

CASE REPORT

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Adjunctive Use of Scanning Electron Microscopy in Bite Mark Analysis: A Three-Dimensional Study

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ABSTRACT: An examination of a case in which adjunctive use of scanning electron microscopy (SEM) demonstrated the presence of unusual three-dimensional characteristics in a bite mark. Despite the fact that many bite marks do not show "depth," demonstration of the presence of this third dimension can produce significant data for evidentiary purposes. In some instances, these data may transform what seem to be *class characteristics* of a bite mark into individual characteristics and thus impart much more uniqueness to the evidence. Because of the high level of resolution and magnification of SEM, some three-dimensional characteristics not visible to the eye can be shown quite clearly by its use. Emphasis will be given to the value of SEM as a tool of the forensic odontologist in bite mark analysis.

KEYWORDS: odontology, bite marks, microscopy, scanning electron microscopy, depth, individual characteristics, class characteristics

While bite mark investigation itself is certainly not new [1], the method used for bite mark analysis has evolved into a dynamic process. It thus offers ample opportunity for a variety of techniques to the forensic odontologist [2]. In spite of the wide variety of methods used, some have gained more acceptance than others. This is due, in part at least, to certain legal decisions [3-5]. The purpose of this study is not to eliminate the use of various methods, but rather to enhance their validity with valuable corroborative evidence.

Case Report

On 24 Oct. 1982, the body of a 21-year-old black female was discovered in a vacant lot. Superficial examination of the body revealed extensive blunt force injury. It was apparent that the victim had been dead for more than 24 h.

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Autopsy

Postmortem examination revealed the cause of death to be asphyxia as a result of strangulation, although significant blunt force trauma was also present. In addition, the medical examiner² noted another injury of special significance (Fig. 1). This injury was described as follows in the autopsy report: "In the skin of the epigastrium, a rather oval, patterned, abraded, minimally bruised lesion consistent with a bite mark is noted." Accordingly, these lesions were photographed with an appropriate linear scale to allow accurate enlargement. They were then excised, fixed in formalin, and retained for further study.

Evidence Production and Development

A black male who was living with the decedent came under immediate suspicion and was subsequently arrested on 26 Oct. 1982. The suspect gave voluntary consent to a dental examination including impressions of his teeth. Thus models of the suspect's teeth (Figs. 2 and 3) were available for comparison with the bite mark photograph of the decedent (Fig. 1). Comparison of bite mark patterns from the suspect with the bite mark photograph from the victim seemed to indicate some points of correlation. The lower half of the suspect's bite mark pattern (Fig. 4) appeared to relate rather well with the lower half of the bite mark photograph in Fig. 1.

However, interpretation of the upper part of the bite mark in the photograph (Fig. 1) remained a problem. Since all the anterior teeth were not represented in the bite mark,

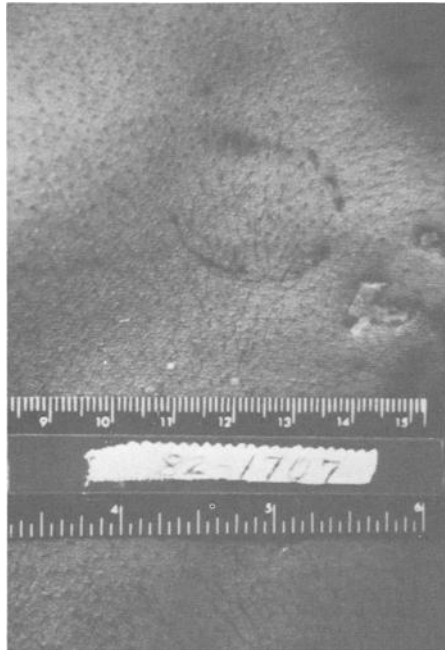


FIG. 1—Bite mark on chest of victim. Markings to the right of the bite mark are the result of insect predation.

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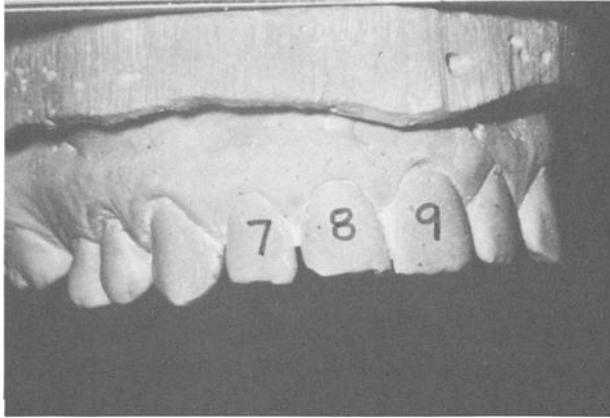


FIG. 2—*Suspect's upper model with numerals indicating teeth using Universal System.*

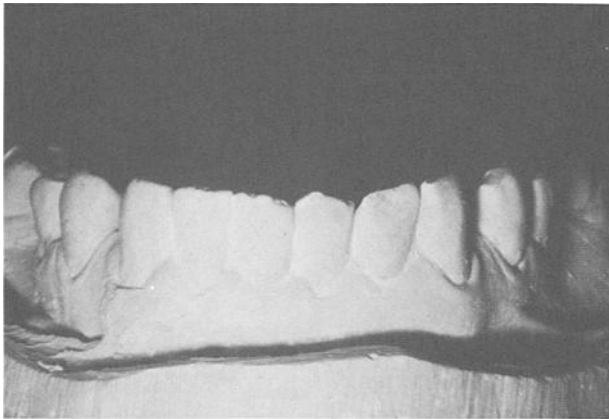


FIG. 3—*Suspect's lower model.*

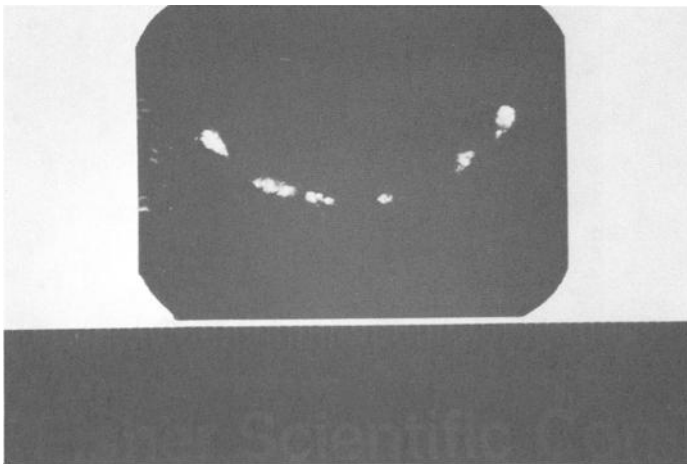


FIG. 4—*Suspect's lower bite pattern.*

determination of which teeth made which marks proved difficult from the outset. At this point, the preservation of the bite mark tissue proved invaluable. Comparison of the excised tissue with the corresponding photograph revealed a significant disparity between the two. The mark in the photograph showed essentially no indentation, while the bite mark itself showed considerable depth below the adjacent tissue contour. Closer inspection of the suspect's upper teeth (Fig. 2) demonstrated certain unusual characteristics that coincided remarkably with the depth characteristics of the bite mark tissue. In addition, a portion of the suspect's upper model fit almost exactly into the impression created by the bite mark (Figs. 5 and 6).

Because of these remarkable circumstances, Dr. Peter Mills³ suggested that the tissue and

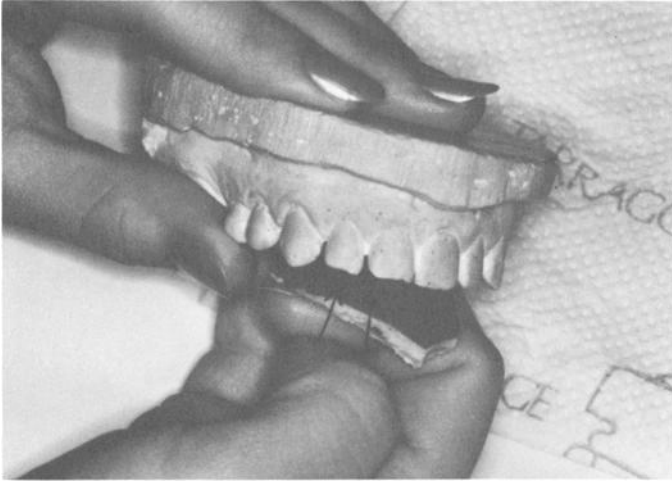


FIG. 5—*Suspect's upper model compared with bite mark tissue. See arrows.*

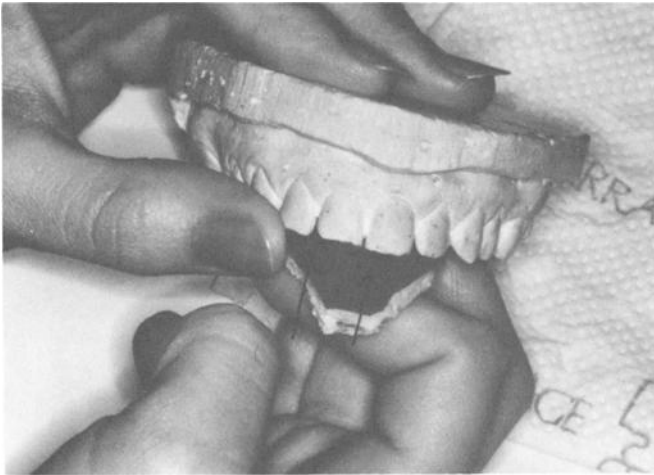


FIG. 6—*Suspect's upper model compared with bite mark tissue. See arrows.*

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suspect's upper model be examined more closely under a scanning electron microscope. Accordingly, acrylic models of both tissue and teeth were prepared and taken to the Georgia Division of Forensic Sciences for further study [6]. Both models were studied under SEM with the assistance of Mr. Bob Clemensen⁴ and appropriate photographs were taken. The SEM demonstrated considerable detail that was not previously apparent.

Case Preparation

As a result of correlation of SEM photographs, it was determined that the upper portion of the bite mark (Fig. 1) was made by the suspect's right lateral and central incisor, and upper left central incisor (Teeth 7,8, and 9, universal system, Fig. 2). All three of these teeth showed distinctive individual characteristics which corresponded remarkably with the three-dimensional characteristics in the bite mark itself. The upper right lateral incisor (7—Fig. 7, upper) showed an indentation along the center of the incisal edge which could segment the normal bite pattern into two halves. The comparable portion of the bite mark (Fig. 7, lower) showed dual depressions with a central area void of any marking. The upper right central

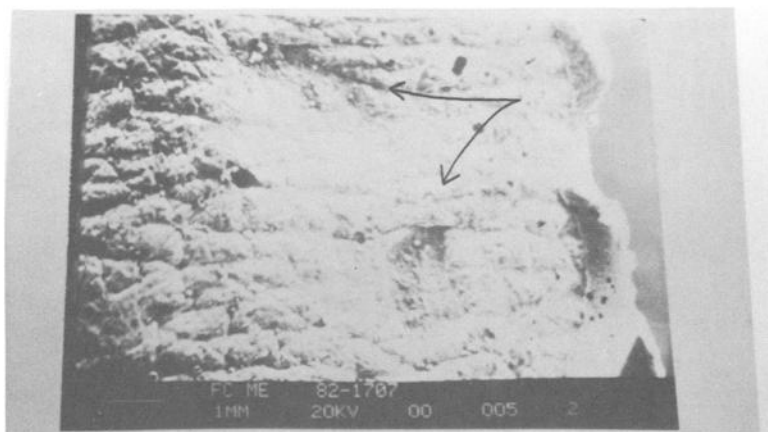
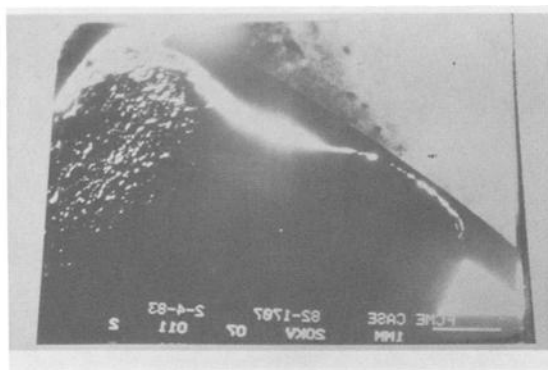


FIG. 7—SEM photograph, upper right lateral incisor (#7—above) compared with corresponding bite mark tissue (below). Magnification $\times 13.5$.

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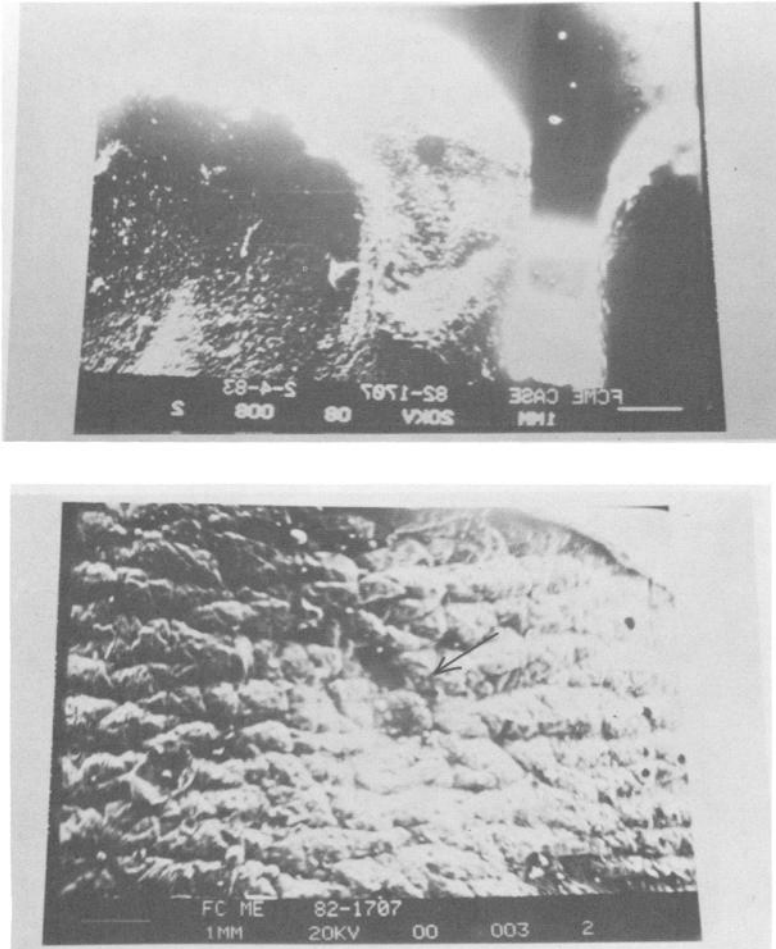


FIG. 8—SEM photograph, distal edge of upper right central incisor (#8-above) compared with corresponding bite mark tissue (below). Magnification $\times 13.5$.

incisor (8) showed two distinct fracture patterns and an island of intact tooth structure on the mesial portion of the incisal edge. The distal portion of the incisal (Fig. 8, upper) exhibited a sharp vertical fracture oriented approximately 45° to the facial plane. The center of the incisal edge (Fig. 9, upper) was fractured horizontally 1 to 2 mm coronal to the normal incisal plane, while the mesial portion (Fig. 9, upper) contained a small segment of tooth structure unaffected by fracture. The bite mark itself showed distal marking (Fig. 8, lower, see arrow) oriented approximately 45° to the tissue plane⁵ [7], a central void, and mesial marking (Fig. 9, lower, see arrow) corresponding to the unfractured tooth structure. The upper left central incisor (9, Fig. 10, upper, see arrows) contained a combination of wear facets and mamelon remnants which produced four prominences along the incisal edge. The outer two prominences were slightly coronal to the incisal plane while the inner two were even

⁵This fracture was so sharp as to produce a knife edge. Thus it created significant marking, despite being out of contact with the normal incisal plane.

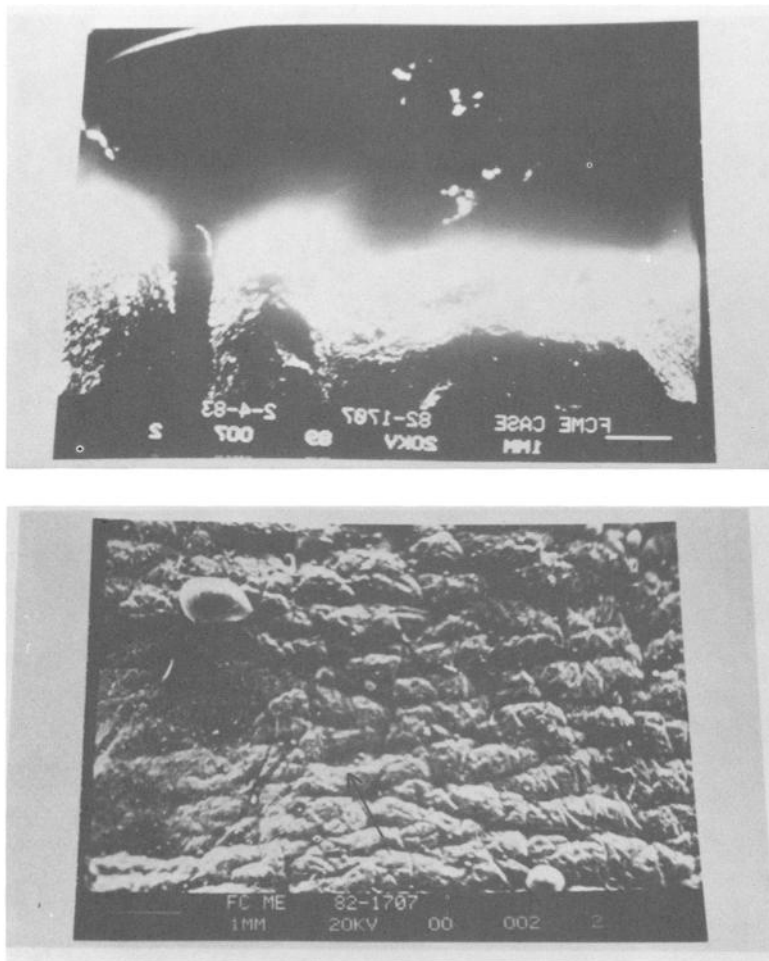


FIG. 9—SEM photograph, center and mesial edge of upper right central incisor (#8-above) compared with corresponding bite mark tissue (below). Magnification $\times 13.5$.

with it. The marking consistent with this tooth (Fig. 10, lower, see arrows) showed four distinct depressions. The two in the center were slightly superior while the outer ones were slightly inferior. All of these characteristics were consistent with a positive match between the suspect's teeth and the bite mark in question.

Conclusions

With the use of the SEM, what appeared to be class characteristics were clearly identified as individual characteristics [8]. Demonstration of these features would have been very difficult, if not impossible, without the SEM. The unique nature of the evidence became apparent when the effect of the third dimension was added to the testimony [8]. This corroboration increased the weight of the evidence markedly. Using the rationale of the Frye and Kelly precedents, the admission of bite mark evidence may be based solely on its weight as a whole rather than individual admissibility of each item [3,4,8]. Therefore, weight of evidence alone

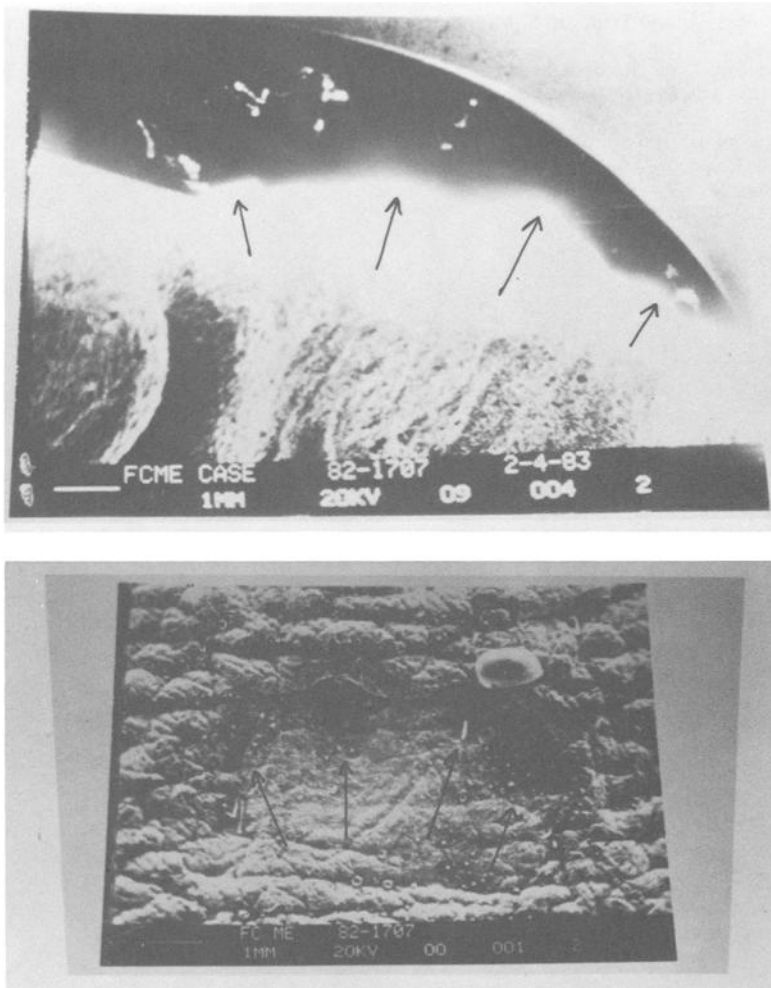


FIG. 10—SEM photograph, upper left central incisor (#9-above) compared with corresponding bite mark tissue (below). Magnification $\times 13.5$.

may determine whether the forensic odontologist testifies at all. In short, the use of all available methods can ensure that an expert's opinion is heard by the court.

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