Iain A. Pretty,[1] *B.D.S. (Hons), M.Sc. and David Sweet,*[2] *D.M.D., Ph.D.*

Adherence of Forensic Odontologists to the ABFO Bite Mark Guidelines for Suspect Evidence Collection

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ABSTRACT: Boards and associations within forensic science have long been accepted as vehicles for the development and dissemination of protocols and recommendations for practice. Recent controversies surrounding bite mark analyses have brought the methods and practices of forensic dentists to the attention of both the courts and the media. In the mid-eighties the American Board of Forensic Odontology developed guidelines for bite mark analysis in response to unfavorable commentaries on the discipline by legal observers.

The purpose of this study is to examine the adherence of board certified and noncertified forensic dentists to the guidelines for collection of evidence from bite mark suspects. A questionnaire was employed during an American Academy of Forensic Sciences meeting. Results showed that, in general, when the odontologists collected evidence they did adhere to the guidelines, although collection of salivary samples was not common. Of concern is the large number of odontologists who do not collect their own evidence from suspects. Police officers or other individuals often perform this task and therefore the guidelines must be disseminated to these groups to ensure that the maximum yield is obtained from bite mark evidence. A review of the materials used to collect evidence is also included with details of applications in forensic science.

KEYWORDS: forensic science, guidelines, bite marks, dental materials, odontology

Chapter 11 of the ASFO Manual of Forensic Odontology (1) is devoted to the American Board of Forensic Odontology's (ABFO) guidelines. The guidelines cover body identification, missing persons, developing a disaster dental team, and bite mark methodologies. The focus of this paper is those guidelines that pertain to the collection of evidence from suspects in bite cases. At this point it is important to note that the bite suspect may not necessarily be the "suspect" in a criminal sense, indeed it is often the victim of a violent assault who bites the attacker as a defensive action (2). These individuals are, however, considered bite mark suspects within the context of this paper.

Bite marks remain a contentious issue within the forensic dental field and dissenting opinions on the reliability and accuracy of the current methods employed are becoming increasingly common. The ABFO, who certifies specialists in forensic dentistry, have attempted to unify the discipline and achieve a degree of consistency of both quality and methodology. These efforts are extolled in the guidelines that are presented both in the ASFO Manual and also within the dental literature (3–6). The papers are widely quoted and the guidelines form an integral part of the examination required to achieve certification as a specialist and thus be known as a Diplomate of the ABFO.

The purpose of this paper is to examine if forensic odontologists adhere to the guidelines recommended by the ABFO. Previous studies have examined the adherence of Diplomates to the wording of bite mark conclusions recommended by the Board (7). The collection of suspect evidence was chosen for this study as it is frequently raised in court proceedings: did the odontologist collect the evidence correctly? Were suitable materials used? Were the procedures safe?

Inappropriate collection of suspect evidence, or the presentation of evidence of poor quality has been raised by defendants at trial and is difficult to defend when published guidelines exist to ensure that evidence is of the best quality achievable.

The Guidelines

Participants of the ABFO bite mark workshop developed the guidelines in 1984 (1). They are described as dynamic and open to modification should new techniques become available. The guidelines were first published in the ASFO's Manual of Forensic Odontology in 1984 and in the Journal of the American Dental Association in 1986. Revisions were made in 1994 and first published in the 1995 third edition of the ASFO Manual and have not been extensively updated since 1994. As a preface to the guidelines, Diplomates are informed that they are responsible for being familiar with the document and that they should be able to defend any departure from them if asked to do so.

The standards were developed to consolidate the multitude of techniques and methods that were being employed by forensic dentists. The force behind the guidelines was a desire to ensure a unified profession that aimed for excellence and continued to present bite mark analysis as a true science. It is hoped that this drive will secure the continued acceptance of bite mark evidence in court. With the recent rulings of *Kumho* and *Daubert,* judicial scrutiny of forensic science is increasing and now, more than ever, forensic dentists must be able to defend their actions in court. The ABFO guidelines present a mechanism for achieving this.

A summary of the guidelines can be found in Fig. 1. These guidelines have been taken from the ASFO Manual. It is interesting to note that in this Manual Type II dental stone is recommended

[1] Doctoral student, Department of Clinical Dental Sciences, Faculty of Medicine, University of Liverpool, England.

[2] Director, Bureau of Legal Dentistry, University of British Columbia, Canada.

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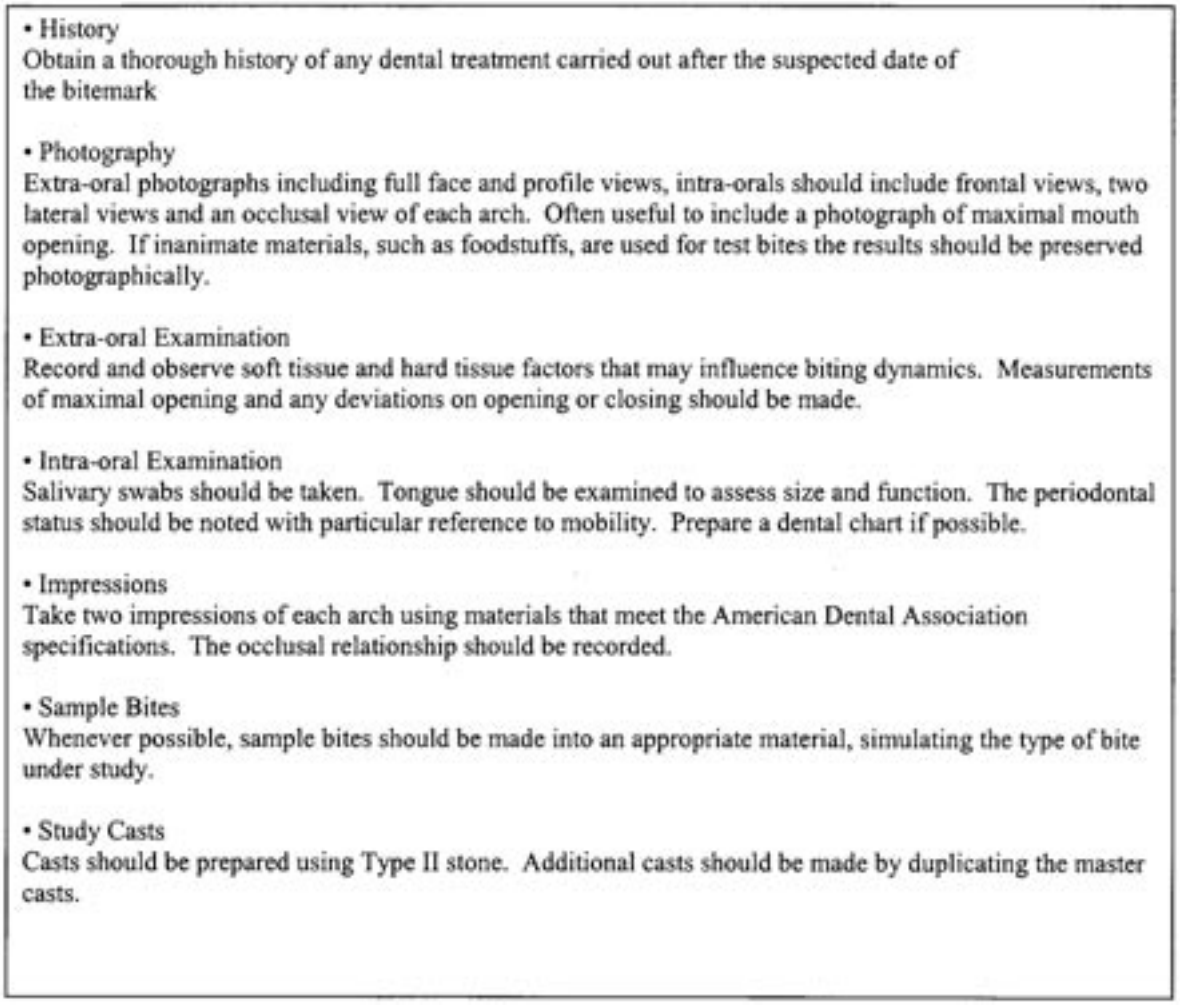

FIG. 1—*Summary of the ABFO guidelines for collection of evidence from a bite mark suspect.*

for casts. In the version of the guidelines published in JADA, Type IV dental stone is recommended. It is likely that the latter is the preferred stone as Type II is a weaker material, prone to fracture.

Materials and Methods

In order to collect data regarding odontologists' collection of evidence, a questionnaire was developed (Fig. 2). The study was carried out at the 1999 American Academy of Forensic Sciences Annual Scientific Meeting in San Francisco, CA. The subjects presented with the questionnaire belonged to one of two groups: a) Diplomates of the ABFO or b) members of the American Society of Forensic Odontology (ASFO). These groups were selected to investigate differences between the Diplomates who are required to be familiar with the guidelines and ASFO members who have no affiliation with the Board. Diplomates of the ABFO who were present at the ASFO meeting were requested not to complete the questionnaire to ensure separation of results.

In addition to data relating directly to the guidelines the subjects were asked their level of experience and to indicate if, as part of their clinical examination, they examined the tooth mobility of the suspect. This question was posed as tooth mobility represents a potentially significant source of error in subsequent analysis and the examination of mobility is stated specifically in the guidelines.

Results

In total, 69 questionnaires were correctly completed. Forty-one responses (59%) were received from Diplomates and 28 (41%) from ASFO members. Figure 3 illustrates the self-reported number of bite mark cases performed by Diplomates and nonDiplomates each year. Table 1 illustrates the evidence collected by respondents and Table 2 shows the impression and cast materials utilized.

Discussion

Cases Completed

The majority of non-Diplomates completed between zero to one cases per year. Most Diplomates were involved in five cases or less. Two Diplomates and one non-Diplomate carried out 20 or more cases. The non-Diplomate in this case is likely to be an experienced forensic odontologist who has not challenged the certification exam. The relatively low number of bite mark cases analyzed by individual forensic odontologists is recognized as a limiting factor in gaining experience and certification for younger odontologists. Agencies requesting experts for bite mark examinations will tend to choose those with extensive and documented experience. This is prudent practice although it does threaten the ongoing availability of individuals with training in bite marks. The formation of

Questionnaire for Diplomates of the American Board of Forensic Odontology.

Materials used in the collection of bitemark suspect exemplars.

Dear Diplomate,

The purpose of this questionnaire is to assess the evidence that is collected from bitemark suspects and to examine the materials and methods used to achieve this. The results of this study may be published in the forensic literature. Confidentiality is ensured and you should not place your name on this form. If you have any questions regarding this questionnaire please contact me at the address at the end of this form. Thank you for your assistance.

Kindest regards,

Iain A Pretty.

Please circle the appropriate response:

1 How many bitemark cases do you participate in? Use a figure for an average year.

0-1 **2-5** **6-10** **11-15** **16-20** **20+**

2 Do you personally collect evidence from bitemark suspects?

Yes, always **No, never** **Sometimes**

3 If the answer to question 2 was 'No, never', please indicate who normally collects the evidence and return this questionnaire. Thank you.

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.....
.....

4 Please indicate the exemplars that you would normally collect.

Photographs **Wax Bite** **Dental Impressions** **Clinical Exam** **Saliva Swab**

5 If you indicated dental impressions on your previous answer, please describe the material you use to take these impressions. Indicate both the type of materials and, if appropriate, the brand that you use most commonly, E.g. Alginate, Kerr Dental, Medium Viscosity. E.g. Vinyl polysiloxane, Coltene President, Light Body

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6 If you indicated dental impressions in Question 4, do you routinely pour you own casts? If so what material do you use? E.g. lab stone, die stone etc....

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7 If you indicated clinical examination in Question 4, do you routinely examine the mobility of the suspects' teeth?

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8 Do you collect any additional exemplars that were not listed in Question 4? Please give details.

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Thank you for completing this questionnaire.

FIG. 2—*The questionnaire.*

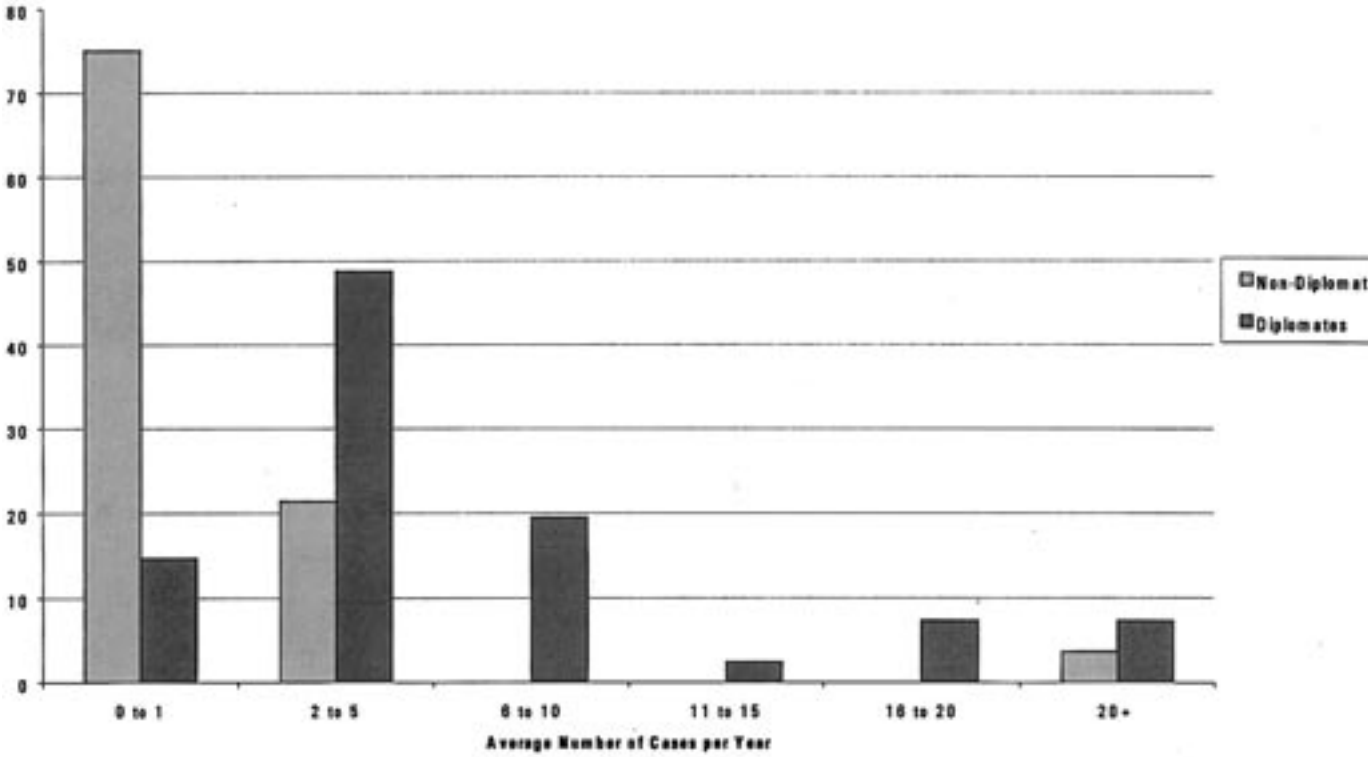

FIG. 3—*Comparison of bite mark cases (self-reported) performed by ABFO Diplomates and non-Diplomates per average year.*

TABLE 1—*Results of questionnaire indicating whether or not the odontologists collected their own evidence and what evidence was collected on those occasions.*

	Evidence Collected Personally?			Evidence Collected					Tooth Mobility Checked?	
	Yes, %	No, %	Sometimes, %	Photographs, %	Wax Bite, %	Dental Impressions, %	Clinical Exam, %	Saliva Swabs, %	Yes, %	No, %
Diplomates	37	2	61	100	93	100	93	62.5	83	17
Non-Diplomates	61	15	33	100	95	100	95	54	77	23

n = 69, Diplomates 41, non-Diplomates 28.

TABLE 2—*The material types reported by the questionnaire respondents for both impression taking and for cast pouring.*

	Impression Material*				Cast Materials*		
	Alginate, %	VPS,† %	Putty & Wash Systems, %	Polyether, %	Orthodontic Stone, %	Lab Stone (Yellow), %	Die Stone, %
Diplomates	61	34	10	…	11	30	59
Non-Diplomates	57	40	…	3	8	23	74
Brands indicated	Jeltrate De Trey	3M Express 3M Extrude Rapid (Coltene) Light Body Heavy Body Medium Body	Reprosil President F 3M Express	Impregnum F	Kerr Generic	Kerr Generic	Kerr Die Keen Generic

NOTE: n = 69, Diplomates 41, Non-Diplomates 28.
All brand names are trademarks of their respective manufacturers.
* Some responders indicated the use of more than one material.
† VPS - Vinyl polysiloxane.

a mentoring system between odontologists with a large caseload and those with less bite mark experience presents a method of addressing this issue.

Evidence Collected

The study found that the majority of Diplomates did not collect the bitemark evidence personally on all occasions. Many respondents indicated that police officers collected this evidence and therefore they were usually only involved in the analysis of the injury. This result differs from the 61% of non-Diplomates that reported personally collecting suspect exemplars. There could be many explanations for this difference. Speculatively, it could be suggested that as non-Diplomates have a lower bite mark workload than their Diplomate colleagues, they find sufficient time to assist in the evidence collection personally. The collection of evidence is also an aspect of the Board certification procedures. Therefore, those non-Diplomates who wish to challenge the Board exam will need this experience. Another potential explanation is the proportion of defense cases undertaken by each group. While this information was not collected in this study, anecdotally it is more common for experienced odontologists (Diplomates) to be invited to review the evidence for the defense. When handling such cases the suspect is often not available, or such a time lapse has occurred that it would no longer be of use to collect evidence from them. Such review cases normally use the materials collected by the first investigator.

There are diverging opinions on the value of evidence collection. Some investigators believe that meeting with the suspect can taint the unbiased approach to bite mark analysis that must be taken; others believe that valuable information may be unreported or missed unless an expert examines the suspect. Often suspects are located in facilities that are not within commuting distance of the forensic dentist and this can often play an important role in the decision to collect evidence personally.

In general, both the Diplomates and non-Diplomates adhered to the guidelines for suspect collection. The collection of dental impressions and exposure of photographs was performed by all respondents. The collection of a wax bite exemplar was less frequent, but still extensively used. Some individuals stated that, although they didn't collect a wax exemplar, they used another material to record the biting relationship, including Styrofoam and dental materials used for occlusal analysis. The wax bite therefore may have differing uses.

Five percent of Diplomates and 7% of non-Diplomates reported that they did not routinely perform an oral examination. This is a surprising result. The oral examination can reveal a multitude of information including whether or not recent dental treatments have been carried out, the number of teeth present and their restorative condition, loose or poorly fitting crowns, recent extractions, maximal mouth opening and other clinical data. Only 83% of Diplomates and 77% of non-Diplomates who stated that they performed a clinical examination carried out an examination of tooth mobility. The recording of tooth mobility is specifically described in the guidelines and loose teeth represent a potentially significant source of error in bite mark analysis.

Most forensic odontologists are not collecting salivary samples from suspects. It is likely that this is a reflection of the nature of seizure warrants. Typically dental warrants will not permit the taking of DNA samples from suspects for which a separate court order is required. The value of salivary evidence is well documented and represents a highly effective method for biter identification (8–10). It should be noted that some odontologists (12% Diplomates 7% non-Diplomates) reported that another party usually collected DNA from suspects. While the collection of DNA evidence from a suspect is usually beyond the remit of the forensic odontologist, the swabbing of bite mark victims for salivary evidence is not.

Materials Used

Alginate was the most popular choice for both groups of forensic dentists for impression taking. Alginate was followed closely by the vinyl polysiloxane (VPS) materials. Many respondents (58%) indicated that they used a variety of materials, often on the same case (i.e., one alginate and one VPS impression). One individual used a polyether impression material. A large proportion of the dentists questioned indicated that they used an American Dental Association (ADA) approved product (42%). The use of such materials is recommended by the ABFO.

Alginate

Irreversible hydrocolloids (alginates) are supplied as powders that are then mixed with water (11,12). A summary of the composition of alginate is given in Table 3. Freshly mixed alginate has a low viscosity although the manufacturer can modify this, and many grades of alginate are now available. One main advantage of the alginates is their rapid setting reaction combined with an adequate reaction time (13). Alginates are flexible enough to be withdrawn easily from the mouth in most cases.

The disadvantage of alginates is poor mechanical properties. Alginates are liable to tear when being withdrawn from deep undercuts or proximal areas particularly in the anterior region. This can be minimized with the use of an alginate adhesive system (14). Alginates must also be poured promptly according to the manufacturer's recommendations, usually within 2 h if kept moist, as they tend to lose dimensional stability via synerisis (12). Syneresis is the drawing together of particles in a gel, with expulsion of water, leading to shrinkage of the material.

It is usual to only pour one cast from each alginate impression, although if care is taken not to tear the material, subsequent casts of acceptable accuracy can be poured (15). Another method of achieving multiple casts is to take repeated impressions of the cast produced from the initial impression. Multiple casts are often required for court exhibits, although the original cast should be kept untouched and presented in court so that the trier-of-fact can see an exact duplication of the suspect's teeth. The ABFO states that ad-

TABLE 3—*Typical composition of alginate impression materials. After McCabe (11).*

Material	Function
Sodium or potassium Salt of alginic acid	This is the main reactive component of alginate forming the sol initially and then the gel.
Gypsum	Provides calcium ions that are used to cross link the alginate chains.
Sodium phosphate	Controls the working time of the product.
Inert filler	Allows easy manipulation and mixing of the product.
Reaction indicator	Modern alginates change color as the cross link reaction takes place.

ditional casts may be fabricated in appropriate materials for special studies. As with all materials exposed to the oral cavity it is important to disinfect alginate impressions. This is especially important considering the higher rate of blood borne pathogens found in prison populations. The use of sprays and immersion systems has been suggested with varying degrees of success (16). It is thought that the alginate surface is particularly attractive for bacteria and other oral pathogens (17). Studies have shown that casts produced from disinfected (immersed) alginates compare favorably in terms of accuracy and dimensional stability with nondisinfected casts (18).

One of the stipulations that courts impose is that evidence collected from suspects must be obtained quickly and painlessly with minimal intrusion of privacy. The use of alginate materials satisfies these requirements, although those products with low viscosity can cause gagging when taking maxillary impressions (19).

Vinyl Polysiloxanes (VPS)

These materials are also known as polyvinylsiloxanes (PVS) and, more correctly, as addition reaction silicones. More accurate and stable than condensation cured silicones and alginates, VPS materials form a highly cross linked material without any by-products (20). These materials are supplied as two pastes each containing a liquid silicone prepolymer and filler and one paste with a reaction catalyst (11). The tubes are frequently incorporated into a convenient cartridge delivery system.

This group of impression materials is supplied in a range of viscosities, including light, medium, heavy, and putty. There are usually two methods commonly employed: a) one stage technique or b) two stage technique. In a one-stage technique either medium viscosity material alone or heavy-body with light bodied added are placed in the mouth. A two-stage technique usually employs putty or heavy-body material that is used to create an initial impression. A wash of light-body material is added to this first mold and then the impression is reseated. This two-stage system is usually employed when fine detail is required such as details of crown or bridge preparations, but is used infrequently in forensic practice. VPS materials have a significantly longer working and setting time than alginates that may have an impact upon suspect and court acceptability.

The materials are very hydrophobic and are displaced by saliva and so the areas of the mouth in which the highest detail is required should be dried. The consequence of using these materials in a wet field is the occurrence of "blow holes" (11). Materials have recently been developed that have improved wetting capabilities. The VPS materials have excellent dimensional stability and may be poured up to seven days after the impression is taken (20). The materials can be used for multiple pours without loss of accuracy. VPS materials are significantly more expensive than alginates and the cartridge systems are the most costly of the group.

Table 4 illustrates some common brands of both alginate and VPS materials.

Cast Materials

The results indicate a wide spread of stone types used to pour impressions. The confusion within the ABFO guidelines mentioned previously makes a definitive recommendation difficult. The majority of all respondents used a die stone for casts. This is a strong gypsum product and is ideally suited to casting suspects' impressions. The transportation of casts to and from court or between experts requires the use of a stronger material less prone to fracture.

TABLE 4—*Variety of impression materials in each category.*

Alginates	VPS
Alginoplast (Bayer)	Elite H-D (Zhermack)
Aroma Fine (G-C)	Express (3M)
Blend-a-Print (Crest)	Extrude XP (Kerr)
Blueprint Cremix (Dentsply)	Perfexil (Septodont)
Hydrogum (Zhermack)	President (Coltene)
Jeltrate (Dentsply)	Extrude MPV (Kerr)
Xantalgin (Bayer)	Imprint (3M)

For this reason the use of plain dental plaster should be discouraged. In order to avoid any potential legal uncertainties, ABFO should clarify its guidelines on this point.

Conclusions

The adherence of both groups of forensic dentists questioned in this study to the ABFO guidelines was good. An area that falls short of complete adherence is the clinical examination and, further to this, the detection and recording of tooth mobility. This is a serious shortcoming. Every suspect, warrant permitting, should undergo a thorough clinical examination. Forensic dentists who neglect this aspect of evidence collection could face harsh criticism when testifying in court or presenting to peers. Further work is required to encourage odontologists to collect saliva from both bite marks and suspects whenever possible. The authors recommend that a forensic dentist, preferably the individual who will ultimately analyze the injury, collect the evidence from the suspect. In this way, it is assured that a clinical examination will be properly conducted and the evidence collected proficiently. Additional emphasis of this point within the ABFO guidelines may help to clarify this issue, although what is implicit from the guidelines is that the Board expects that a dentist will collect the evidence.

It is important to note the variability of warrants and the range of evidence that may be collected under them. It is possible to have certain items of evidence excluded from a warrant that may be pivotal to the bite mark assessment. Generally the evidence that is collected from bite mark suspects can be done in such a way to cause very little discomfort to the suspect and is not regarded as invasive. It is important for the forensic odontologist to work with the police service to ensure that the warrant applications contain all evidence types required and that the reasons for each item are carefully explained.

The materials employed by the odontologists are acceptable and defendable in court. Alginate is thought to be appropriate for forensic use although those odontologists that take impressions using two or more materials should be applauded for their thoroughness. The advantages inherent in VPS may be useful for many odontologists; particularly those who find the immediate pouring of casts difficult. Disinfection of impressions is an important feature to protect staff and examining dentists.

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Additional information and reprint requests:
Iain A Pretty
Clinical Dental Sciences
Edwards Building
School of Dentistry
Daulby Street
Liverpool, L69 3GN
England
Phone: (0151) 706 5288
Fax: (0151) 706 5908
E-mail: ipretty@liv.ac.uk