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Expert Disagreement in Bitemark Casework*

ABSTRACT: Bitemark cases continue to raise controversy due to the degree of expert disagreement which is frequently seen. Using a case mix of 49 bitemark cases from 2000 to 2007 each injury was independently assessed for its forensic significance using a previously described bitemark severity scale. Following the assessment, the mean value for the bites was categorized according to the crime type, the degree of expert agreement, and the judicial outcome. Results suggest that bitemarks found in child abuse cases have statistically significantly lower forensic value than those in other crime types, that bites where there is mutual agreement between experts will have higher forensic value than those where there is disagreement at trial, and that cases in which DNA has provided an exoneration will demonstrate similar quality to those where a conviction was secured. Forensic odontologists should carefully assess bitemark evidence and ensure that it meets certain minimums in relation to the presence of class and unique features before undertaking an analysis.

KEYWORDS: forensic science, bitemarks, legal, validity, quality, disagreement

Bitemarks can be important physical evidence in the prosecution of violent crimes (1). The ability for an injury pattern to be linked to the dentition of a suspect can represent compelling evidence of guilt. There are two prerequisites upon which the basis of bitemark analysis is based; the first that the human dentition is unique with respect to the position, shape, and characteristics of the anterior teeth and the second that these unique features are represented on the bitten substrate, most commonly skin in criminal cases, with sufficient detail to enable a comparison (2). A large body of scientific work has aimed to prove the first of these prerequisites although it has often been plagued with methodological errors and assumptions regarding statistical probabilities of uniqueness (3). However, there is a general acceptance that the teeth of an individual are unique, although the *degree* to which a given *individual's* dentition is unique will vary. Certainly those individuals with gross discrepancies of tooth position, number, or arch shape will be recognized by lay juries as unique within a population of possible biters (1).

Work on the second basis for bitemark analysis is more problematic. It is certainly possible for a trained forensic odontologist to examine the dental casts of several individuals and identify and characterize the differences between them. However, when this comparison is undertaken using marks and patterns on skin, a poor registration material, the position is more uncertain (4–6). A review of the appellate cases in the US found that a large percentage of cases featured testimony from opposing odontologists disagreeing on whether or not the injury was a bitemark or not (7). This was often compounded by the fact the prosecution odontologists were able to link an injury, positively, to a suspect. This degree of disagreement is not often seen in other comparative forensic disciplines, for example within fingerprint testimony (8).

The results from the legal review have been supported by a number of high profile cases, again from the US, where cases in which individuals have been found guilty, predominantly or even exclusively on bitemark evidence, have been overturned following a DNA exoneration (8). In many of these cases the bitemark injuries were of low forensic significance, i.e., they offered only gross or class characteristics of teeth, rather than the unique features which are necessary to positively identify an individual (8).

In an effort to enable forensic dentists, pathologists, lawyers, and others within the judicial system to gauge the forensic quality of a bitemark a visual and written index was developed (9). This scale differed from those used previously in that it linked the severity of the bitemark to its forensic significance. In brief, those injuries at the extremities of the severity scale (mild, diffuse bruising, or avulsive injuries) offered the poorest forensic evidence while those in the center of the scale, injuries with lacerations, generally offer the most forensic detail. It was hoped that the scale could be applied at the beginning of a bitemark assessment to enable odontologists, and those commissioning their services, the ability to place the injury into context and understand the limitations of any analysis of the pattern.

The scale was developed and validated using a number of professional groups and a good level of agreement was achieved. However to demonstrate its utility within forensic case work, and identify issues within cases with a poor outcome (as measured by appellate courts overturning convictions) the current study sought to apply the index *post-hoc* to a number of bitemark cases. The value of this work is to establish if the index scale can be a predictor of bitemark case success; i.e., if a bitemark of low forensic significance was positively linked to a suspect and led to a conviction was this subsequently overturned on appeal?

The bitemark severity and significance scale is a linear scale with respect to severity; i.e., level 1 is the lowest level of severity and this rises to level 6 which is the highest. However, significance is not linear, with the most forensically significant injuries occurring in the 3 and 4 levels, with 1, 2 and 5, 6 representing poor significance. For the purposes of this study (in order to use appropriate statistics) the scale was adapted to linearize the significance portion of the scale. This was undertaken by recoding the severity score variables within SPSS to ensure linearity; thus levels 1 and 2 are poor significance and 5 and 6 represent the most significant injuries in terms of the presence of unique characteristics (9).

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Materials and Methods

A total of 49 bitemark cases dating from 2000 to 2007 were employed within the study. Each of these cases had been the subject of a US appellate proceeding in which the bitemark evidence was questioned by the defense. In each case photographs of the bite injury, as used by the prosecution odontologist were available as was the ultimate outcome of the judicial proceedings. Each case had been examined by one of the authors (CMB) as a defense expert.

Each of the case photographs was randomly assigned a number and provided blinded (no knowledge of the case, or its outcome) to a second examiner (IAP) who rated each photograph for its forensic significance based on the linearized significance scale. This was undertaken on two separate occasions with a 2-week washout period between examinations.

Each of the case circumstances were then examined and a range of case descriptors developed. These are shown in Table 1. The case descriptors and their associated bitemark severity scales were entered into SPSS version 15 and mean bitemark significances calculated. Analysis of variance was undertaken comparing the results of each case descriptor to determine if there were any statistical differences between the mean scores for each of the descriptors and *post-hoc* tests applied to determine where these differences lay.

Results

Table 2 characterizes the cases examined within the current study. Figure 1 demonstrates the mean significance score for the bitemarks in each of the crime types, for example cases involving assault featured more forensically significant bitemarks than those featured in child abuse. Figure 2 demonstrates the mean scores for the disagreement. For example, in those cases where the experts agreed on the bitemark analysis the significance score is higher than those where there was disagreement within the appellate process. Figure 3 presents the mean significance scores for the cases when categorized by judicial outcome where the scores are similar across all the categories, but marginally less for those cases where an acquittal was seen.

TABLE 1—*Case descriptors.*

Category	Descriptors
Expert agreement	Mutual agreement
	Disagreement
	Disagreement at trial
	Disagreement at appeal
Judicial outcome	Conviction
	Appeal
	Acquittal
	DNA exoneration
Crime type	Assault
	Homicide
	Rape
	Child abuse

TABLE 2—*Crime types within the cases examined (*n = *49).*

	Number of Cases
Crime category	
Homicide	35
Child abuse	9
Rape	7
Assault	5
Child homicide	9
Adult male homicide	12
Adult female homicide	14
Victim category	
Victim is biter	2
Attacker is biter	47

Total crime types exceed the total number of cases as some cases feature more than one crime type; i.e., rape homicide.

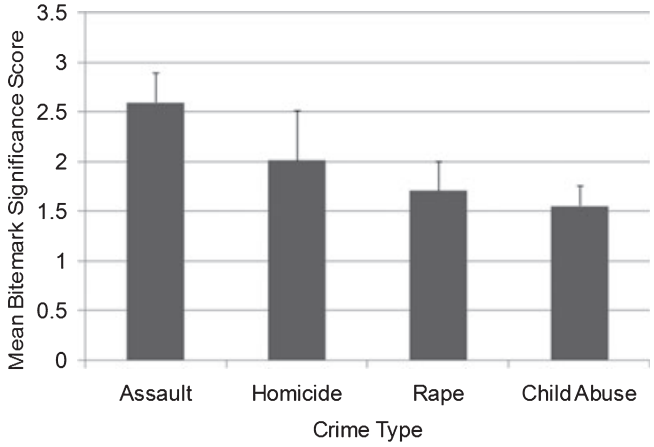

FIG. 1—*Mean bitemark forensic significance score for each crime type within the studies examined. Error bars are SD.*

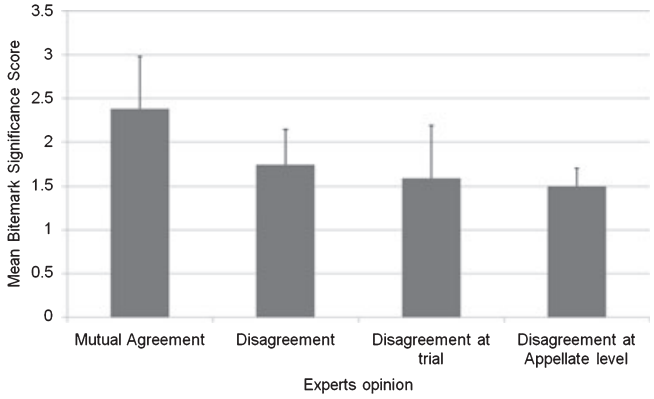

FIG. 2—*Mean bitemark forensic significance score for the expert disagreement categories within the studies examined. Error bars are SD.*

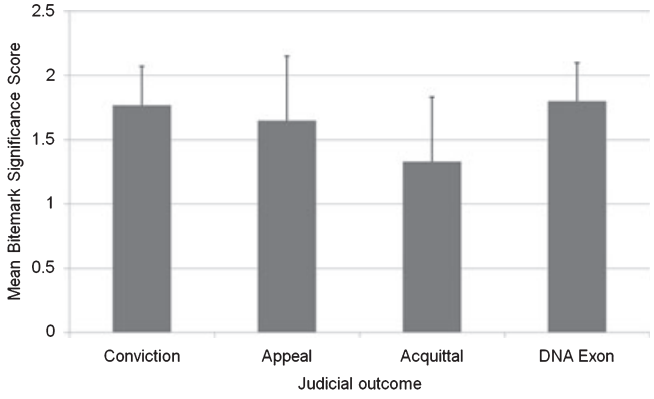

FIG. 3—*Mean bitemark forensic significance score for cases when categorized by judicial outcome. Error bars are SD.*

A number of the differences in mean values were determined to be statistically significant following ANOVA and *post-hoc* tests were undertaken with alpha set to 0.05. For crime type, child abuse had significantly lower forensic value than all the other crime types ($p = 0.029$) but no other differences existed in the categories. When examining experts' opinion there was a difference detected between mutual agreement and disagreement at trial and postconviction appellate review ($p = 0.041$), while there were no statistically significant differences found between any of the judicial outcome categories.

Discussion

The purpose of this study was to investigate the relationship between the quality of bitemarks, as measured by visual and written index, and a range of outcomes including the crime type, agreement between experts and the judicial result (10). The main aims were: to determine if a relationship between the forensic significance and poor outcomes existed and if any recommendations could be made on the basis of this relationship (11).

Categorical Analysis

When examining crime type the lower forensic significance associated with cases of child abuse is statistically different from other case types. There may be reasons for this; child abuse cases are often "closed populations" where only one or two potential suspects may have access to the child. In such cases odontologists may feel that accepting a lower level of detail within a bitemark is justified. There may also be a greater desire to assist given the emotive nature of these cases. It is the authors' experience that as children are frequently bitten by their carers and these injuries often present late to medical staff (regularly as chance findings related to other injuries) they will often be of lower forensic value than, for example, a bite on a living rape victim who reports their attack promptly (12–15).

Perhaps the most compelling data from the study are those surrounding the expert's opinion. Here a clear relationship between the forensic value of the injury and the likelihood of disagreement can be seen; with a statistically significant different between mutual agreement and disagreement at appellate level. If one considers Fig. 2 it can be seen that if bitemarks of value 2 or more alone were examined then this would eradicate disagreements that reach the appellate level—in summary, the higher the forensic value, the less likelihood of disagreement. In a perfect science it would be ideal to remove all disagreement between experts with similar experience and training; and whilst this is not possible the current data tend to suggest that if odontologists limit their conclusions in cases where the significance of the injury is below 2, then the chance of disagreement is greatly reduced and the probability of a safe, scientific, and just analysis is increased. These data also provide further validation evidence for the use of the bitemark significance scale as they clearly demonstrate that with increased significance there is reduced uncertainty.

If the expert disagreement data is the most interesting, the judicial outcome is perhaps the most worrying. There are no statistically significant differences between any of the outcomes. For example the bitemark cases where DNA has exonerated the implicated suspect share a similar significance level to those where a conviction was secured. The data do suggest a slight trend in that those cases resulting in an acquittal have bitemarks of lower forensic value but the sample size is too small to detect this statistically. What should be noted is that the forensic significance of most of the bites within these categories all fall at the lower end of the significance scale—i.e., below 2.

Limitations of the Study

All the cases analyzed within the current work were based upon the case mix of a single appellate defense expert; although at original trial a defense and prosecution expert was represented—hence a wide range of opinions, expertise, and skill. As these cases were brought for a defense opinion this may bias the sample that we have examined—i.e., that they are the poorer cases and hence the values achieved here. This would explain the overall low scores for bitemark significance. Those bites with higher scores are successfully prosecuted without recourse to a defense opinion, or achieve a mutual agreement. This possibility is suggested in Fig. 2 where the forensic value of the bitemarks is at the highest when the mutual agreement category is considered.

The sample size used in the current study is small. This is somewhat pragmatic in nature—while many hundreds of dental identifications take place across the US each year, a far smaller number of bitemark cases are undertaken and even fewer of these will be made available for research purposes. The effect of the small sample size within the current study would tend to underestimate relationships between the mean significance score and the categories; for example, statistically significant differences may be found if the sample size was of sufficient power. However, differences can be detected at this power and trends can be detected within the data sets.

Conclusion

Caution must be exercised when examining the results of this analysis based on the potential for bias due to the source of the sample material. However, clear trends can be seen in these data and they exhibit forensic plausibility—i.e., as the injury patterns exhibit more unique features, expert disagreement about their analysis decreases. This internal validity lends value to the data. Forensic odontologists should carefully assess a suspected bitemark injury for its forensic value, possibly using a visual scale to enable the injury to be placed into context. The data from the current study suggests that those injuries rating 2 or less on the significance scale may present opportunities for error, disagreement, and possible miscarriages of justice.

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