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A Web-Based Survey of Odontologist's Opinions Concerning Bitemark Analyses

ABSTRACT: Within the field of forensic dentistry, the detection, collection, and analysis of bitemarks remains one of the most contentious areas. Attempts at the production of consensus documents have produced documents such as the ABFO's Guidelines for Bitemark Evidence Collection. Despite this, the range of differing analysis techniques, allied with a varied opinion base on the robustness of bitemark conclusions has led to polarized views within the profession. The purpose of this study was to survey forensic dentists to obtain their views on a number of crucial components of bitemark theory and contentious areas within the discipline. Using a web-based survey, 14 questions were asked of respondents. Seventy-two odontologists completed the survey, with 38% being of Diplomate status, 10% had completed 20 or more bitemark cases, and 20% between 10 and 20 cases, 91% of respondents believed that the human dentition was unique, with 78% believing that this uniqueness could be represented on human skin during the biting process. Seventy percent believed that they could positively identify an individual from a bitemark, and 22% stated that the statistical tool, the product rule, should be applied to bitemark conclusions. Over half of the odontologists used overlays for bitemark analysis, with a digital method of production the most popular. The implications of these and other findings are discussed.

KEYWORDS: forensic science, forensic dentistry, opinion, bitemarks, statistics, odontology

Within contemporary forensic dentistry, there are five main areas of practice: a) human identification, b) mass disaster assistance, c) bitemarks, d) abuse (child, spousal and elder), and e) dento-legal issues (1–3). A sound consensus of opinion in relation to detection, collection, analysis and presentation of findings in relation to human identification, the mass disaster process, human abuse, and, to a lesser degree, dento-legal work exists. However, the field of bitemark analysis does not enjoy such homogeneity of opinion (4). This is seen in the polarized views of odontologists within the judicial system, with, in one case, one expert stating that a suspect has been positively identified from a bitemark, and another expert stating that the injury is unlikely to be caused by teeth at all (5–8).

Previous works have determined that a number of key contentious issues exist within bitemark analysis: a) the accuracy of human skin as a registration material for bitemarks, b) the uniqueness of the human dentition and the application of statistics to quantify this, and c) the analytical techniques employed (9). These areas of contention have been determined from reviews of scientific literature and therefore represent the views of a scientific minority, rather than the majority of operational forensic scientists. A potential "ivory-tower" bias exists, and therefore the purpose of this study was to gage the views of a large number of odontologists to see if such concerns were reflected in their responses to a number of questions.

It is important to note that the discipline has recognized the discord surrounding bitemark analyses and has worked hard to produce consensus documents. Instrumental in this process has been the American Board of Forensic Odontology (ABFO) who have produced a range of guidelines covering evidence collection from bitemark suspects and victims, bitemark analysis techniques, and bitemark report writing, including a thorough discussion on the terminology of conclusion levels within forensic reports (10–12). Despite this, forensic case reports and discussion of analytical techniques continues to raise issues of consistency (13).

Materials and Methods

In order to reach as many odontologists as possible, and employ an economical design, a web-based survey system was employed. The survey was written in PEARL and hosted on a standard internet server. Individuals visiting an odontology website (www.forensicdentistryonline.org) were asked to participate. A link was also placed on a popular forensic search engine (www.forensic.to) and individuals were asked via e-mail to volunteer. An example of the manner in which the questions were delivered is shown in Fig. 1. Each screen contained two questions, and following completion of the survey, the respondent was shown a summary of the results. The questions asked in the survey were designed to illicit: a) initial demographic information, including the experience and training level, b) opinions on the uniqueness of the human dentition, c) representation of any asserted uniqueness on skin, d) use of statistics, e) analysis techniques, and f) adherence to guidelines. A total of 14 questions were posed, and the survey was available on the website for a total of six months.

In order to ensure that the data collected reflected the opinion base of those who are operational within the field of bitemark analysis, responses from individuals who had not completed one bitemark case were not included in the analysis. Using I.P. address mapping, individuals could only answer the survey once from any given location. The survey was carried out anonymously with the responses e-mailed to the investigator following completion. It is considered that a completed bitemark case is one where the respondent has examined primary materials, conducted an analysis,

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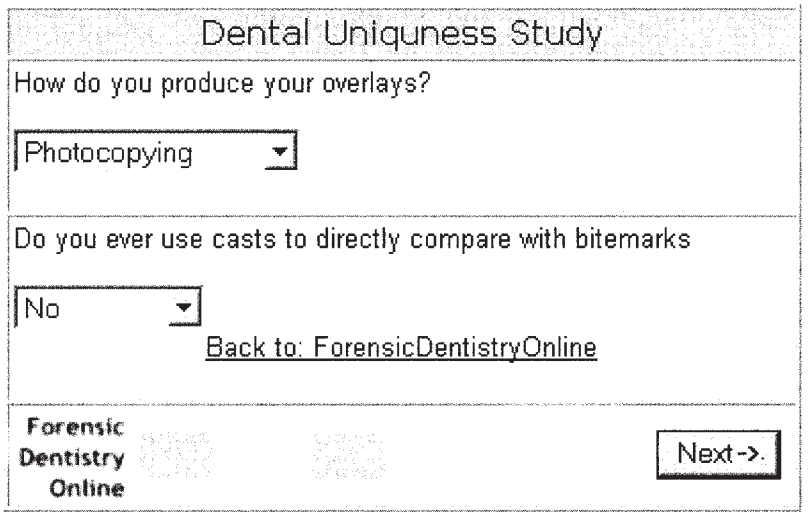

FIG. 1—*Survey form.*

and produced a written report describing the results of the analysis and the conclusions that can be drawn from them.

Results

Seventy-two odontologists completed the survey with a further 56 individuals taking part who had no bitemark experience. The data from these individuals have not been included within the survey. Categorized by their highest level of expertise; 38% of the respondents were Diplomates of the American Board of Forensic Odontology; Academy of Forensic Sciences (AAFS) Fellows (3%), AAFS Members (33%), ASFO Members 24% and others (including European specialists) 2%. The number of bitemark cases undertaken was broken down into categories with 10% of the respondents undertaking 20 or more cases, and 20% having completed between 10 and 20, only 4% of the total had completed 2 or less cases. Those of DABFO status represented 78% of total that had completed 20 or more bitemark cases.

Ninety-one percent of the forensic dentists questioned believed that the human dentition was unique, with only 1% stating that it wasn't, and 8% were unsure; 78% believed that this uniqueness was replicated on human skin during the biting process; while 11% believed that it wasn't, 11% were unsure, 96% of ABFO Diplomates in this survey stated that the human dentition was both unique, and accurately registered on human skin during the biting process.

When questioned concerning the ability of suitably trained individuals to positively identify an individual from a bitemark on human skin (i.e., to state that an individual caused a bitemark to the exclusion of all others), 70% stated that this was possible, 5% stated that it wasn't scientifically sound and 25% stated that this could only be done in certain circumstances. The next question concerned the application of statistical "product" rule to bitemark analyses: 60% of the respondents did not know what the product rule was, 22% thought that its use was justified, 9% believed that it shouldn't be used and 9% were unsure.

The questionnaire then investigated the use of transparent overlays in bitemark analysis; 63% of the respondents (93% of ABFO Diplomates) stated that they used overlays routinely, 18% never used overlays and 20% used them occasionally. The reported method of overlay production is shown in Fig. 2, and it is important to note that 18% of individuals reported that they used at least two of these techniques in tandem; 76% stated that they also used the bite suspect's dental cast to compare directly to the injury, 43% had used DNA in a bitemark case, 45% hadn't and 13% stated that they wouldn't know how DNA could be used for bitemark analysis.

Adherence to ABFO guidelines was investigated, 70% followed the evidence collection guidelines entirely (with the exception of skin harvesting), 11% some of the guidelines and 17% weren't aware of the document. Similarly 73% followed the analysis guidelines, with 20% being unaware of the details of the ABFO paper.

When questioned if bitemarks should only be used to exclude a suspect, 22% (6% Diplomates of ABFO) agreed with this, 69% disagreed and 8% were unsure. Finally, when asked if forensic odontologists with an appropriate level of training should continue to analyze and render opinions in bitemark cases 86% responded positively, with the remainder being undecided.

Discussion

Respondents

The survey represents a good spread of odontological opinion, with 72 odontologists of which 38% represent those individuals with the highest level of training and experience (Diplomates of the ABFO). The bitemark caseload undertaken is similar to that elicited in a previous study, and demonstrates the wide range of bitemark experience which is gained during an odontologist's career (12,14). With traditional survey techniques it is usual to report a response rate, however, as this was a web-based survey this information is not available. Despite this, the web survey has many advantages; it is economical with little or no cost, it is available worldwide and it is novel and interesting for the respondents to use (15).

There have been relatively few surveys of forensic odontologists to which the current study can be compared. Two studies have examined the adherence of odontologists to the ABFO guidelines for evidence collection from bite mark suspects and victims, each describing the responses from 69 (41 Diplomates) and 34 (8 Diplomates) respondents respectively (11,12). In 1994 a survey examining odontologist's case load was conducted by Atkinson with a response rate of 27 individuals (14). Like the current work, Atkinson found that the vast majority of the bitemark cases were

conducted by a small minority of experienced odontologists (14). The sample size of this study is reasonable given the small number of individuals active in conducting actual casework compared to those with an expressed interest in the subject.

Opinions on the Uniqueness of the Human Dentition

The uniqueness of the human dentition and the assertion that this uniqueness is replicated in bitemarks forms the central dogma of bite injury analysis. It is generally accepted that the arrangement of the mandibular and maxillary anterior teeth is unique when measured with sufficient resolution; however, the fact that these features are replicated, in even the most significant bitemarks, is far more contentious. A recent review of the literature demonstrated that there is little empirical evidence to support this claim, and that which was available was often scientifically flawed (9). It was interesting therefore to note that the overwhelming majority of odontologists, despite these concerns, are quite satisfied that bitemarks demonstrate sufficient detail of the suspect's dentition.

Peer-reviewed support for this assertion is, as previously described, limited. It would appear that this confidence in the scientific basis for bitemarks is based upon anecdotal knowledge and experience. In the new climate of increased judicial scrutiny heralded by *Daubert* more research is required to confirm this fundamental basis for the science of bitemark analysis.

An interesting side issue surrounding the individuality of the human dentition is the use of the product rule. This was employed in the study that many odontologists claim prove the uniqueness of the dentition. However, several authors have re-examined the study and have found the use of the product rule flawed, due mainly to the lack of independence of tooth position (16). Nearly a quarter of the respondents in this study agreed with the use of the product rule, while many had never heard of the term. The discussion on the appropriateness of the product rule has been discussed extensively within the literature, at conferences and on numerous odontological websites. It would appear that many individuals would state that the human dentition is unique and yet they have little knowledge of the evidence to substantiate this claim, or some of the controversies surrounding works that have claimed to support their views. In court, experts should be able to cite peer-reviewed works that substantiate their claims, and it is the duty of any individual appearing in court or preparing expert reports to be aware of the science, or lack thereof, surrounding their discipline.

Analysis of Bitemarks

There is a plethora of methods for the analysis of bitemarks and this study has demonstrated that transparent bitemark overlays are one of the more popular methods, with over 90% of Diplomates using them. Several methods of overlay production were examined, and the digital techniques predominated. Interestingly a study published in 1998 determined that the digital techniques were superior to other methods; however, many odontologists were still employing hand-drawn or radiographic overlays (17). In the post-*Daubert* era, it could be argued that once published evidence suggests that one technique is superior to another, the use of an "inferior" technique must be justified. Currently only one study has examined the relative accuracy of overlay production methods and perhaps odontologist are waiting for further evidence before changing their techniques (17).

The use of DNA in the assessment of bitemarks has been established for some time, although previous studies have suggested that the uptake of this technique has been slow. It is encouraging to note that nearly half of the respondents in this case have employed biological evidence in a bitemark case. The use of this objective method has been well described and the advantages of the technique over the more subjective overlay systems are well accepted. However, it must be noted that DNA is not available in all cases

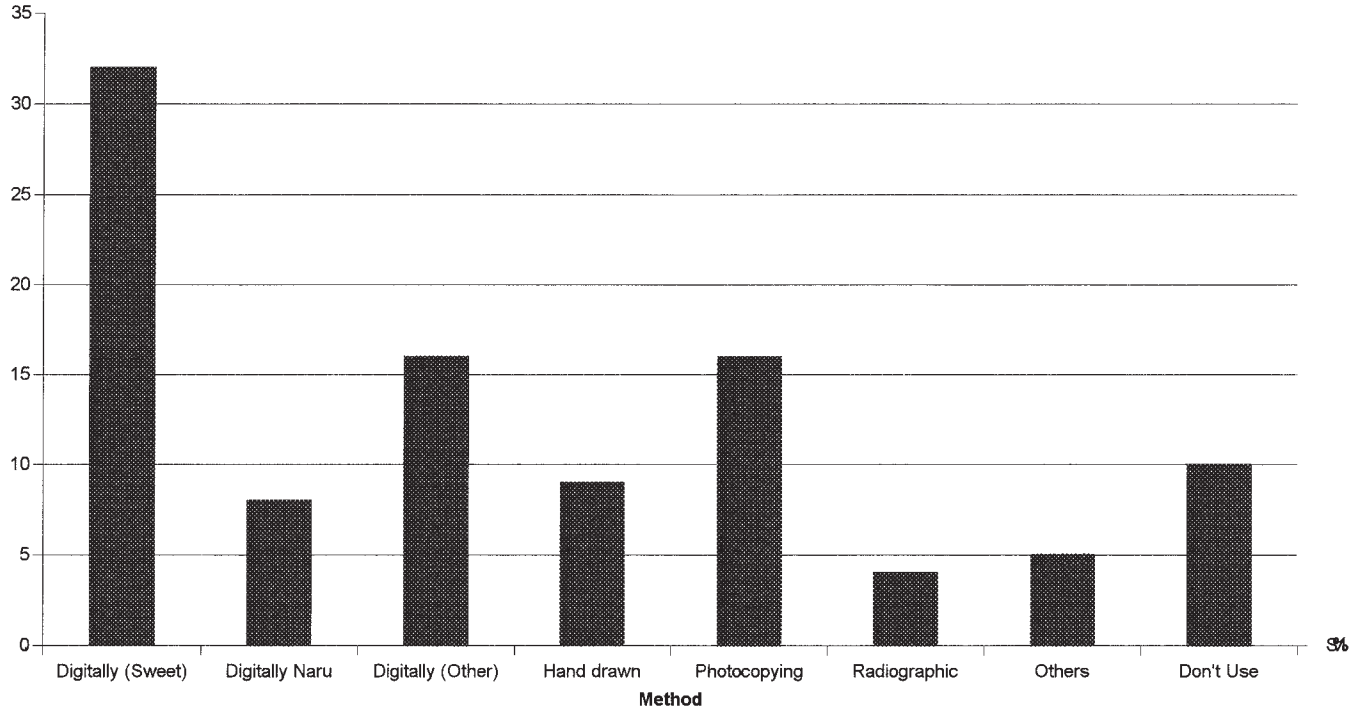

FIG. 2—*Method of overlay production call respondents.*

and therefore efforts to decrease the subjectivity of the overlay techniques are still warranted.

Adherence to Guidelines

Two previous studies have examined the adherence of odontologists to the ABFO Guidelines for evidence collection from bitemark suspects and victims and found that the guidelines were well accepted (11,12). The same is found in this study; with the vast proportion following both the collection and analysis guidelines. Adherence of the odontological community to a single set of guidelines is important to ensure that the consistency of approach. It strengthens the discipline as a science, but it is essential that the guidelines are updated to reflect an evidence-based or research-informed approach. The guidelines were last updated in 1986 (10,18). The guidelines are now available on a number of on-line sites and therefore the penetration of these guidelines is likely to increase.

Exclusion of Suspects

It has been proposed, by odontologists who are concerned about the level of subjectivity in traditional bitemark analyses, that bitemark evidence should only be used to *exclude* a suspect (19). This is supported by research which shows that the exclusion of non-biters within a population of suspects is extremely accurate; far more so than the positive identification of biters (20,21). Two independent studies have both reached this conclusion. However, the respondents in this study have not supported this principle, with less than 10% of individuals agreeing with the proposition. Again, the acceptance of published research among the odontological community is apparently low. This may change as courts review the published literature before accepting evidence under *Daubert.* If odontologists disagree with the results of individual studies, further research should be undertaken. There is currently a real hiatus of quality controlled investigations into bitemark analysis.

Continuing Use of Bitemark Evidence

Perhaps, the most important result of this study was that none of the respondents thought that bitemark analysis should be suspended and the vast majority agreed that such evidence should be analyzed and reported on by appropriately trained individuals. This belief in the process of bitemark analyses is echoed in the number of cases being assessed, but the scientific support in the peer-reviewed literature is lacking.

Conclusion

There appears to be little concern in the odontological community with regard to the effectiveness of bitemark analyses. However, recent studies examining the scientific evidence for bitemarks, and those examining the accuracy of techniques, suggests that the continuing use of bitemark to positively identify suspects may need to be revisited. In any event, there is a need for further research to develop more objective analysis techniques and demonstrate the error-rates of such techniques in the hands of odontologists. The ABFO are to be commended for developing a series of guidelines that have been well accepted and may represent the best method of informing active odontologists about further developments and research in the field.

The use of a web-based questionnaire has been shown to reach a large number of odontologists in an economical method and may be of use in other forensic investigations.

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