

Image Perception Technology a New Horizon: A Comparative Study on Bite Mark Analysis**Pallavi Rathore, Saloni Sood**

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ABSTRACT:

BACKGROUND: Bite mark analysis is a vital area of forensic odontology which has been the commonest form of dental evidence presented in the criminal court. The process of comparing bite marks with a suspect's dentition include analysis and measurement of shape, size and position of an individual's teeth.

AIM: To compare the bite mark overlays generated by three methods, i.e., manual, photocopying, photography and computer assisted methods of overlay generation.

METHODS: Impressions of maxillary and mandibular arches of 30 individuals participating in the study were made and dental study models were prepared. Overlay production was done by manual, photocopying, and computer assisted methods. Finally, the overlays obtained by each method were compared.

RESULTS: Kruskal Wallis ANOVA H test was used for the comparison of manual, photocopying, and computer assisted overlay generation methods.

CONCLUSION: We conclude that the method of computer assisted overlay generation is the best among all the methods used in our study.

Keywords: Bite mark, computer assisted method, manual, photocopying, photography

INTRODUCTION

Forensic investigation is one of the major investigation of the crime scene under which Bite mark analysis plays an important role.¹ Bite marks can occur on the skin of a victim or on other objects, including foods such as cheese, chocolate, apples, or chewing gums. Solid food has an advantage in such cases.² Bite marks tend to have a double horseshoe shape

pattern showing the anterior teeth of the upper jaw and similarly the anterior teeth in the lower jaw.³ Bite marks reveals the peculiar features such as gaps between the teeth, ridges on the biting surfaces of the teeth, rough fillings, as well as missing, broken, chipped, or distorted teeth which helps in identification of a particular individual.⁴ There are so many different

ways for analysis of bite marks such as on food substances like impression making from dental stone and hand tracing from dental study casts, photography method, photocopying and computer assisted overlay generation method.⁵

The 1st case established the legal presence of bite mark evidence was Doyle vs State of Texas in 1954. This case also involved bite marks left on some pieces of cheese at crime scene. The process of comparing bite marks with a suspect's dentition includes analysis and measurement of size, shape and position of the individual teeth. There are a number of different ways to produce overlays from a suspect's dentition: hand tracing from dental study casts, hand-tracing from wax impressions, hand-tracing from xerographic images, the radio opaque wax impression method⁹ and the computer-based method.⁶⁻⁸

So this study was carried out to compare the bite mark analysis by four different methods, i.e., manual, photocopying, photography and computer assisted methods of overlay generation.

MATERIALS AND METHOD

Total 30 number of young adults age ranging from 18-25 years were included in the study. This study was carried out in Manav Rachna Dental College, Faridabad, Haryana. Impressions of maxillary and mandibular arches of 30 individuals participating in the study were made and dental study models prepared in dental stone. Overlay production was done by manual, photocopying, photography and computer assisted method of overlay generation.

Material used were as following:

- ⊙ Dental stone
- ⊙ Cellophane sheet
- ⊙ Marking pencil
- ⊙ Vernier caliper

- ⊙ Apple
- ⊙ Chocolate
- ⊙ Camera (EOS100D)
- ⊙ Image perception software (Magnus Pro)

Manual method

In manual method a sheet of transparent film and a fine tipped pen were used to mark the biting surface. The transparent sheet was directly placed over the biting edges of the dental model. Then the biting edges were traced. Both the maxillary and mandibular models were traced individually in horse shoe shape pattern to simulate a human bite.

Photography method

In photography method, take a photograph of bite marks on any food item like apple and chocolate and measured the incisal details with the help of vernier calliper then compare this measurement with the bite marks on victim's body. (Figure 1,2)



Figure 1: Bite mark on apple



Figure 2: Bite mark on chocolate

Photocopying method

In the photocopying method, an accurate image of the dental model was made by placing the biting edges of the dental model over the glass plate of the photocopying machine. The dental models were again placed to simulate human bite. This image was then placed upside down on a radiograph view box and the tooth edge outlines were traced. These outlines were then photocopied on a transparent sheet

Computer Assisted Image analysis method

In the computer assisted method, first the study models were scanned with the biting edges of the dental model over the glass plate of the scanner. The scanned images (Figure 3) were transferred to a laptop. The images were opened in photoshop software which is already installed in the laptop. Then a gradual selection of biting edges of the teeth was done using magic wand selection tool resident in the photoshop software. The outlines of the biting edges were reproduced (Figure 4 & 5). The images obtained were printed on transparent sheet. Thus, three overlays were made for one set of dental model. Different levels of biting edge match was used among the four methods. (Table 1)



Figure 3: Scanned dental Model



Figure 4: Selected region of interest from original photograph

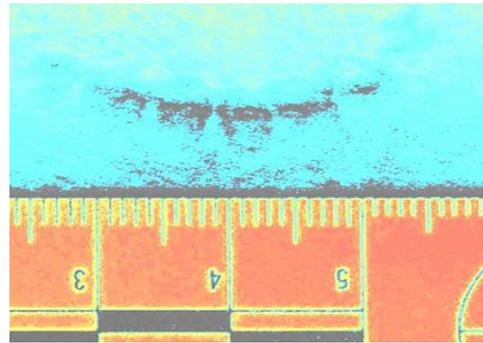


Figure 5: Coloured image with visible incisal layered over original photograph

RESULTS AND OBSERVATIONS

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ANOVA test was used for the comparison of manual, photocopying, photography and computer assisted overlay production methods whereas the list effective method was used among the four methods to show the efficacy of biting edges. In the other tables the comparison of the different methods shown one by one out of which computer assisted generated method shows the excellent matching for the biting edges. (Table 2,3 & 4)

DISCUSSION

Human bite mark is far most the demanding and challenging area of forensic dentistry.¹⁰ The principle of bite mark analysis is based on the premise that no two people have similar teeth, and hence the bite marks made are also dissimilar. Bite mark distortion through skin elasticity, anatomical location and

body positioning is a recurring problem. Historically, the manual method was the

only method known for generating overlays and was used first in about 1966.¹

Table 1: Different levels of biting edge match

| Method | No matching | Slightly matching | Moderate matching | Excellent matching |
|---------------------------|-------------|-------------------|-------------------|--------------------|
| Manual method | | ✓ | | |
| Photography method | | ✓ | | |
| Photocopying method | | | ✓ | |
| Computer generated method | | | | ✓ |

TABLE 2: MANUAL vs PHOTOCOPYING

| METHOD | NO MATCHING | SLIGHTLY MATCHING | MODERATE MATCHING | EXCELLENT MATCHING |
|---------------------|-------------|-------------------|-------------------|--------------------|
| Manual method | | ✓ | | |
| Photocopying method | | | ✓ | |

TABLE 3: MANUAL vs COMPUTER GENERATED METHOD

| METHOD | NO MATCHING | SLIGHTLY MATCHING | MODERATE MATCHING | EXCELLENT MATCHING |
|---------------------------|-------------|-------------------|-------------------|--------------------|
| MANUAL METHOD | | | ✓ | |
| COMPUTER GENERATED METHOD | | | | ✓ |

TABLE 4: MANUAL vs PHOTOGRAPHY METHOD

| METHOD | NO MATCHING | SLIGHTLY METHOD | MODERATE MATCHING | EXCELLENT MATCHING |
|--------------------|-------------|-----------------|-------------------|--------------------|
| MANUAL METHOD | | ✓ | | |
| PHOTOGRAPHY METHOD | | | ✓ | |

In 1991, Dailey found out a quick, inexpensive and accurate technique for generating transparent overlays, using office photocopy machines, for use in bite mark case analysis.⁷ Later in 1996, Naru

and Dykes introduced the computer assisted overlay generation method to forensic odontology. They advocated a method of selection of tooth edges from the image by a technique known as “edge

detection.” The selected edges were then printed onto transparent sheets as overlays.⁵ The present study was undertaken to find the best method out of these four methods, i.e., manual, photocopying, photography and computer assisted method for overlay generation.

In our study, the computer assisted overlay generated matched excellently with study models. In comparison, only three overlays generated by photocopying method matched excellently with the study models. None of the overlay generated in a manual method matched excellently with the study models. Thus, the results of our study shows that computer assisted method is more reliable than manual, photography and photocopying method.

A recently developed new software package, “Dental Print” (2004, University of Granada, Department of Forensic Medicine and Forensic Odontology, Granada, Spain) generates comparison overlays from 3D images of the suspect's dental cast. This software allows users to accurately and objectively select the biting edges of interest from the suspect's teeth when compared to 2D images. The procedure for generating comparison overlays is entirely automatic and it is impossible for third parties to manipulate or alter the 3D images. This dental print software is an important step forward in Forensic Sciences for bite mark analysis.¹²⁻¹⁴

CONCLUSION

Although many newer and advanced methods of bite mark comparison have evolved, comparison by overlay generation remains one of the best and easiest possible methods. Within various overlay generation methods, computer assisted

overlay generation method have number of advantages over other methods like ease of production, and being inexpensive along with being well researched. So it can be concluded that computer assisted overlay generation method is the best method of overlay generation.

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