COMPARISON OF BITEMARKS LEFT IN FOODSTUFFS WITH MODELS OF THE SUSPECTS' DENTITIONS AS A MEANS OF IDENTIFYING A PERPETRATOR

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ABSTRACT

In a recent court case, a comparison was made between an impression of marks left in cheese at a murder scene and a set of study models of one of the suspects. The court was reluctant to accept the validity of the pattern-associated comparison that was used in the identification.

This study compared marks made in cheese, butter and cooked potato with study models taken from volunteers. Pattern-associated comparison was the method used. Eighty pair-wise comparisons were made by two odontologists. The examiners correctly identified all the true matches from among the eighty comparisons as well as selecting the dental models for which there were no corresponding silicone impressions. In the absence of identifiable fingerprints or DNA samples, the method can be employed for matching left in foodstuffs to the dentitions of suspects. **(J Forensic Odontostomatol 2000;18:27-31)**

Keywords: Identification, bitemarks, foodstuffs

INTRODUCTION

In a recent court case, the State verses Shabangu, the prosecution attempted to prove the identity of the murderer, based on an impression made from a piece of cheese with bitemarks found at the scene of the crime. A pattern-associated comparison between the cheese impression and a study model of the suspect was performed. The court was only prepared to accept the match between the cheese bitemarks and the suspect as substantive evidence, whereas fingerprints found at the scene of the crime were used as the definitive evidence in the final judgement.

This study was carried out to test the method used in identifying the perpetrator in the above court case. The science of fingerprint analysis was officially adopted in 1901 when Sir Edward Henry successfully matched a suspect to fingerprints found at a crime scene.[1] Today, twelve concordant fingerprint features are universally accepted as a minimum to establish identity.[2, 3] DNA technology has a discrimination potential of 1 in 303 billion and eight-locus Tandem Repeat (STR) multiplexing DNA analysis has become an important method of accurately matching an individual to any DNA contaminated object.[4] No DNA evidence was found at the crime scene, and therefore was not considered in the above court case.

Simply stated, a bitemark is a patterned injury produced by teeth on animate or inanimate objects[5] and is caused by small enamel defects on the incisal edge of incisor teeth creating individual characteristics during the biting process.[6] The concept of comparing the "mark" made by the dentition of an individual in skin with the dentition of the suspected perpetrator has been well accepted by forensic odontologists, law enforcement officers, and trial and appellate level courts.[7] Bitemarks found in certain foodstuffs, such as cheese, chocolate and potato have also contributed in implicating perpetrators.[8] Bitemark identification relies on the individual characteristics of each bite pattern, the quality of bite registration and the stability of the object bitten. It is easier to demonstrate that a person's dentition could

not have caused a particular bite mark than to conclude the presence of an exact match.

The individuality of a bitemark stems from the uniqueness of the human dentition.[9,10] Regressive changes, namely attrition, abrasion and erosion will cause changes to the dentition with time[11] but as these changes occur relatively slowly, their influence will only be a serious complicating factor when the match takes place several months or years after the bite took place. Dental procedures, for example extractions, restorations and occlusal adjustments will also cause changes to the dentition.

The aim of this study was to match bitemarks made in foodstuffs with the models taken from a selection of individuals and to test the reliability of the method

MATERIALS AND METHODS

A random sample of 16 persons (8 oral hygiene students from the Dental Faculty, University of Pretoria, and 8 patients presenting for treatment at a private dental practice in Middelburg, Mpumalanga, South Africa) were chosen as volunteers for this study. Their ages ranged between 7 and 47 years of age and no person who had a history of orthodontic treatment was included. The oral hygiene students were volunteers who had to take impressions of each other and cast models as part of their practical studies. Eight impressions and models were selected by the first author from the class of 24 oral hygiene students. The patients were randomly selected by the first author, and after prior consent, an alginate impression was taken of each person's upper and lower dentitions by the practitioner's oral hygienist. A set of plaster study models for each impression was cast by the laboratory assistant. All the plaster study models were laid out in random order and sequentially numbered 1 to 16. The laboratory assistant kept a record of the relationship between plaster study model number and individual identity so that the study would be blind.

Blocks of cheese, butter, and cooked potato of size 40 x 20 x 20mm were prepared and each one of the 16 participants was asked to bite into one or more of the different foodstuffs with his or her front teeth. A total of 20 bite samples were made. The foodstuffs were left for 1 day before impressions were taken of the bite patterns using hydrophilic vinyl polysiloxane, type 1, low viscosity Reprosil* impression material.[12] The time delay was introduced to simulate the usual sequence of crime investigation.

The 16 pairs of models and 20 impressions were randomly divided into four groups of four and five respectively. Both odontologists (HB & TS) had previous experience in evaluating bitemarks. Each received two groups of models/impressions. Each group was subjected to comparison, i.e. in each of the four cases twenty pair-wise comparisons were made. A total of 80 pair-wise comparisons were made between sixteen study models and twenty silicone impressions.

The protocol tested is based on the principle of the double blind experiment. To prevent any subjective bias the forensic odontologists were presented with numbered models and silicone impressions, i.e. they did not know the names of the persons producing them. There were no identifying marks, colours or features on either the impressions or models that could give any clue as to their identity. To prevent matching by a process of elimination they were not told whether every study model had at least one corresponding silicone impression. To ensure that they did not stop after finding a positive match they were told that there was at least one instance where two impressions corresponded to one study model.

In order to perform a pattern-associated comparison, the examiners (HB & TS) were instructed to take a set of study models and a silicone impression, juxtaposing the two, and to compare them feature by feature. They were requested to hold the study model and silicone impression in close proximity and to work interactively back and forth between the two. If at any stage of the comparison an obvious discrepancy was found, a mismatch was declared. If a positive match was suspected, every possible point of concordance was documented.

To ensure that each examination was comprehensive, nine features (Table 1) were used as a guide during

*Caulk Dentsply. Dentsply International Inc, Milford, USA.

the comparison. The features chosen were those seen in previously examined bite mark cases. Any other distinctive features found were also documented under "Other", e.g. rotations.

Table 1: *The ten classes of features used to examine the study models and impressions*

A	Significant difference in incisal height between 11/21 and 31/41
B	Anterior teeth placed out of arch (state tooth number)
C	Anterior open bite (state position and expanse)
D	Chip on anterior teeth (state tooth number and position)
E	Midline status (use mandible and state L,R or no deviation)
F	Abnormal incisal slope(state tooth number)
G	Anterior teeth missing (state tooth number)
H	Diastema present (state position and whether wide or narrow)
I	Crossbite present (state position)
J	Other (e.g. rotation)

The data from this comparison (i.e. comparative double blind) was tabulated (Table 2) documenting the most obvious discordant feature in each of the 80 pair-wise comparisons. In those cases where no obvious discrepancy could be seen a star was placed and a further detailed analysis was carried out. Each of these candidate pairs was carefully examined using the nine categories of features (Table 1) and the results recorded separately. Table 3 provides an example on one such result.

Table 2: *Obvious discordant features (asterisk indicates no discordant features and therefore possible match*

MODELS	MODEL 11	MODEL 2	MODEL 7	MODEL 3
Impression no				
2_(butter)	Even lower teeth	Even lower teeth	Diastema 11/21	Diastema 11/21
3 (cheese)	23 present	No diastema 11/21	Diastema 32/31	*
9 (cheese)	Position 41/42	No diastema 11/21	Position of 11/21	No diastema 42/42, 31/32
11 (cheese)	Even lower teeth	No diastema 11/21	Even front teeth	Even 11/21
12 (butter)	Position 31/41	No diastema 11/21	*	Prominent d. edge 11
19 (potato)	Position 12 and 33	No diastema 11/21	Position 41/31	No diastema 43/42, 31/32
20 (cheese)	Diastema 11/21	*	Diastema 11/21	Diastema
22 (butter)	*	No diastema 11/21	Position 11 and 31	No diastema lower teeth
41 (potato)	Position 41/41	No diastema 11/21	Position 21	*
200 (potato)	Position 41/42	No diastema 11/21	Angle of 42	Rotated 42

RESULTS

Odontologists HB and TS correctly identified the fifteen true matches from among the 80 pair-wise comparisons as well as selecting the dental models for which there were no corresponding silicone impressions. Neither odontologist found any false positives (i.e. said that there was a match when in fact there was none).

In addition, they did not find any false negatives (i.e. missed a match). Both HB & TS had similar numbers of features for categories A to D and H but had very different frequencies for categories E to G and I and J (Table 1). The major differences were in categories E (midline status) and J (rotated teeth). HB made positive matches using more features than TS. It should be remembered that the two operators did not examine the same sets of models and impressions.

Table 3: *Example of comparison of one set of models with an impression*

Identification: Model 3 with bite No.41
(bold print indicates features present,
normal print indicates features not present)

Difference in height between 11/12 and 31/41
Teeth placed out of arch 11
Chip on anterior teeth
Midline status Lower jaw deviates left
Abnormal incisal slopes
Anterior missing teeth
Diastemas present 43/42, 31/32 and 32/33
Abnormal incisal slopes
Crossbite present
Other - Rotated teeth 11 and 32
- 4 + features

DISCUSSION

Each examiner positively matched all models with their respective silicone impressions. This method was based on the three dimensional structure of each tooth as well as its relationship to the surrounding teeth. The relationship of the maxilla to the mandible could also be compared. Both examiners used the features in Table 1 as a guide in the identification process and as the individual features could not be weighted in any way, their individual occurrence

(common, uncommon or very uncommon)[13] did not contribute substantially in the final identification. More research is needed to establish the probability of occurrence of selected dental features in the population in which the case occurred. Without this data a full statistical analysis of this method cannot be made.

This method can be compared to a puzzle piece that has to be placed in an exact position to complete a picture. Even though there are several pieces that could fit into a specific space in the puzzle, only one piece will have the right shape and picture. Another example of three-dimensional recognition is that of one's own child among hundreds or thousands of other children. All the children have common features i.e. one nose, two eyes, two ears, one mouth etc, but it is the relationship of each of the features to one another that gives us the ability to recognise our specific child.

Pattern-associated comparison was used in preference to metrical comparison. Unreliable dynamic changes which occur during the shrinkage period[10] in most foodstuffs, would create problems for the expert witness during cross-examination if metrical analysis were used.

The quality of the bite marks left in different foodstuffs will vary according to the physical characteristics of the material. The more pronounced the individual traits of a dentition are, the less important the quality of the bite marks becomes and vice versa. It was found that the movement of the mandible during the biting process produced longer bite marks with the frequent presence of scratch marks, than that of the maxilla. The firmer the foodstuff, the more reliable the midline status seemed to be when examining the silicone impressions taken from the different foods. Inanimate objects such as cheese, butter and potatoes have a limited shelf-life and the impressions should be made as soon as possible. The bitten objects will change shape in time, depending on humidity, temperature and storage quality[14] and such changes make metric analysis unreliable. Only pattern association may be demonstrated between an impression and the suspect's dentition.

Notwithstanding the imperfections of the proposed technique, it is possible to match bitemarks left in foodstuff to the dentition of the person who produced the bite marks. However, it should be remembered that bitemarks must be clearly visible. The nearer the suspect's dentition is to "perfect", the more difficult it will be to match.

Information on the probability of occurrence of dental characteristics specific to particular populations is not available for the population in which this study took place. The frequency of occurrence of dental features would allow the presence/absence of that feature in a model to be weighted.

CONCLUSION

In the absence of identifiable fingerprints or DNA samples, the method can be employed for matching bitemarks left in foodstuffs to the dentitions of suspects. Until such time as statistics exist on the probability of occurrence of dental features in a specific population, multiple concordant features in the absence of any unexplainable discrepancies should be present to express the likelihood that a given suspect has made a sledge mark. If such features are especially characteristic, less features would need to be present. However, the highly reliable identification methods of finger printing and DNA analysis remain the procedures of choice and bite mark recognition cannot equal them at present[15].

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