Forensic Examination of Bite marks – State of the Art.

Article · August 2005

3 authors:

Rakesh Gorea
Gian Sagar Medical College

O P Jasuja
Chandigarh University

Gagandeep Singh
Guru Angad Dev Veterinary and Animal Sciences University

Derleme

FORENSIC EXAMINATION OF BITE MARKS-STATE OF THE ART

ADLİ ISIRIK İZİ İNCELEMESİ – SON TEKNİKLER

Prof. Dr. Kumar Rakesh Gorea*
Gagandeep Singh**
Prof. Dr. Om Prakash Jasuja***

Adli Bilimler Dergisi / Turkish Journal of Forensic Sciences, 4 (3): 59 - 66, 2005

ABSTRACT

Bite mark analysis has been an integral part of crime investigations. The identification and analysis of bite marks presents particular problems for the forensic scienctist. While the technology in forensic bite mark analysis has reached quite a sophisticated level, still a universal and objective approach is lacking in this particular field. Using a literature review, several aspects of analytical work, which has been carried out over a period of time as well as the present scenario, has been assessed. The importance of bite mark registration materials, recording of bite mark evidence, analysis and legal status has been discussed in detail, specifically for in-depth analysis of state of the art in the forensic bite mark analysis.

Keywords: Bite mark, identification forensic odontology.

ÖZET

Isırık izi analizleri suç araştırmalarının önemli bir kısmını oluşturmaktadır. Isırık izinden yapılan kimliklendirme ve analizler adli bilimciler için özel problemler ortaya koyar. Adli ısırık izi analizlerinde teknoloji gelişmiş bir seviyeye ulaşmış olsada, bu özel alanda halen evrensel ve objektif yaklaşımlar eksiktir. Bu konuda kaynaklar gözden geçirilerek, uzun süredir uygulanan analitik işlerin çeşitli yönleri ile günümüzün uygulamaları değerlendirilmiştir. Özellikle adli ısırık izi analizlerinde; ısırık izi kayıt materyallerinin önemi, ısırık izi delillerinin kaydı, analiz ve adli durumun değerlendirilmesi derinlemesine detaylı bir şekilde tartışılmıştır.

Anahtar Kelimeler: Isırık izleri, kimliklendirme, adli diş hekimliği.

Introduction

Human teeth are basically designed to cut and grind food, but some people revert to more primitive instincts and use their teeth to inflict bites on unsuspecting victims, thus, producing bite marks (1). Bite marks can be defined as a physical alteration in a medium caused by the contact of teeth. In criminological cases and researches, bite mark data obtained directly from skin, wax, models and indirectly from record photographs & scanned images are regarded as the objective evidences close to the fingerprints for identity determination (2). Bite mark evidence has become accepted as a powerful tool in the investigation of crime, but still the universal applicability is lacking in the field and there is a need to develop more objective methods of analysis of bite mark evidence. In recent times, hand drawn acetate overlays have given

* Professor, Department of Forensic Medicine and Toxicology,Govt. Medical College, Patiala, INDIA
** Junior Research Fellow, Department of Forensic science, Punjabi University, Patiala INDIA
*** Professor, Department Of Forensic Science, Punjabi University, Patiala INDIA

way to computer assisted analytical techniques. The most recent development in the field is that of 3D/CAD supported photogrammetry (FPHG) based on tooth-to-tooth and arch-to-arch comparison (3). The state of the art in forensic bite mark analysis has progressed beyond its earlier roots to the point of using sophisticated instrumentation and in providing more positive and objective results.

The central dogma of bite mark analysis is based upon two assumptions i.e. human teeth are unique and sufficient details are transformed to biting surface, which aids in identification (4). But the validity of bite mark evidence has been challenged over the years, citing the reason that bite marks cannot be treated as the true representative of an individual's denture due to lesser number of participating teeth and consequently, a healthy scientific skepticism surrounding bite marks has developed.

American board of forensic odontology (ABFO) and British association of forensic odontology (BAFO) are the premier bodies, which governs the various parameters of bite mark analysis. More particularly, ABFO has laid down certain guidelines regarding the bite mark analysis, formulated during Bite mark workshop of ABFO, in Anaheim, California (1984) and ABFO bite mark workshop #2 held in the year 1993(5, 6).

Analysis: The majority of techniques employed for forensic bite mark analysis are emphasizing on comparative studies .The simplest of the techniques employed included hand drawn acetate overlays, which were prepared by simply holding an acetate sheet over the bite mark surface and drawing the details (7). Another analytical method included inking of the occlusal surface of teeth, which were then placed on the white board and subsequently photographed (8). This technique is still in use for court exhibits for bite mark comparisons. Computerization of all these techniques is taking place these days, which has increased the reliability of the results obtained from these techniques.

The three dimensional measurement of tooth impression using the stereo microscope for measuring third dimension of bite marks has been reported (9). Later on, scanning electron microscope was also used for investigation of bite marks in foodstuffs and other materials (10, 11). Examination of the bite marks by virtue of simple visual description, stereo-photography, stereo-metric graphic plotting and reflex microscopy has also been reported (12, 13). Microscopy in the bite mark analysis is playing more of an adjunctive role.

The use of the statistical methods in the bite mark analysis has also been cited, which was used to determine the number of individuals capable of producing the bite, and the results were later presented in the court (14, 15). The study was carried out in the Scotland and it is worth noting that half of he Scottish population was edentulous at that time.

Radiographic analysis of bite marks is also one of the used techniques but its limited use has been reported (16) which includes the comparison of radiographs for studying occlusal arch form and individual tooth position. Soft-tissue carrying the bite marks were removed from the cadavers and subsequently, radiographed. This technique has not been extensively used due to its complexity. A technique involving the comparison of bite mark photographs with the radiographs of Amalgam filled dental casts is also reported (17).

Computer assisted bite mark analysis first came into being when it was used for establishing the dental "uniqueness", even in case of identical twins (18). The techniques are utilized for generating digital bite mark

overlays (19, 20) using computer software like ADOBE PhotoShop 6.0, a desktop computer and a flat bed scanner, in one of the techniques (21). Also, by using a scanner and an image processing software, a three dimensional model of bitten object can be transferred to a two-dimensional image, which can be easily analyzed (2). Photographed bite mark evidence can also be digitally rectified and resizing correction can be done, so as to transform it into a true representative of its true shape and dimension.

For quantitative analysis of bite marks, a Shape Comparison Interactive Programme (SCIP) has been developed (22, 23) in form of a similarity index (SI) between the offender's teeth and bite marks produced on wax, foodstuffs and human skin under experimental conditions.

DNA analysis can also be done from the bite marks by extracting the same from saliva collected from bite mark by a number of techniques named organic (phenol-chloroform) extraction, Chelex extraction and a modified chelex method (24).

A novel aspect of bite mark analysis involves the microbiological/histological/histochemical methods (25). Saliva collected from the bite marks is analyzed for a particular strain of bacteria i.e. Streptococcus salivarius (26). As viable bacteria can be sampled even after approx.6.25 hours from the bite marks, this can be used for individualization purposes. Recent studies antagonize the previous results quoting that more than one thousand viable organisms can be recovered after 24 hours of biting (27), provided the site remains relatively undisturbed. The "Genomic profiles" (DNA "fingerprints") of bacteria recovered from the bite marks can be identified exclusively with those from teeth of responsible individual. Findings suggested that bacterial genotypic approach to bite mark analysis could have forensic applications in situations where the perpetrator's DNA cannot be recovered from an oral contact site (27). The most recent technique employing the computers is a 3-D documentation, analysis and visualization approach based on 3D/CAD-supported photogrammetry coupled with the scanner (3). It involves the documentation of whole data with a metric 3-D measurement, orientation and analysis in 3-D space. The technique can also be utilized for studying topographical 3-D features of individual tooth.

BITE MARK-REGISTERING MATERIALS

Bite marks can be encountered on variety of food materials or any other miscellaneous materials, possibly available at the scene of crime or on the skin i.e. body of the suspect or victim. Apart from this, many experimental studies are also undertaken to access the accuracy of bite mark details, so transferred, on to a different type of substrates.

Although skin is a poor registration material, as on skin bite marks can undergo a certain degree of distortion in a very short span of time (28), but still it is the most investigated and debated aspect (29, 30, 31, 8, 32). Bite marks on skin are found in most of the homicide cases and in some of the diversified cases such as child abuse cases as battered baby syndrome (33, 34, 35). Skin is highly variable in terms of anatomical location, underlying musculature, fat or looseness; thus, the distortion on skin is natural. Studies on the distortion of human bite marks has also been reported .For the purpose of carrying out studies in the morphological changing process of human bite marks, skin of dogs, pigs and sheep has been utilized (36, 37, 38). In above-mentioned studies, terms like primary distortion and secondary distortion have been introduced and described which is based upon

the causative factors of production of bitemarks and their interrelationships (28).

Other materials including foodstuffs are also reported in casework as well as in the experimental studies, such as cheese (39, 40, 41), apples (42, 43), chewing gum (44), chocolate (45), soap (46), sandwich (47) and even in the case of bullet also (48). Recovery of bite marks from the aforementioned materials has taken place in the theft and burglary cases. Out of all the materials, the frequency of cheese has been reported to be the most.

RECORDING OF BITE MARK EVIDENCE

For the purpose of through analysis of any physical evidence, proper collection of the bite marks plays an important role in the investigation of the case. First and the foremost task for collection of bite mark evidence is of photographing the bite mark as early as possible. In addition to this, Photography is also utilized to record injuries on skin associated with bite marks and other patterned injuries (49). ABFO recommends the use of bite mark standard reference scale-ABFO no.2, which is now universally adopted by the forensic dentists and professionals, for photographing the bite marks (50). Studies have recommended the use of rigid ruler for scale, proper camera positioning in relation to scale and proper light arrangements (51). The use of alternative light sources such as reflective U.V. (52) and Trans-illumination (53) has also been reported. Almost all bite mark photographs are susceptible to some degree of distortion (54), so only the corrected photographic procedure should be followed. In case of sub-quality photographs, Digital enhancement software named LUCIS has been used for improving the resolution of images (55).

Apart from photography, different types of casting materials are used for recording the bite mark evidence. Preparation of patterns from the bite mark impression from using ceramic dough is reported (56) which is soft and flexible like human skin and is unaltered by the environmental conditions. Cast to be made should be stable and permanent and should not distort the details of bite marks. Stoddart reported the method of producing permanent models from perishable substances by using a silicon impression material (57). The use of elastomeric impression material for bite marks preservation has also been reported (58). For the preservation of human skin exhibiting injuries, workers have also reported the use of cyano-acrylate adhesives and acrylate ring along with the 10% formalin solution (59).

Alternatively, some other miscellaneous materials like inked dental casts (60), white plaster and silicon rubber cast (40) and Styrofoam has been reported.

Another method of recording the bite mark evidence is the generation of overlays through xerographic procedures. In one of the cases, involving bite marks on cheese, detective used photocopier to record the evidence (41). Photocopier generated overlays were significantly more accurate at matching the correct bite marks to models are more sensitive (61).

In addition to this, a novel technique involving the use of powder and brush method to lift the so called "tooth prints" from body surface of the living and dead persons has also been reported (62).

Thus, in case of recording of bite mark evidence, photography still finds the universal applicability as the primary technique but any particular casting method is not universally applied and a certain degree of variation exists in this case. Although the photocopy generated overlay is relatively an effective method, still its extensive use has not been reported.

The forensic docum... ...
atable matter. There is a clear demarcation between the experts ...
on in these types of cases and those who are against this. This question becomes
... the 'Linguistic diversity' of India. But the
... to deal with the

LEGAL STATUS

Bite marks are hard evidence and are highly persuasive to juries who weigh evidence. Right from beginning, bite mark evidence has undergone and sustained a number of legal challenges involving the constitutional rights of accused and courtroom acceptance of such an approach. The first attempt to admit bite mark evidence in court of law in U.S. was in of Ohio vs. Robinson in 1870 (63) while bite mark analysis has been judicially accepted in U.S. since 1954 in case of Doyle vs. State (21). The very first statements about the bite marks evidence included that "it is unlikely to establish a convincing proof in most cases" (64). During the course of years, presentation of bite marks evidence and legal status have improved. Most famous court cases include "The Biggar Murder" case in 1966 (31) and "Ted Bundy Case" in 1973-78.

U.S. courts state that witness must be able to identify published works that define operational parameters of any tests and procedures that form the basis of scientific conclusions (65). However, still in recent times it is observed that the courts are reluctant to accept the validity of pattern-associated comparisons. This type of behavior of courts can be explained by the weak inter-examiner reliability, which in turn explains the divergence among the odontologist's opinions in the courtrooms.

Moreover, the jury is generally more willing to accept the positioning of study model on one-to-one basis life size photographs rather than complicated procedures (66). Similarly, the quantitative measures of importance of evidence such as "likelihood" ratio have become increasingly popular in the courtroom, which are used by the expert witness to describe their certainty about a piece of evidence (67). Thus, for courts to have broader view about the bite marks evidence, expert opinion has to be based on objective comparisons rather than subjective norms.

Positively, as the science continues to evolve with more precise and demonstrative methods of performing the investigations and development of research data on the individuality of human dentition, the value of bite mark analysis in legal system will continue to increase (68).

CONCLUSIONS

Through this review concerning the state of art of the bite mark analysis over the years, the evidentiary value of the bite mark evidence has been tried to illustrate. Several reviews in past have highlighted the lacuna created in the bite mark evidence analysis due to lack of scientific evidence supporting the odontologist's opinions (69). In spite of number of objective techniques have come up recently, still it is felt that there is no consensus on opinion or methodology concerning the bite mark analysis. Nevertheless, the employment of computers in bite mark analysis has added more objectivity to the physical comparison process. The use of adjunctive techniques like salivary DNA and oral bacterial analysis is highly commendable in the last few years. Bite mark evidence has become accepted as powerful tool in investigation of crime, and a new level of court interest is brimming, but it is most likely that forensic scientists will have to refine all the scientific techniques, presently available in the field.

REFERENCES

1. Whittaker D.K. (2004) Bite marks--the criminal's calling cards. *Br Dent J*. Vol.; 196(4): 237.

2. Atsü Sağlam, S., Gökdemir, K., Kedici, P.S., İlkyaz, Y.Y., (1998)

"Bitemarks In Forensic Odontology." The Journal of Forensic

Odonto-Stomatology. 16:30-34.

3. Thali M.J., Braun M, Markwalder T.H., Brueschweiler W., Zollinger U., Malik N.J., Yen K. and Dirnhofer R. (2003) Bite mark documentation and analysis: the forensic 3D/CAD supported photogrammetry approach. *Forensic science international* Vol.; 135(2): 115-21.

4. Pretty I.A. and Turnbull M.D. (2001) Lack of dental uniqueness between two bite mark suspects. *J Forensic Sci.;* Vol.46 (6): 1487-91.

5. ABFO Inc. (1986) Guidelines for bitemark analysis. *JADA*; Vol.112: 383-6.

6. http://www.forensicdentistryonline.com/

7. Fearnhead, R.W. (1960) Facilities for forensic odontology. *Med Sci Law*; Vol.1: 273-77.

8. Furness, J. (1968) A new method for the identification of teeth marks in case of assault and homicide. *Br Dent Journal*; Vol.124 (6): 261-7.

9. Jonason, C.O., Frykholm, K.O. and Frykholm, A. (1974) Three-dimensional measurement of tooth impression of criminological investigation. *Int J For Dent*; Vol.2 (6): 70-8.

10. Solheim, T. and Leidal, T.I. (1975) Scanning electron microscopy in the investigation of bitemarks in foodstuffs. *Forensic Sci.*; vol.6 (3): 205-15.

11. David, T.J. (1986) Adjunctive use of scanning electron microscopy in bitemark analysis-a 3D study. *J forensic Sci.*; Vol.31 (3): 1126-34.

12. Bang, G. (1976) Analysis of tooth marks in homicide case. *Acta Odontol Scand*; Vol.34 (1): 1-11.

13. Ligthelm, A.J., Coetzee, W.J.and Van Niekerk, P.J. (1987) The identification of bitemarks using the reflex microscope.*J Forensic Odontos.*;Vol.5 (1):1-8.

14. Macdonald, D.G., MacFarlane, T.W. and Sutherland, D.A. (1974) Statistical problems in dental identification. *J For Sci Soc*; Vol.14 (3): 247-52.

15. Rawson, R.D. (1984) Statistical evidence for the individuality of the human dentition. *J forensic science;* Vol.29 (1): 245-53.

16. Rawson, R.D., Bell, A., Kinard, B.S. and Kinard, J.G. (1979) Radiographic interpetation of contrast media enhanced bitemarks. *J For Sci.*; Vol.24 (4): 898-901.

17. Wood, R.E., Miller, P.A., and Blenkinsop, B.R. (1994) Image editing and computer assisted bitemark analysis: a case report. *J Forensic Odontos*; Vol.12 (2): 30-6.

18. Sognnaes, R.F., Rawson, R.D., Gratt, B.M. and Nguyen, N.B. (1982) Computer comparison of bitemark patterns in identical twins. *JADA*; Vol.105 (3): 449-51.

19. Naru, A.S. and Dykes, E. (1996) The use of digital imaging technique to aid bite mark analysis. *Science and Justice*; Vol.36 (1): 47-50.

20. Sweet, D., Parhar, M. and Wood, R.E. (1998) Computer based production of bitemark comparison overlays. *J Forensic Science*; Vol.43 (5): 1050-5.

21. Bowers, M.C. and Johansen, R.J. (2000) Digital rectification and resizing correction of photographic bite mark evidence. *Forensic Science Communications.*

22. Nambiar, P., Bridges, T.E. and Brown, K.A. (1995) Quantitative forensic evaluation of bite marks with the aid of shape analysis computer programme: Part I.*Journal of forensic odontostomatology*; Vol.13(2):18-25.

23. Nambiar, P., Bridges, T.E. and Brown, K.A.(1995) Quantitative forensic evaluation of bite marks with the aid of shape analysis computer programme: Part II.*Journal of forensic odontostomatology*; Vol.13 (2): 26-32.

24. Sweet, D., Lorente,M.,Valenzula, A. Lorente, J.A. and Alvarez, J.C. (1996) Increasing DNA extraction yield from saliva stains with a modified chelex method. *For Sci Int*; Vol. 83 (3): 167-77.

25. Glass, R.T., Andrews, E.E. and Jones, K. (1980) Bitemark evidence: A case report using accepted and new techniques. *J Forensic Sci;* Vol.25 (3): 638-45.

26. Elliot, T.R., Rogers, A.Haverkamp, J.R. and Groothuis, D.(1984)Analytical pyrolysis of Streptococcus salivarius as an aid to identification in bitemark investigation.*Forensic science international*;Vol.26(3):131-7.

debatable matter. There is a clear ... This question ...
inion in these types of cases and those who are against this.
... the 'Linguistic diversity' of India. But the
... deal with the

27. Borgula L.M., Robinson F.G, Rahimi M., Chew K.E., Birchmeier K.R., Owens S.G., Kieser J.A. and Tompkins G.R. (2003) Isolation and genotypic comparison of oral streptococci from experimental bitemarks. *J Forensic Odontostomatol*. Vol. 21 (2): 23-30.

28. Sheasby DR and MacDonald DG (2001) A forensic classification of distortion in human bite marks. *Forensic Sci Int.*, Vol. 15; 122(1): 75-8.

29. Furness, J. (1970) Dental evidence in a case of a rape. *Probe*; Vol.11: 221-222.

30. Dorion, R.B. (1984) Preservation and fixation of skin for ulterior scientific evaluation and courtroom presentation. *J Can Dent Assoc*; Vol.50 (2): 129-30.

31. Harvey, W., Butler, O., Furness, J and Laid, R. (1966) The biggar murder. *J forensic science society*; Vol.8 (4): 157-219.

32. Thompson,I.O. and Phillips,V.M.(1994) A bitemark case with a twist. *J.Forensic Odontos.*;Vol.12(2):37-40.

33. Sims, B.G., Grant, J.H. and Cameron, J.M. (1973) Bitemarks in the "Battered baby syndrome". *Med Sci Law*; Vol.13 (3): 207-10.

34. Anderson, W.R., and Hudson, R.P. (1976) Self inflicted bitemarks in battered child syndrome. *For Sci Int*; Vol.7 (1): 71-4.

35. Sognnaes, R.F.(1977)Battered child death involving enigmatic bitemark evidence. *J Cal Dent Association*;Vol.4:22-8.

36. Chen X, Sun D and Wu Y (2004) A biomechanical study on the morphological changing process of human bitemarks. *Sheng Wu Yi Xue Gong Cheng Xue Za Zhi*, Vol. 21(4): 622-4.

37. Ligthelm, A.J. and deWet, F.A. (1983) Registration of bitemarks: a preliminary report. *J Forensic Odontostomatology*; Vol.1 (1): 19-26.

38. Whittaker, D.K. (1975) Some laboratory studies on the accuracy of bitemark comparisons. *Int Dent J*; Vol.25 (3): 166-71.

39. Bernitz H, Piper S.E., Solheim T., Van Niekerk P.J. and Swart T.J. (2000) Comparison of bitemarks left in foodstuffs with models of the suspects' dentitions as a means of identifying a perpetrator. *J Forensic Odontostomatol.*; Vol.18 (2): 27-31.

40. Bernitz H. and Kloppers B.A. (2002) Comparison microscope identification of a cheese bitemark: A case report. *J Forensic Odontostomatol*; Vol.; 20(1): 13-6.

41. McCullough, D.C. (1983) Rapid comparison of bitemarks by xerography. *Am J For Med Path*; Vol.4 (4): 355-8.

42. Kerr, N.W. (1977) Apple bitemark identificationof a suspect .*Int J Forensic Dent*; Vol.4: 22-8.

43. Marshall, W. (1974) Bitemarks in apples – forensic aspects. *Criminol*; Vol.9 (32): 21-34.

44. Nambiar.P, Carson, G., Taylor, J.A. and Brown, K.A. (2001) Identification from a Bitemark in a wad of chewing gum. *Journal of forensic odontostomatology*; Vol.19: 5-8.

45. McKenna C.J., Haron M.I., Brown K.A. and Jones A.J. (2000) Bitemarks in chocolate: a case report. *J Forensic Odontostomatol;* Vol. 18(1): 10-4.

46. Corbett, M.E. and Spence, D. (1984) A forensic investigation of teeth marks in soap. *British dental journal*; Vol.157 (8): 270-1.

47. Simon, A., Jordan, H. and Pforte, K. (1974) Successful identification of a bitemark in a sandwich. *Int J For Dent*; Vol.2: 17-22.

48. Mills, P.B. (1976) An unusual case of bitemark identification. *Int J For Dent*; Vol.3: 38-9.

49. Wright, F.D. (1998) Photography in bitemark and patterened injury documentation;J Forensic Science;Vol.43(4):881-7.

50. Hyzer, W.G.and Krauss, T.G. (1988) The bite mark standard reference scale—ABFO No.2. *Journal of forensic science*; Vol.33 (2): 498-506.

51. Krauss, T.C. (1984) Photographic techniques of concern in metric bitemark analysis. *J Forensic Sci.*; Vol.29 (2): 633-8.

52. Krauss, T.C. and Warlen, S.C. (1985) The forensic use of reflective ultraviolet photography. *J Forensic Sci.*; Vol.30 (1): 262-8.

53. Dorion, R.B. (1987) Transillumination in bitemark evidence. *J forensic Science*; Vol.32 (3): 690-7.

54. Robinson, E., and Wentzel, J. (1992) Toneline bitemark photography. *Journal of forensic science*; Vol.37 (1): 195-207.

55. Karazalus,C.P.;Palmbach,T.T;and Lee,H.C.(2001) Digital enhancement of sub quality photographs. *Journal of Forensic Science*;Vol.46(4):954-58.

56. Karaman, F., Afsin, H. and Cologlu, S. (2000) Identification by analysis of teeth marks. Presentation in 9th Biennial Scientific Meeting of the International Association for Craniofacial Identification, Washington, DC, July 24–28, 2000.*Forensic science communications*;Vol.2(4).

57. Stoddart, T.J. (1973) Bitemarks in perishable substances. *Br Dent Journal;* Vol.135 (6): 285-7.

58. Sognnaes,R.F.(1977) The case for better bite and bite mark preservations.Int J Forensic Dent;Vol.4(13):17-20.

59. Rothwell B.R. and Thien A.V. (2001) Analysis of distortion in preserved bite mark skin. *J Forensic Sci*., Vol.; 46(3): 573-6.

60. West, M.H., Barsley, R.E., Frair, J and Seal, M.D. (1990) The use of human skin in then fabrication of bitemark template: two case reports. *J Forensic Science*; Vol.35 (6): 1477-85.

61. Kouble, R.F. and Craig, G.T. (2004) A comparison between direct and indirect methods available for human bite mark analysis. *J Forensic Science*, Vol. 49(1): 111-8.

62. Rao, V.J.and Souviron, R.R (1984) Dusting and lifting the bite print: a new technique. *Journal of forensic science*; Vol.19 (1): 326-30.

63. Pierce, L.J., Strickland, D.J. and Smith, E.S. (1990) The case of Ohio v. Robinson.An 1870 bitemark case. Am *J Forensic Med Pathology*; Vol.11 (2): 171-7.

64. Taylor, D.V. (1963) the law and the dentist. *Brit Dent Journal*; Vol.114: 389.

65. Pretty, I.A. and Sweet, D (2001) Digital bite marks overlays--an analysis of effectiveness. *J Forensic Sci*.; Vol.46 (6): 1385-91.

66. Fischman S.L. (2002) Bite marks. *Alpha Omegan*.Vol.; 95(4): 42-6.

67. Kittelson, J.M., Kieser, J.A., Buckingham, D.M. and Herbison, G.P. (2002) Weighing Evidence: Quantitative measures of the importance of bitemark evidence. *Journal of forensic odontostomatology*, Vol. 20:31-7.

68. Wright F.D. and Dailey J.C. (2001) Human bite marks in forensic dentistry. *Dent Clin North Am.*; Vol.45 (2): 365-97.

69. Zarkowski, P (1988) Bitemark evidence: its worth in the eyes of the expert. *J Law & Ethhi Dent*; Vol.1 (1): 47-57.

Corresponding Author

Jasuja, O. P. Professor,

Department Of Forensic Science,

Punjabi University,

Patiala INDIA

debatable matter. There is a clear ... this. This question ...
inion in these types of cases and those who are against this. This question ...
... the 'Linguistic diversity' of India. But the
... deal with the

27. Borgula L.M., Robinson F.G, Rahimi M., Chew K.E., Birchmeier K.R., Owens S.G., Kieser J.A. and Tompkins G.R. (2003) Isolation and genotypic comparison of oral streptococci from experimental bitemarks. *J Forensic Odontostomatol*. Vol. 21 (2): 23-30.

28. Sheasby DR and MacDonald DG (2001) A forensic classification of distortion in human bite marks. *Forensic Sci Int.*, Vol. 15; 122(1): 75-8.

29. Furness, J. (1970) Dental evidence in a case of a rape. *Probe*; Vol.11: 221-222.

30. Dorion, R.B. (1984) Preservation and fixation of skin for ulterior scientific evaluation and courtroom presentation. *J Can Dent Assoc*; Vol.50 (2): 129-30.

31. Harvey, W., Butler, O., Furness, J and Laid, R. (1966) The biggar murder. *J forensic science society*; Vol.8 (4): 157-219.

32. Thompson,I.O. and Phillips,V.M.(1994) A bitemark case with a twist. *J.Forensic Odontos.*;Vol.12(2):37-40.

33. Sims, B.G., Grant, J.H. and Cameron, J.M. (1973) Bitemarks in the "Battered baby syndrome". *Med Sci Law*; Vol.13 (3): 207-10.

34. Anderson, W.R., and Hudson, R.P. (1976) Self inflicted bitemarks in battered child syndrome. *For Sci Int*; Vol.7 (1): 71-4.

35. Sognnaes, R.F.(1977)Battered child death involving enigmatic bitemark evidence. *J Cal Dent Association*;Vol.4:22-8.

36. Chen X, Sun D and Wu Y (2004) A biomechanical study on the morphological changing process of human bitemarks. *Sheng Wu Yi Xue Gong Cheng Xue Za Zhi*, Vol. 21(4): 622-4.

37. Ligthelm, A.J. and deWet, F.A. (1983) Registration of bitemarks: a preliminary report. *J Forensic Odontostomatology*; Vol.1 (1): 19-26.

38. Whittaker, D.K. (1975) Some laboratory studies on the accuracy of bitemark comparisons. *Int Dent J*; Vol.25 (3): 166-71.

39. Bernitz H, Piper S.E., Solheim T., Van Niekerk P.J. and Swart T.J. (2000) Comparison of bitemarks left in foodstuffs with models of the suspects' dentitions as a means of identifying a perpetrator. *J Forensic Odontostomatol.*; Vol.18 (2): 27-31.

40. Bernitz H. and Kloppers B.A. (2002) Comparison microscope identification of a cheese bitemark: A case report. *J Forensic Odontostomatol*; Vol.; 20(1): 13-6.

41. McCullough, D.C. (1983) Rapid comparison of bitemarks by xerography. *Am J For Med Path*; Vol.4 (4): 355-8.

42. Kerr, N.W. (1977) Apple bitemark identificationof a suspect .*Int J Forensic Dent*; Vol.4: 22-8.

43. Marshall, W. (1974) Bitemarks in apples – forensic aspects. *Criminol*; Vol.9 (32): 21-34.

44. Nambiar.P, Carson, G., Taylor, J.A. and Brown, K.A. (2001) Identification from a Bitemark in a wad of chewing gum. *Journal of forensic odontostomatology*; Vol.19: 5-8.

45. McKenna C.J., Haron M.I., Brown K.A. and Jones A.J. (2000) Bitemarks in chocolate: a case report. *J Forensic Odontostomatol;* Vol. 18(1): 10-4.

46. Corbett, M.E. and Spence, D. (1984) A forensic investigation of teeth marks in soap. *British dental journal*; Vol.157 (8): 270-1.

47. Simon, A., Jordan, H. and Pforte, K. (1974) Successful identification of a bitemark in a sandwich. *Int J For Dent*; Vol.2: 17-22.

48. Mills, P.B. (1976) An unusual case of bitemark identification. *Int J For Dent*; Vol.3: 38-9.

49. Wright, F.D. (1998) Photography in bitemark and patterened injury documentation;J Forensic Science;Vol.43(4):881-7.

50. Hyzer, W.G.and Krauss, T.G. (1988) The bite mark standard reference scale—ABFO No.2. *Journal of forensic science*; Vol.33 (2): 498-506.

51. Krauss, T.C. (1984) Photographic techniques of concern in metric bitemark analysis. *J Forensic Sci.*; Vol.29 (2): 633-8.

52. Krauss, T.C. and Warlen, S.C. (1985) The forensic use of reflective ultraviolet photography. *J Forensic Sci.*; Vol.30 (1): 262-8.

53. Dorion, R.B. (1987) Transillumination in bitemark evidence. *J forensic Science*; Vol.32 (3): 690-7.

54. Robinson, E., and Wentzel, J. (1992) Toneline bitemark photography. *Journal of forensic science*; Vol.37 (1): 195-207.

55. Karazalus,C.P.;Palmbach,T.T;and Lee,H.C.(2001) Digital enhancement of sub quality photographs. *Journal of Forensic Science*;Vol.46(4):954-58.

56. Karaman, F., Afsin, H. and Cologlu, S. (2000) Identification by analysis of teeth marks. Presentation in 9th Biennial Scientific Meeting of the International Association for Craniofacial Identification, Washington, DC, July 24–28, 2000.*Forensic science communications*;Vol.2(4).

57. Stoddart, T.J. (1973) Bitemarks in perishable substances. *Br Dent Journal;* Vol.135 (6): 285-7.

58. Sognnaes,R.F.(1977) The case for better bite and bite mark preservations.Int J Forensic Dent;Vol.4(13):17-20.

59. Rothwell B.R. and Thien A.V. (2001) Analysis of distortion in preserved bite mark skin. *J Forensic Sci*., Vol.; 46(3): 573-6.

60. West, M.H., Barsley, R.E., Frair, J and Seal, M.D. (1990) The use of human skin in then fabrication of bitemark template: two case reports. *J Forensic Science*; Vol.35 (6): 1477-85.

61. Kouble, R.F. and Craig, G.T. (2004) A comparison between direct and indirect methods available for human bite mark analysis. *J Forensic Science*, Vol. 49(1): 111-8.

62. Rao, V.J.and Souviron, R.R (1984) Dusting and lifting the bite print: a new technique. *Journal of forensic science*; Vol.19 (1): 326-30.

63. Pierce, L.J., Strickland, D.J. and Smith, E.S. (1990) The case of Ohio v. Robinson.An 1870 bitemark case. Am *J Forensic Med Pathology*; Vol.11 (2): 171-7.

64. Taylor, D.V. (1963) the law and the dentist. *Brit Dent Journal*; Vol.114: 389.

65. Pretty, I.A. and Sweet, D (2001) Digital bite marks overlays--an analysis of effectiveness. *J Forensic Sci*.; Vol.46 (6): 1385-91.

66. Fischman S.L. (2002) Bite marks. *Alpha Omegan*.Vol.; 95(4): 42-6.

67. Kittelson, J.M., Kieser, J.A., Buckingham, D.M. and Herbison, G.P. (2002) Weighing Evidence: Quantitative measures of the importance of bitemark evidence. *Journal of forensic odontostomatology*, Vol. 20:31-7.

68. Wright F.D. and Dailey J.C. (2001) Human bite marks in forensic dentistry. *Dent Clin North Am.*; Vol.45 (2): 365-97.

69. Zarkowski, P (1988) Bitemark evidence: its worth in the eyes of the expert. *J Law & Ethhi Dent*; Vol.1 (1): 47-57.

Corresponding Author

Jasuja, O. P. Professor,

Department Of Forensic Science,

Punjabi University,

Patiala INDIA