more than one bite occurring in 40% of the instances.[4]

Females are most often bitten on the breasts, arms and legs, but bites on males are commonly seen on the arms and shoulders during sexual attacks. In defensive circumstances, as when the arms are held up to ward off an attacker, the arms and hands are often bitten. A practical homicide investigation points out that homosexual homicides, when they have bitemarks involved, tend to have them on the back, arms, shoulders, face and scrotum of the victim. Breast and thigh marks indicate heterosexual aggression and tend to be done slowly and sadistically, which leaves an excellent impression. Battered children have randomly placed bitemarks that are generally diffuse and of poor detail.[68]

Krauss T C et al advises the use of a rigid scale, proper positioning in relation to the scale and a method to evaluate the distortion in a two dimensional print that records a three dimensional object. In the present study an ABFO NO:2 scale was used and a customized box was used for the proper placement of the camera. [32]

Whittaker D.K et al conducted a study on 84 bitemark cases. Bitemarks were voluntarily created on wax and pigskin. Comparison was done based on a visual

method depending upon arch curvature, width of teeth, angulations of teeth and spacings between teeth. Only 68% cases were matched and they stated that visual matching using subjective criteria is less accurate. In the present study, bitemarks were made on apples from 30 volunteers and comparison was done based on cross sections obtained from 3D model scanned casts and computer generated overlays of these levels. A 100% positive match was obtained with the present study. Also a level 2mm apical to the incisal edges for maxillary teeth and a level 1 or 2 mm from the incisal edges for mandibular teeth were found as most matchable.[26]

Wood, miller et al in their study of a bitemark analysis of a sexual assault case used radiographic, xeroradiographic and computer based methods. They stated that among 3 methods, radiography and xeroradiographic methods lack accurate details and that they were able to match accurately with computer based method. The present study is superior in the way that a three dimensional scanning of casts and the various levels of cross sections of teeth from these scanned casts were compared with the computer generated overlays. All the samples matched accurately indicating that 3D comparison is accurate.[39]

Webster. G conducted a study on 30 bitemarks on food stuffs. He used food stuffs like cheese, chocolate and apples and all the bitemarks were matched with the biters teeth. He stated that it is the labial surfaces rather than the biting edges that are responsible for bitemarks in foods. Whereas in skin it is almost always the incisal edges which will be responsible. The present study was conducted on 30 subjects using apples to evaluate at which level of the teeth actually made the indentations on

apple. The results of the present study is in concordance with his statement that it is the labial surface which is involved rather than the biting or incisal edges.[19]

Balwant Rai. S et al conducted a study on 103 volunteers, where they used cheese as foodstuff material to bite but they used different techniques for analysis like direct cast method and photography based method and the result was 81%.The present study used only one food stuff (apple) and a 2D comparison of various levels of cross sections of teeth obtained from 3D scanned casts was made with 2D photographs of the bitten apple. A 100% positive match was obtained with the present study. Also a level 2mm apical to the incisal edges for maxillary teeth and a level 1 or 2 mm from the incisal edges for mandibular teeth were found as most matchable.[56]

Lessing et al had done an investigation on the bitemarks left on the apple by the perpetrator. Their analysis was different from the computer based method in that they took impression of the apple and matched with the cast of the suspect. In the present study upper and lower arch impressions of all the subjects were taken, scanned using 3D model scanner and various levels of cross sections of teeth made from the scanned casts were matched with the bite marks on apple. All the samples matched positively.[69]

S. A. Blackwell et al presented a technique for 3-D imaging and quantitative comparison of human dentitions and simulated bite marks and concluded that 15% of combinations of dentitions and bite models in this sample were categorized as a match when they were in fact a non-match, i.e. 15% of non-matching combinations were indistinguishable from the true match. The present study used qualitative comparison

of 3-D scanned images of the dental casts to match with the 2-D photographs of bite marks on apple.100% match was obtained.[6]

Lorkiewicz - Muszyńska D et al conducted a study on five volunteers to compare bite marks and teeth features using 2D and 3D methods .The wax bite impressions and bite marks from different materials were scanned with 2D and 3D scanners and photographs were taken and then compared using different methods -2D and 3D.The present study was conducted on 30 volunteers and dental casts of all them were made and scanned using 3D scanners, four levels of cross sections were made with these casts and the 2D images of these levels were compared with the 2Dphotographs using photoshop software. All the samples matched positively. Also a level 2mm apical to the incisal edges for maxillary teeth and a level 1 or 2 mm from the incisal edges for mandibular teeth were found as most matchable.[70]

The perpetrator tends to eat food stuff in consciousness .So bitemarks appear clear with good gross, class and individual features whereas bitemarks on humans depends upon the movement of the victim and perpetrator, aggressiveness of the perpetrator and the consciousness of the victim and perpetrator. The appearance and features of the bitemark in humans indicates whether the victim is an active or a passive participant (like unconscious, dead). Aggressiveness of the perpetrator and movements of the victim as well as perpetrator may result in multiple bitemarks, incomplete bitemarks where only a half or some teeth seen. Skin is a poor medium for bitemarks as it is resilient furthermore inflammatory changes in it results in distortion. Postmortem changes in deceased victims also results in distortion of the bitemark. All these factors should be considered during bitemark analysis.

The present study used qualitative comparison of 3D scanned images of the dental casts to match with the 2D photographs of the bitemark on apple. Also from the results obtained with the present study, a level which is 2mm apical apical from the incisal edges of maxillary teeth and 1-2 mm from the incisal edges of mandibular teeth was found to be more relevant than incisal edges in food substances. These results are in contrast with the results of previous studies which states that incisal edges are used for comparison of bitemark using compound overlay technique. Also the frequency distribution shows that level 4,a level which is deeper than the above mentioned levels are found to be more involved than level 1,which is the incisal edge. So with the present study a new concept can be proposed, ie, labial surfaces of teeth are best for the comparison rather than the incisal edges. Hence with this study, we can conclude that although 2D compound overlay has been used all along for comparison and analysis of bitemarks,3D compound overlay technique has better sensitivity and relevance in the analysis of bitemarks. This should also be the cause for a lot of inconclusiveness in the 2D overlay technique by different researchers, this study with its conclusions should show the light of way.

SUMMARY AND CONCLUSION

The applicability of 3D model scanning for the analysis of bitemark were evaluated with respect to how accurately each level of cross section made from the models produced the shape, level of the labial surface which produced the indentations of the upper and lower anterior teeth of a suspect in the field of Forensic Dentistry. The present study was conducted to evaluate and compare the accuracy of various levels of cross sections obtained with 3D model scanner with the computer-based method for human bite mark analysis with respect to six upper and six lower anterior teeth of 30 subjects. The results obtained in this study indicate that level 3 (2mm labial to the incisal edges of central incisors, lateral incisors and canines) for maxillary and level 2(1mm from incisal edges) and level 3(2mm from incisal edges) for mandibular was found to be the highest in frequency percentage. So it is recommended that labial surfaces of the teeth rather than incisal edges be looked in for the comparison of bite marks in food substances. The results also indicated that there is no considerable variation in the determination of incisal edge or labial surface area among the four levels of overlay production methods which indicates the high reliability and minimal subjective errors of 3D model scanning and computer based method of overlay production. Setting apart the practical difficulties and concerns of 3D model scanning, it is recommended that 3D model scanning be used as there is no scope for manipulation and minimal observer bias. The software used in this study allows users to accurately and objectively selects the biting edges or various levels of cross section of interest from the suspect's teeth. The procedure for generating comparison overlays is entirely automatic and it is impossible for third parties to manipulate or alter the 3D images. This is an important step forward in Forensic

Sciences for bite mark analysis. However, further research in the comparison process is needed to enhance the specificity of bite mark analysis.

Comparison techniques used in bite mark analysis are many and varied, the choice of technique depending largely on personal preference. Until recently, no single technique has been shown to be better than the others and very little research had been carried out to compare different methods. Although various methods are used to produce bite mark overlays, inherent subjective error incorporated to the overlays may make it difficult to reach conclusions with a high degree of confidence in court proceedings. Hence to overcome these problems recently, computer-based techniques using two-dimensional scanner or more recently three dimensional scanning and Adobe Photoshop Software are used to produce bite mark comparison overlays. Hence, with the use of three dimensional scanners and advanced softwares , it is possible to make bitemark a highly reliable evidence, provided there are more adequate researches on this area.

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ANNEXURES

Sree Mookambika Institute of Medical Sciences
Kulasekharam (K.K District, TN) 629161

Phone No: 04651-280866, Fax No. 04651-280740

Institutional Human Ethics Committee

Registered under CDSCO with Reg No. ECR/446/Inst/TN/2013

Ref. No. SMIMS/IHEC/2013/C/37 **Date: 27th December 2013**

Certificate

This is to certify that the Research Protocol Ref. No. **SMIMS/IHEC/2013/C/37,** entitled "Human Bite Marks -A Diagnostic Tool in Forensic Odontology" submitted by Dr. Vineetha Vijayakumar, Postgraduate of Department of Oral Medicine and Radiology, SMIDS has been approved by the Institutional Human Ethics Committee at its meeting held on 19th of December 2013.

[This Institutional Human Ethics Committee is organized and operates according to the requirements of ICH-GCP/GLP guidelines and requirements of the Amended Schedule-Y of Drugs and Cosmetics Act, 1940 and Rules 1945 of Government of India.]

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES ★ KULASEKHARAM ★
IHEC Date 27/12/2013

Dr. Rema Menon. N
Member Secretary
Institutional Human Ethics Committee
Professor of Pharmacology and HOD
SMIMS, Kulasekharam [K.K District]
Tamil Nadu -629161

CONSENT FORM -1

PART 1 OF 2

INFORMATION FOR PARTICIPANTS OF THE STUDY

Dear Volunteers,

We welcome you and thank you for your keen interest in participation in this research project. Before you participate in this study, it is important for you to understand why this research is being carried out. This form will provide you all the relevant details of this research. It will explain the nature, the purpose, the benefits, the risks, the discomforts, the precautions and the information about how this project will be carried out. It is important that you read and understand the contents of the form carefully. This form may contain certain scientific terms and hence, if you have any doubts or if you want more information, you are free to ask the study personnel or the contact person mentioned below before you give your consent and also at any time during the entire course of the project.

1.Name of the Principal Investigator:

Dr. Vineetha Vijayakumar
Second Year Post Graduate student
Department of Oral Medicine and Radiology,
Sree Mookambika Institute of Dental Sciences,
Kulasekharam, KanyaKumari District-629161

2.Name of the Guide:

Dr. P. G. Agnihotri, MDS , Professor
Department of oral medicine and Radiology.
Sree Mookambika Institute of Dental Sciences.
Kulasekharam, KanyaKumari District-629161

3.Name of the Co-Guide:

Dr. Hema .G, MDS, Reader
Department of oral medicine and Radiology.
Sree Mookambika Institute of Dental Sciences
Kulasekharam, Kanya Kumari District-629161

4.Institute:

Sree Mookambika Institute of Dental Sciences,
V.P.M Hospital complex, Padanilam , Kulasekharam,
Kanyakumari – 629161
Tamilnadu.

5.Title of the study:

"Human Bite Marks-A Diagnostic Tool In Forensic odontology"

6.Background information:

It is believed that recognizing the left out vital signs after the incidence or accident is helpful in arriving at conclusion for the treatment purpose and also for the academic recording and studying about the forensic odontology.

7.Aims and Objectives:

- To analyze the human bite mark for establishing evidence.
- Study on details of evidence collection techniques and step by step method to analyze the bite mark .

8.Scientific justification of the study:

We as oral diagnosticians are interested in knowing more and more information regarding forensic odontology. The newer methods adopted in identifying the bite marks needs to be studied in detail. We will be helping medico legal cases for better treatment and justice to be given to them.

9.Procedure for the study:

Once you are enrolled into the study a roll number will be implemented to represent the name. They will be asked to bite on the surface of apple with a force so that they could produce bite marks on that surface. These bite marks will be photographed immediately with a digital camera with inbuilt flash and without flash. These photographs will be made life size using Adobe™ Photoshop software. Prints will be taken on the photographic papers. Dental casts of the volunteers will be made using best material for this purpose and. Negatives will be prepared with alginate powder and positives will be prepared with dental stone. Plaster of Paris will be used

to make bases of the casts. All the casts will be scanned using 3D scanners .Life size photographs will be superimposed by transparent overlays and compared .

10.Expected risks for the participants: Not Applicable

11.Expected benefits of research for the participants: Not Applicable

12.Maintenance of confidentiality:

- You have the right to confidentiality regarding the privacy of your medical information (Personal details, results of physical examinations, investigations, and your medical history).
- By signing this document, you will be allowing the research team investigators, other study Personnel, sponsors, institutional ethics committee and any person or agency required by law to view your data, if required.
- The results of clinical tests and therapy performed as part of this research may be included in your medical record.
- The information from this study, if published in scientific journals or presented at scientific meetings, will not reveal your identity.

13.Why have I been chosen to be in this study?

Chosen because of grouping under the inclusion and exclusion criteria.

Need of good sampling size.

No invasive procedure that harm your health and helps in diagnosis and helpful for the society.

14.How many people will be in the study? 30 student volunteers

15.Agreement of compensation to the participants (In case of a study related injury):

Patient will be taken care in case of complication and medical treatment will be provided in the institution.

16.Anticipated prorated payment, if any, to the participant(s) of the study: No

17.Can I withdraw from the study at any time during the study period?

- The participation in this research is purely voluntary and you have the right to withdraw from this study at any time during the course of the study without giving any reasons.
- However, it is advisable that you talk to the research team prior to stopping information.

18.If there is any new findings / information ,would I be informed ?

Yes

19.Expected duration of the participant's participation in the study:

1 year

20.Any other pertinent information:

21.Whom do I contact for further information?

For any study related queries, you are free to contact :

Dr. Vineetha Vijayakumar
Second Year Post Graduate student.
Department of Oral Medicine and Radiology,
Sree Mookambika Institute of Dental Sciences,
Kulasekharam, KanyaKumari District-629161.
Mobile No: 07708326267
vineethanta@yahoo.in

Place:Kulasekharam

Date: **Signature of Principal Investigator**

Signature of the participant

CONSENT FORM

PART 2 OF 2

PARTICIPANTS CONSENT FORM

The details of the study have been explained to me in writing and the details have been fully explained to me. I am aware that the results of the study may not be directly beneficial to me but will help in the advancement or medical sciences. I confirm that I have understood the study and had the opportunity to ask questions. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). I have been given an information sheet giving details of the study. I fully consent to participate in the study titled 'Human Bite Marks - A Diagnostic Tool In Forensic Odontology

Serial no / Reference no:

Name of the participant:
Address of the participant:

Contact number of the participant:

Signature / thumb impression of participant/Legal guardian

Witnesses:

1.

2.

Date:

Place:

ஒப்புதல் படிவம்

பகுதி 1 - 2

ஆய்வில் பங்கேற்பவருக்கான படிவம்

மதிப்பிற்குரிய தன்னார்வலரே,

தாங்கள் இந்த ஆய்வில் பங்கேற்க வந்தமைக்கு நன்றி, இந்த ஆய்வில் பங்கேற்பதற்கு முன் இந்த ஆய்வின் முக்கியத்துவம் மற்றும் தன்மை அறிந்து கொள்ள வேண்டும். இந்த படிவம் ஆய்வின் முழுவிபரங்களையும் உங்களுக்கு தெரிவிக்கும். ஆய்வில் பங்கேற்பதற்கு முன் இந்த படிவத்தை முழுவதும் படித்து புரிந்து கொண்ட பின் பங்கேற்க வேண்டும். இந்த படிவத்தில் சில மருத்துவ மற்றும் அறிவியல் சொற்கள் உள்ளன. ஆதலால் எதேனும் சந்தேகங்கள் ஏற்பட்டால் இந்த படிவத்தின் இறுதியில் குறிப்பிட்டுள்ள நபரிடம் ஆய்வில் பங்கேற்பதற்கு முன் தெளிவு பெற வேண்டும்

1. <u>ஆய்வாளர்</u>

மரு. வினிதா விஜயகுமார்
முதுகலை பட்டதாரி
ஓரல் மெடிசின் மற்றும் ரேடியோலஜி
ஸ்ரீ மூகாம்பிகா பல் மருத்துவமனை கல்லூரி, குலசேகரம்.
கன்னியாகுமரி.

2. <u>வழிகாட்டி</u>

மரு. பி.ஜி. அக்கினி கோத்திரி
பேராசிரியர், தலைமையாளர்
ஓரல் மெடிசின் மற்றும் ரேடியோலஜி
ஸ்ரீ மூகாம்பிகா பல் மருத்துவமனை கல்லூரி, குலசேகரம்.
கன்னியாகுமரி.

3. <u>துணை வழிகாட்டி</u>

மரு. ஹேமா. ஜி.
ரீடர் (துணை பேராசிரியர்)
ஓரல் மெடிசின் மற்றும் ரேடியோலஜி
ஸ்ரீ மூகாம்பிகா பல் மருத்துவமனை கல்லூரி, குலசேகரம்.
கன்னியாகுமரி.

4. <u>ஆய்வு நிலையம்</u>

ஸ்ரீ மூகாம்பிகா பல் மருத்துவமனை கல்லூரி, குலசேகரம்,
கன்னியாகுமரி மாவட்டம். தமிழ்நாடு.

5. **தலைப்பு** : "மனித பற்களின் கடிதடம்" ஒரு பற்களின் தடையவியல் கருவி

6. ஆய்வின் பின்பலம்:

ஒரு நிகழ்வு மற்றும் விபத்தில் ஏற்படும் தடையங்கள் அந்த நிகழ்வின் தன்மை மற்றும் தீர்வுகளையும் கணக்கிட உதவும் என்னும் கோட்பாடுகள் நிலவுகின்றது. இவ்வாறு ஏற்படும் தடையங்கள் நிகழ்வின் காரணத்தை கண்டறியவும் இத்துறையின் வளர்ச்சிக்காக பயன்படும்.

7. குறிக்கோள் :

- மனிதனின் பல் அடையாளங்களை கொண்டு ஒரு தனி நபரை கண்டுபிடித்தல்
- பற்களின் கடி அடையாளத்தை எவ்வாறு எடுத்தல் மற்றும் கடியின் அளவு மற்றும் பாதிப்பை அறிதல்.

8. அறிவியல் பின்பலம் (சான்று) :

நாம் பல் மற்றும் அதனை சார்ந்த நோய் பற்றி தெரிந்து கொள்வதால், நாம் பற்களின் கடிபட்ட அளவை எவ்வாறு பதிவு செய்தல் மற்றும் அதன் முன்னேற்றத்திற்கு வழி செய்ய முடியும். சில மருத்துவம் சார்ந்த பிரச்சனைகளுக்கு தீர்வுகாண முடியும்.

9. செயல்முறை :

- ❖ தாங்கள் இந்த ஆய்வில் பங்கு பெற்றபின் தனி இலக்க எண் கொடுக்கப்படும்.
- ❖ வாய் தூய்மையான நீரால் சுத்தம் செய்து கொள்ளவும்.
- ❖ பின்பு ஒரு ஆப்பிள் பழத்தில் கடிக்க வேண்டும். (முன் பல் பதியும் அளவிற்கு)
- ❖ புகைப்படம் எடுக்கப்படும்.
- ❖ ஆல்ஜினேட் என்னும் கைட்ரோகுலோய்ட் மூலம் அளவு எடுத்து அச்சு பெறப்படும்

10. எதிர்மறை விளைவுகள் : இல்லை

11. ஏற்படும் நன்மைகள் :

- ஆய்விற்காக பணம் எதுவும் தர தேவையில்லை
- ஆய்வின் முடிவுகளை நீங்கள் அறிந்து கொள்ளலாம்.

12. தகவ ன் பாதுகாப்பு :

- ➢ உங்களுடைய தகவல்கள் அனைத்தும் பாதுகாக்கப்படும் எந்த நிலையிலும் வெளியிடப்படாது.
- ➢ நீங்கள் இந்த ஆய்வில் பங்கேற்றபின் எங்களது ஆய்வாளர் உங்களுடைய தகவல்களை தெரிந்து கொள்ள முடியும். மேலும் தேவை ஏற்பட்டால் எத்திக்கல் கமிட்டியிடமும் காண்பிக்கப்படும்.

- ஆய்வின் முடிவுகள் உங்களுடைய மருத்துவ தகவல் படிவத்தில் (கோப்பில்) பதிவு செய்யப்படும்.
- இந்த ஆய்வு முடிவு வெளியிடப்படும் பொழுது உங்களது தகவல்கள் வெளியிடப்படாது.

13. இந்த ஆய்வில் நீங்கள் சேர்வதற்கான காரணம்?

- நீங்கள் இந்த ஆய்வின் சேர்ப்பு மற்றும் விடுப்பு வகுப்புகளின் உள் அமையப்படுவதால்
- ஆய்வின் தேவையான மாதிரிக்காகவும்
- சமூகத்தின் மற்றம் மருத்துவ முன்னேற்றத்திற்காக

14. ஆய்வின் மாதிரி எண்ணிக்கை : 20

15. நஷ்டயீடு :

ஆய்வில் ஏற்படும் மாற்றங்களுக்கான சிகிட்சை ஆய்வு நிலையத்தில் வழங்கப்படும்.

16. நஷ்டயீடு பணம் : பணம் எதுவும் வழங்கபடாது.

17. ஆய்வில் இருந்து எந்த நேரத்திலும் எந்த காரணமும் இன்றி விலகலாம்

18. ஆய்வின் முன்னேற்றத்தில் ஏற்படும் மாற்றங்கள் தெரிவிக்கப்பட வேண்டும்

19. ஆய்வின் கால அவகாசம் : ஒரு ஆண்டு

20. வேறு எந்த தகவல்களும் தேவை இல்லை

21. தொடர்பு கொள்ள வேண்டிய நபர் :

மரு. வினிதா விஜயகுமார்

முதுகலை பட்டதாரி,

ஒரல் மெடிசின் மற்றும் ரேடியோலஜி,

ஸ்ரீ மூகாம்பிகா பல் மருத்துவமனை கல்லூரி, குலசேகரம்.

தொலைபேசி எண் ***7708326267***

மின் அஞ்சல் : vineethanta@yahoo.in

இடம் :

ஆய்வாளர் கையொப்பம்

தேதி :

பங்குபெறுபவர் கையொப்பம்

ஒப்புதல் படிவம்

பாகம் : 2

பங்குபெறுபவரின் ஒப்புதல் படிவம்

இந்த ஆய்வின் முழு விபரங்களும் எழுத்து மூலமாகவும், விரிவாகவும், என்னிடம் கூறப்பட்டது. எனக்கு இந்த ஆய்வின் விளைவுகள் எந்த பயனும் தரவில்லை என்றாலும், மருத்துவ அறிவிய ன் மேம்பாட்டிற்காக பயன்படுத்தப்படும் என்று அறிவேன். நான் இந்த ஆய்வில் எந்த நிர்பந்தமும் இல்லாமல் பங்குபெறுகிறேன். மேலும் இந்த ஆய்வின் எல்லா விதிகள் மற்றும் விதிமுறைகளையும் அறிவேன். எந்த சந்தோகத்திற்கும் கேள்வி கேட்கவோ அல்லது ஆய்வில் இருந்து விலகவோ எல்லா உரிமைகளும் எனக்கு உண்டு என்று அறிவேன். இந்த ஆய்வின் விளைவுகள் எந்த அறிவியல் பயன்பாட்டிற்கும் பயன்படுத்த எனக்கு தடையில்லை. எனக்கு இதற்கு முன்பாக ஆய்வின் தகவல் படிவம் கொடுக்கப்பட்டது. எனக்கு இந்த ஆய்வில் பங்குபெற முழு சம்மதம்.

ஆய்வின் பெயர் :

''மனித பற்களின் கடிதடம்'' ஒரு பற்களின் தடையவிய ன் கருவி

குறிப்பு எண் :
பெயர் :
முகவரி :
தொலைபேசி எண் :

கையொப்பம்

சாட்சி : 1

2

இடம் :
தேதி :

സമ്മതപത്രം - 1

പഠനവുമായി സഹകരിക്കുന്ന വ്യക്തികളുടെ അറിവിലേയ്ക്ക്

പ്രിയപ്പെട്ട സന്നദ്ധ സേവകൻ/സേവക,

ഞങ്ങൾ നിങ്ങളെ സ്വാഗതം ചെയ്യുന്നു. അതോടൊപ്പം ഈ പഠനവുമായി സഹകരിക്കാനുള്ള സന്നദ്ധതയോട് നന്ദി രേഖപ്പെടുത്തുന്നു. നിങ്ങൾ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിന് മുൻപ് ഈ പഠനം എന്തിനാണ് നടത്തപ്പെടുന്നത് എന്ന് അറിയേതു്. അതിനാൽ ഈ ഫോറത്തിൽ ഗവേഷണപഠനത്തിന്റെ വിവരങ്ങളും മറ്റും വിശദമായി രേഖപ്പെടുത്തിയിരിക്കുന്നു. ഈ പഠനത്തിന്റെ രീതി, ഉദ്ദേശം, പ്രയോജനം, അപകടസാദ്ധ്യത, ക്ലേശം, മുൻകരുതൽ, എങ്ങനെ ഈ പഠനം മുൻപോട്ടു കൊുപോകുന്നു എന്നിങ്ങനെ എല്ലാ വിവരങ്ങളും ഫോറത്തിൽ രേഖപ്പെടുത്തിയിരിക്കുന്നു. സദയം ഈ വിവരങ്ങൾ വായിച്ചു മനസ്സിലാക്കുവാൻ അഭ്യർത്ഥിക്കുന്നു. ഈ വിവരങ്ങളിൽ ശാസ്ത്രപരമായ പദങ്ങൾ ഉള്ളതിനാൽ സംശയനിവാരണത്തിനു പ്രധാന പഠനകർത്താവിനോടോ താഴെ രേഖപ്പെടുത്തിയിരിക്കുന്ന വ്യക്തികളോടോ ഫോറം ഒപ്പിടുന്നതിനു മുൻപോ അല്ലെങ്കിൽ ഈ പഠനത്തിന്റെ കാലാവധി തീരുന്നവരെയോ സമീപിക്കാവുന്നതാണ്.

1. **പ്രധാന പഠനകർത്താവ്/ഗവേഷക**

ഡോ. വിനീത വിജയകുമാർ
ബിരുദനാന്തര ബിരുദ വിദ്യാർത്ഥി
ഡിപ്പാർട്ട്മെന്റ് ഓഫ് ഓറൽ മെഡിസിൻ ആന്റ് റേഡിയോളജി,
ശ്രീ മൂകാംബിക ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് ഡെന്റൽ സയൻസസ്,
വി.പി. എം. ഹോസ്പിറ്റൽ കോംപ്ലക്സ്, പടനിലം
കുലശേഖരം, കന്യാകുമാരി - 629 161

2. **പ്രധാന മാർഗ്ഗദർശി**

ഡോ. പി.ജി അഗ്നിഹോത്രി,
പ്രൊഫസർ, ഡിപ്പാർട്ട്മെന്റ് ഓഫ് ഓറൽ
മെഡിസിൻ ആന്റ് റേഡിയോളജി
ശ്രീ മൂകാംബിക ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് ഡെന്റൽ സയൻസസ്,
വി.പി. എം. ഹോസ്പിറ്റൽ കോംപ്ലക്സ്, പടനിലം
കുലശേഖരം, കന്യാകുമാരി - 629 161

3. **സഹമാർഗ്ഗദർശി**

ഡോ. ഹേമ.ജി.
റീഡർ
ഡിപ്പാർട്ട്മെന്റ് ഓഫ് ഓറൽ
മെഡിസിൻ ആന്റ് റേഡിയോളജി
ശ്രീ മൂകാംബിക ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് ഡെന്റൽ സയൻസസ്,
വി.പി. എം. ഹോസ്പിറ്റൽ കോംപ്ലക്സ്, പടനിലം
കുലശേഖരം, കന്യാകുമാരി - 629 161

4. **പഠനകേന്ദ്രം**

ശ്രീ.മൂകാംബിക ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ്
ഡെന്റൽ സയൻസ്, വി.പി.എം.
ഹോസ്പിറ്റൽ കോംപ്ലക്സ്, പടനിലം,
കുലശേഖരം, കന്യാകുമാരി 629 161

5. **പഠനത്തിന്റെ ശീർഷകം**

" കടി അടയാളങ്ങൾ" - ഫോറൻസിക് ഓഡൻറ്റോളജിയിലെ ഒരു നിർണയ ഉപകരണം

6. **പശ്ചാത്തല വിവരം:** നിയമനടപടികൾ ആവശ്യമായ മെഡിക്കൽ കേസുകളിൽ യഥാർത്ഥ നിഗമനത്തിലേയ്ക്ക് എത്തിച്ചേരാനും, അതുവഴി ചികിത്സയ്ക്കും, പഠനാവശ്യങ്ങൾക്കും, ഫോറൻസിക് ഓഡന്റോളജി എന്ന വിഭാഗത്തെ പഠിക്കാനും, അപകട സ്ഥലത്തോ സംഭവ സ്ഥലത്തോ അവശേഷിക്കുന്ന തെളിവുകളുടെ കത്തെൽ സഹായിക്കുന്നു.

7. **ലക്ഷ്യങ്ങളും ഉദ്ദേശങ്ങളും:** 1) നിയമനടപടികൾ ആവശ്യമുള്ള മെഡിക്കൽ കേസുകളിൽ ഒരു മനുഷ്യനാൽ മറ്റൊരാൾക്ക് ഏൽക്കുന്ന കടിഅടയാളങ്ങൾ കുപിക്കുക

2) തെളിവ് ശേഖരണ മാർഗ്ഗങ്ങളും കടിയടയാളങ്ങൾ മൂലമുള്ള മുറികുവകളും പടിപടിയായി വിശകലനം ചെയ്തു കുപിടിക്കുന്നു.

8. **ഗവേഷണം നടത്തുവാനുള്ള ന്യായീകരണം:** 1) ദന്തരോഗങ്ങൾ നിർണ്ണയിക്കുന്നവർ എന്ന നിലയിൽ നമ്മൾ ഫോറൻസിക് ഓഡൻറ്റോളജി എന്ന വിഭാഗത്തെപ്പറ്റി കൂടുതൽ അറിയാൻ താത്പര്യപ്പെടുന്നു. കടിയടയാളങ്ങൾ കുപിടിക്കാനുതകുന്ന പുതിയമാർഗ്ഗങ്ങളെപ്പറ്റി വിശദമായി പഠിക്കേതു്. അതുവഴി നിയമനടപടികൾ ആവശ്യമായ മെഡിക്കൽ കേസുകളുടെ മെച്ചപ്പെട്ട ചികിത്സയും നീതിയും ഉറപ്പു വരുത്തുവാൻ സഹായിക്കുന്നു.

9. **പഠനരീതി:**

1) പഠനത്തിന്റെ ഭാഗമായി വ്യക്തിക്ക് ഒരു നമ്പർ നൽകുന്നതാണ്.
2) നിങ്ങളുടെ മുഴുവൻ വിവരങ്ങളുമടങ്ങിയ Case History രേഖപ്പെടുത്തുന്നതാണ്.
3) ആവശ്യമെങ്കിൽ പരിശോധന നടത്തപ്പെടുത്തുന്നതാണ്
4) ആവശ്യാനുസരണമായി ചിത്രങ്ങൾ എടുക്കുന്നതാണ്.
5) താങ്കളോട് ഒരു ആഫ്പിളിൽ കടിക്കാൻ ആവശ്യപ്പെടുന്നു.
6) ആഫ്പിളിൽ പതിഞ്ഞിട്ടുള്ള കടിയടയാളങ്ങളുടെ ചിത്രം ഡിജിറ്റൽ ക്യാമറയിൽ എടുക്കുന്നു.
7) കംപ്യൂട്ടറുകളുടെ സഹായത്തോടെ ഈ ചിത്രത്തെ വിശകലനം ചെയ്യുന്നു.
8) ഫോട്ടോ പേഫ്പറിൽ ഇത് പ്രിന്റ് ചെയ്യുന്നു.
9) ആൾജിനേറ്റ് ഉപയോഗിച്ച് താങ്കളുടെ വായുടെ അളവ് എടുക്കുന്നു.
10) താങ്കളുടെ വായുടെ അളവിൽ മോഡലുകൾ തയ്യാർ ചെയ്തെടുക്കുന്നു. ഇതിന്റെയും ചിത്രങ്ങൾ എടുക്കുന്നു.
11) അതിനുശേഫ്പം കംപ്യൂട്ടറുകളുടെ സഹായത്തോടെ ഈ ചിത്രങ്ങളുടെ താരതമ്യം നടത്തുന്നു.

10) **പ്രതീക്ഷിക്കുന്ന അപകടസാദ്ധ്യതകൾ:**

ഇല്ല.

11) **പ്രതീക്ഷിക്കാവുന്ന പ്രയോജനങ്ങൾ:**

1) ലാബ് ടെസ്റ്റുകൾക്ക് നിങ്ങൾ തുക നൽകേതില്ല
2) നിങ്ങൾക്ക് ഈ ഗവേഷണത്തിന്റെ വിവരങ്ങൾ തിരക്കാവുന്നതാണ്.

12) **വ്യക്തിവിവരങ്ങളുടെ സ്വകാര്യത:**

1) രോഗവിവരങ്ങളും മറ്റ് വ്യക്തിവിവരങ്ങളും സ്വകാര്യമായി സൂക്ഷിക്കപ്പെടുന്നതായിരിക്കും
2) ഈ ഫോറത്തിൽ ഒപ്പിടുന്നത് വഴി നിയമം അനുശാസിക്കുന്ന രീതിയിൽ പഠനത്തിൽ ഉൾപ്പെടുന്ന വ്യക്തികൾക്ക് നിങ്ങളുടെ വിവരങ്ങൾ പരിശോധിക്കാവുന്നതാണ്.
3) ഈ പഠനത്തിന്റെ വിവരങ്ങൾ ശാസ്ത്രാനുപാധികളായ പ്രസിദ്ധീകരണങ്ങളിലോ, കൂടി ആലോചനകളിലോ വെളിപ്പെടുത്തമ്പോൾ നിങ്ങളുടെ സ്വകാര്യത സൂക്ഷിക്കപ്പെടുന്നതാണ്

13) **എന്തുകൊ് നിങ്ങൾ തിരഞ്ഞെടുക്കപ്പെട്ടു?**

1) പഠനത്തിന് നല്ല ശതമാനം ആളുകൾ ആവശ്യമാണ്.
2) പല കൂട്ടിക്കുറച്ചിലുകൾക്കൊടുവിൽ നിങ്ങൾ ഉൾപ്പെടുന്ന വിഭാഗത്തെ തിരഞ്ഞെടുത്തു
3) നിങ്ങളുടെ സഹകരണം മൂലം സമൂഹത്തിന് സഹായവും നന്മയും ഉാകുന്നു.

14) **എത്ര ആളുകൾ ഈ പഠനത്തിൽ ഉൾപ്പെടുന്നു?**

20

15) **നഷ്ടപരിഹാര ഉടമ്പടി? (പഠനവുമായി ബന്ധപ്പെട്ട് എന്തെങ്കിലും പരിക്കുായാൽ)**

പഠനവിധേയമായി ഏതെങ്കിലും തരത്തിൽ രോഗം സങ്കീർണ്ണമായാൽ രോഗിയെ ഈ സ്ഥാപനത്തിൽ വിദഗ്ദ്ധ ചികിത്സക്കു വിധേയനാക്കുന്നതാണ്.

16) **ഏതെങ്കിലും വിധത്തിൽ വേതനം ലഭിക്കുമോ?**

ഇല്ല

17) **എപ്പോൾ വേണമെങ്കിലും എനിക്ക് ഈ പഠനത്തിൽ നിന്ന് പിൻമാറാമോ?**

കാരണം വ്യക്തമാക്കാതെ എപ്പോൾ വേണമെങ്കിലും നിങ്ങൾക്ക് ഈ പഠനത്തിൽ നിന്നും പിന്മാറാവുന്നതാണ്. എങ്കിലും അതിന് മുൻപായി ഗവേഷകരുമായി സംസാരിക്കുന്നത് നല്ലതാണ്.

18) **പഠനവുമായി ബന്ധപ്പെട്ട എന്തെങ്കിലും പുതിയ വിവരങ്ങൾ ഉങ്കിൽ എന്നെ അറിയിക്കുന്നതാണോ?**

അതെ

19) **പ്രതീക്ഷിക്കുന്ന പഠനകാലാവധി ?**

ഒരു വർഷം

20) **മറ്റെന്തെങ്കിലും വിവരം ?**

ഇല്ല

21) **വിവരങ്ങൾക്ക് ബന്ധപ്പെടേത് ആരെ?**

ഡോ. വിന്നീത വിജയകുമാർ
ബിരുദാനന്തര ബിരുദ വിദ്യാർത്ഥി/നി
ഡിപ്പാർട്ട്മെന്റ് ഓഫ് ഓറൽ മെഡിസിൻ ആന്റ് റേഡിയോളജി
ശീ മൂകാംബിക ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് ഡെന്റൽ സയൻസസ്,
വി.പി. എം. ഹോസ്പിറ്റൽ കോംപ്ലക്സ്, പടനിലം
ഡോ. വിന്നീത വിജയകുമാർ- 07708326267
ഇ.മെയിൽ,ഐ.ഡി.: Vineethanta@yahoo.in

സ്ഥലം: **പ്രധാന ഗവേഷകന്റെ ഒപ്പ്**

തീയതി **സന്നദ്ധ സേവകൻ/ സേവക**

സമ്മതപത്രം - 2

ഈ പഠനത്തിലുള്ള എന്റെ പങ്കാളിത്തം സ്വന്തം താൽപര്യപ്രകാരം മാത്രമാണെന്നും, എപ്പോൾ വേണമെങ്കിലും ചോദ്യങ്ങൾ ബന്ധപ്പെട്ടവരോട് ചോദിക്കാമെന്നും, ഈ പഠനത്തിൽ നിന്നും കാരണം രേഖപ്പെടുത്താതെ എപ്പോൾ വേണമെങ്കിലും എനിക്ക് പിൻവാങ്ങാമെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. ഈ പഠനാവസാനം വെളപ്പെടുന്ന അറിവുകളും, രേഖകളും, ശാസ്ത്രപരമായ ഉദ്ദേശങ്ങൾക്കു ഉപയോഗിക്കാൻ ഞാൻ സമ്മതിക്കുന്നു. പഠനോദ്ദേശം വിവരിക്കുന്ന വിശദാംശങ്ങൾ നൽകിയിട്ടു്. "കടി അടയാളങ്ങൾ ഫോറൻസിക് ഒഡൻറ്റോളജിയിലെ ഒരു നിർണ്ണായ ഉപകരണം" എന്ന ഈ പഠനവുമായി സഹകരിക്കാൻ എന്റെ പരിപൂർണ്ണ സമ്മതം അറിയിക്കുന്നു.

ഡോ.വിനീത വിജയകുമാർ

പേര് (സന്നദ്ധ സേവകൻ/സേവക)
ബന്ധപ്പെടാനുള്ള നമ്പർ

സന്നദ്ധ സേവകന്റെയോ/
സേവകയുടെയോ വിലാസം

സാക്ഷികൾ

1.

2.

ഒപ്പ്/വിരൽ അടയാളം
(സ്വന്തം/നിയമപരായ
സംരക്ഷകൻ)

തീയതി:

സ്ഥലം:

CASE RECORD FORM

Name :

Age : OP No :

Sex : Date :

Occupation :

Address :

Family History :

Personal History :

a) Marital Status

b) Type of personality

c) Diet

d) Appetite

e) Habits (areca nut , pan , smoking , alcohol , others)

Examination

A)General examination :

1.Gait

2.Built & nourishment

3.Vital Signs(temperature , B.P , respiratory rate , pulse rate)

4.Skin

5.Hair

6.Nails

7.Fingers

8.Eyes

9.Pedal edema

10.Lymphadenopathy

B)Extra Oral examination :

1. Face

2.Jaws

3.TMJ

4.Regional Lymphadenopathy

C)Intra Oral examination

Soft Tissue

1.Lips

2.Labial Mucosa

3.Buccal Mucosa

4.Palate

5.Oropharynx

6.Floor of the mouth

7.Tongue

8.Gingiva

Hard Tissue

1.Dental formula

2.Regressive Changes

3.Mobility

4.Fractures

5.Rotation

6.Other findings (Mesial drift , Supra eruption)

Provisional Diagnosis :

EXAMINATION OF THE BITE MARK

1.Type of food stuff :

2.Shape of bite mark :

3.Surface contour : flat/curved/irregular :

INTEROBSERVER ANALYSIS -

SL. NO		UPPER LEVELS						LOWER LEVELS					
1.													
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