USE OF BITEMARKS FOR HUMAN IDENTIFICATION BY USING INTER-CANINE DISTANCE AND MESIO-DISTAL WIDTH OF MAXILLARY INCISORS.

Forensic Science

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ABSTRACT

Aim: To determine the use of bite marks for human identification by using inter-canine distance and mesio-distal width of maxillary incisors.

Introduction: Odontogenic evidence is considered to be the third most precise method of identification of human in forensic sciences. Bite-marks on the body are intentionally made, those found on food particles are usually impractically left by the offender at the scene of crime, these marks are of great importance in identification of the offender. The present study was aimed to determine the use of bitemarks for human identification by using inter-canine distance and mesio-distal width of the maxillary incisors.

Materials and Methods: 40 consenting volunteers were included in the study. With the help of autoclaved Vernier calliper, the inter-canine distance and mesio-distal width of maxillary incisors were measured and bite on chocolate (CADBURY 5Star) was taken. Using Vernier calliper, Inter-canine distance and Mesio-distal width (2 maxillary central and 2 lateral incisors), were measured from the bite mark. Both measurements obtained were coded and matching was done by two doubly blinded examiners.

Results: The probability of correct identification on the basis of IC distance and MD width obtained from bite-marks is 68.35%. The average proportion of correct matching is 0.78 for IC distance measurement and 0.46 for MD width.

Conclusion: Metric method can be used for human identification by using bite-mark. IC distance is more reliable and efficient in human identification than MD width.

KEYWORDS

Bite-marks, IC (intercanine) distance, MD (mesio-distal) width, Vernier calliper

INTRODUCTION:

Odontogenic evidence is considered to be the third most precise method of identification of human in forensic sciences. Mc Donald in 1972 defined Bite-marks as "A mark made by the teeth either alone or in combination with other mouth parts" (1). Bitemark is commonly caused by anterior six teeth, namely central and lateral incisors and canines. They are mainly caused due to sexual attacks, thus bitemarks have become an imperative area of forensic dentistry which can be used for the identification of the individual. The analysis of bite marks is challenging and it depends upon two important assumptions one that is; dentition of individual is unique with respect to position, shape, size and pattern and the other is that the bitemark represents these characteristics with sufficient detail to enable comparison. Uniqueness of the human dentition helps the forensic odontologist to derive at positive identification in cases bite mark analysis (2-7).

The bite action is a dynamic process due to movement of maxilla and mandible of biter and the reaction of bitten person. Human bitemarks are found when the teeth are used as weapons for expressing extreme emotions. The impression can be left on the various body parts, perishable and imperishable objects. Bitemarks on the body are intentionally made, while those found on food particles are usually impractically left by the offender at the scene of crime. Therefore, these bitemarks are of great importance in identification of the offender (8).

The forensic value of bite in food materials is based upon the nature of material itself, i.e. bite on cheese, apple, sandwich may get distorted due to temperature variation and shrinkage of the food material, but chocolate has been found to be reliable food material and hence used for bite mark analysis as it is stable with least variability (9-10).

Various methods of bite mark analysis include indirect and direct methods. Indirect methods are expensive and make use of transparent overlays, photographic overlays, radiographic film overlays, computer-based overlays, whereas direct method includes metric analysis, which includes mesio-distal width, angular rotation, inter canine distance and so on (11-12). The present study was aimed to

determine the use of bitemarks for human identification by using inter-canine distance and mesiodistal width of the maxillary incisors.

MATERIALS AND METHODS:

The study was conducted with a convenient target population taken from the Department of Oral and Maxillofacial Pathology at VSPM Dental College & Research Centre, Nagpur, India, from December 2019 – February 2020, after the approval from Institutional Ethics Committee.

40 Subjects (20 Male and 20 Female) of age group 20-30 years of the same race and ethnicity on voluntarily basis (convenient sampling) were selected for the study.

Inclusion Criteria

- Signed informed consent from compliant volunteers.
- Volunteers in good general health.
- Presence of natural healthy teeth (2 canines, 2 central and 2 lateral incisors) in maxillary arch.

Exclusion Criteria

- Major hard and soft tissue lesions and trauma.
- Presence of dental caries and dental anomalies.
- Absence of maxillary incisors and canines.
- Previous or current orthodontic treatment.

After carefully evaluating the subjects based on the above criteria, basic demographic data of volunteer related to age, gender, address was additionally collected. Apart from this, dental history was taken including h/o trauma, orthodontic treatment and clinical examination was done. The importance and need of study were explained to all subjects and informed consent was obtained for the same.

- Clinical Measurements: After the clinical examination, with the help of autoclaved Vernier calliper, the inter-canine distance and mesio-distal width of maxillary incisors were measured. The measurements were coded and list was prepared.
- Bitemark impression: Literature tells that bitemarks on chocolate

are stable and are confined to the least variable changes (13), therefore chocolate was taken as impression material. The subjects participating in the study were asked to bite on chocolate (CADBURY 5Star) with a pressure sufficient for the bite imprints to be generated with care, such that food substance (chocolate) is not sheared. The bite was taken so as to include the canine-canine region. The food material was stored at room temperature (15-30 degree Celsius) during day and night time, without covering. The humidity was between 30%-60%.

- Using Vernier calliper, inter-canine distance and mesio-distal width (2 maxillary central and 2 lateral incisors), were measured from the bite mark. Coding of patients' identity was done, while measurements were revealed to be compared by two examiners.
- The measurements of bitemarks were shuffled, and two double blinded examiners were assigned for matching of clinical measurements and bite-mark measurements (inter-canine distance and mesio-distal width).
- The data was entered into Microsoft Excel Office and further the statistical analysis was done using IBM SPSS Version 20 software, using discriminate analysis and z test, where z is 2.9483 and the value of p is 0.00318 < 0.05.

RESULTS:

40 subjects (20 male and 20 female) with a mean age of 22.5 years (SD 1.41) were included in the study. The bite taken on the chocolate bar, an average of six teeth of maxilla and 7-8 teeth of mandible were visible. As per the method of the research explained above, only maxillary arch was taken into consideration. On analysis, mean IC distance for clinical measurements is 3.87, whereas for bite mark the mean IC distance is 3.91, while the mean MD width for clinical measurements is 3.86, whereas for bitemark mean MD width is 3.80 (Table 1).

Table 1: Descriptive statistics (below)

	N	Mean	Std deviation
Age	40	22.55	1.41
Clinical measurements (IC)	40	3.87	0.29
Clinical measurements (MD)	40	3.86	0.25
Bite-mark measurements (IC)	40	3.91	0.26
Bite-mark measurements (MD)	40	3.80	0.25

The present study showed that, evaluation of use of bite-marks in individual's identification using intercanine distance and mesiodistal width of maxillary incisors is as follows. There were two cases:

Examiner 1: From the sample of size 40, we sorted out the cases where the identification of the individual on the basis of IC an MD is same for Examiner 1. There are such 21 cases, so the effective sample size is 21. Using discriminant analysis, we get to see that for Examiner 1, 66.7% of original grouped cases were correctly matched as shown in following (Table 2).

Table 2: Matching results of Examiner 1 (below)

Matching Results				
Examiner1	Predicted Group Membership			Total
		MD	IC	
Count	Unmatched	7	3	10
	Matched	4	7	11
%	Unmatched	70.0	30.0	100.0
	Matched	36.4	63.6	100.0

66.7% of original grouped cases correctly matched.

Examiner 2: From the sample of size 40, we sorted out the cases where the identification of the individual on the basis of IC an MD is same for Examiner 2. There are such 20 cases, so the effective sample size is 20. Using discriminant analysis, we get to see that for Examiner 2, 70% of the original grouped cases matched correctly (Table 3).

Table 3: Matching results of Examiner 2 (below)

Classification Results				
Examiner 2	Predicted Group Membership			Total
		MD	IC	
Count	Unmatched	4	0	4
	Matched	6	10	16
%	Unmatched	100.0	.0	100.0
	Matched	37.5	62.5	100.0

70.0% of original grouped cases correctly matched.

The average success rate came out to be **68.35 %**, which indicated that

the probability of correct identification on the basis of IC distance and MD width obtained from bite-marks is 68.35%.

On comparing the efficiency of intercanine distance and mesiodistal width of maxillary incisors used for identification of individual, which was verified using statistical test of proportions for two samples (Z test). It was found that the average proportion of correct matching is 0.78 on the basis of IC distance measurement and 0.46 for MD width measurement. The calculated value of z is 2.9483 and the value of p was 0.00318 < 0.05, which is significant (Table 4). Hence, it indicates that efficiency of IC distance is more than MD width of maxillary incisors used for identification of individual (Pie chart 1).

Table 4: Comparative matching for IC distance and MD width measurements (below)

	Category	Average Prop. (Examiner1 and Examiner 2)	Test Prop.
IC	Unmatched	0.23	.50
	Matched	0.78	
MD	Unmatched	0.54	.50
	Matched	0.46	

Using a z test of proportions for two samples. z is 2.9483 and the value of p is 0.00318 < 0.05,

Graph 1: Pie-chart showing average probability of Correct matching for IC distance and MD width (below)

DISCUSSION:

Bite marks are the marks left by the actions of teeth and surrounding oral parts during biting of objects and people. The physical characteristics of bite marks which contributes to its authenticity include the shape of dental arches, distance between canines, rotation of teeth, missing teeth, curves of biting edges, and the wear patterns (6). This uniqueness is replicated on the bitten food material in sufficient detail to enable a match of the individual under suspicion. The forensic values of bite marks on foodstuffs depend on the nature of food substance and ability of perishable food substance to dehydrate and deform at room temperature. (9-10)

Naether.S (2012) conducted the study using different food materials (cheese, chocolate, apple, buttered bread), which implied that, albeit not idealistic, chocolates had good properties to record position, shape, size and pattern of dentition, correspondingly in the present study, chocolate was used as an impression material. Chocolate displayed and recorded characteristic features of teeth, which were important for identification. All the significant features like tip of canine and incisal edges of incisors were visible on the impression when taken on chocolate (12).

Maji.A et al. (2018), chose incisors and canines as a guide for establishing correlation with human bite marks and canine marks were found to be more obvious. Similarly, in the present study, inter-canine distance and mesio-distal width were used for human identification, Wherein, inter-canine distance was found to be more reliable than mesio-distal width (6).

Analysis of bite mark done by Pratik Tarvadi et al., showed that inter-canine distance gave poorer results, whereas in present study, I-C distance came out to be more reliable method when compared with M-D width (9).

Literature reveals various methods for bite mark analysis, which is in contradiction to present study such as manual, radiographic and

computer-assisted by different authors. However, owing to errors in analysis caused due to observer bias, measurement bias and evidentiary error as it uses computer enhanced methodology and adobe photoshop (10). These factors can affect the analysis. Many criminal cases have been encountered where metric analysis proved to be more reliable than computer-assisted analysis or DNA analysis, here the traditional method showed out to be a boon for analysing clear suspects or offender (14). There are some limitations too, such as identification of the cases which were excluded. Also, perishable substances of long standing duration do have limitations of measurement, on bite mark analysis.

To end with, there has to be a use of both traditional and modern methods for identification of suspects, as the traditional method gives the correct matching of the suspects, the modern methods can be used as confirmatory analysis or vice versa.

CONCLUSION:

Present study concluded that, as the average success rate came out to be 68.35 %, therefore metric method (IC distance and MD width) can be used for human identification by using bite-mark. It is also observed, inter-canine distance measurements matched more successfully in association with other parameter i.e. mesio-distal width measurements, thus IC distance is reliable and efficient in human identification and can be used in forensic science. As forensic experts have to be cautious in identification of individual, therefore it is better to make use of additional modern techniques for confirmation of the results. Bite mark should not by itself be allowed to lead the final verdict, other evidences should also be taken into consideration. There is a scope for further studies, to evaluate different parameters and techniques used for the analysis of the human bite marks. Extensive researches can also be taken place regarding the use of different impression materials used in the field of forensic dentistry.

Conflict of interests: There are no conflicts of interest.

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