ORIGINAL ARTICLE

Berry's index: Adjuvant to bite marks

Sinthia Bhagat,
Vineeta Gupta,
Nutan Tyagi,
Ettishree Sharma,
Sonia Gupta, Mohit Dadu[1]
Departments of Oral Pathology and Microbiology and [1]Public Health Dentistry, Institute of Dental Studies and Technologies, Modinagar, Uttar Pradesh, India

Address for correspondence:
Dr. Sinthia Bhagat, Department of Oral Pathology, Institute of Dental Studies and Technologies, Modinagar, Uttar Pradesh, India.
E-mail: sinthiabhagat2102@gmail.com

Abstract

Introduction: Bite-mark analysis has proven its advantage as an important forensic tool in the past but also has a few limitations to it. To enhance its utility in forensic odontology in this study we have coupled it with Berry's Index (BI) which is an index used to select anterior teeth in prosthetic practice. **Aims and Objectives:** This study was attempted to analyze the applicability of BI in identifying an individual. **Materials and Methods:** This study was directed among 300 individuals with ages ranging between 19 and 30 years. The study conducted at Institute of Dental Studies and Technology College, Kadrabad, Modinagar, Ghaziabad. Out of the total population studied, 149 were males and 151 were females. The analysis of the data obtained was done using SPSS version 19. **Results:** The results in our study indicated that the widths of both maxillary central incisors and the bizygomatic width were found to be higher in females when compared to males. A positive correlation was observed between both the widths of upper central incisors and the bizygomatic width. **Conclusion:** BI could be successfully used as an adjuvant to bite analysis and could be an aid in determining the facial proportions of an individual from the width of the central incisors. This could further be correlated with the forensic facial reconstruction.

Key words: Berry's formula, bite marks, bizygomatic width and incisal width

Introduction

Forensic odontology plays an important role in the identification of people injured in mass disasters, for example, in earthquakes, tsunamis, aviation accidents and in the identification of decomposed and disfigured bodies in investigations of homicides, burn victims or even roadside accidents. Dentistry can help the law enforcement in deciphering cases or in case proceedings by-law.[1]

One of the most debatable and intricate areas of forensic odontology is bite-mark analysis.[2] Bite marks may be found on diverse materials in a crime scene, but the most unfortunate and most common site is human skin. Bite-mark analysis is a promising identification tool but has many shortcomings such as non-elastic reproducibility of the original mark which presents identification errors.[3]

A critical entity in bite-mark analysis is the distortional properties of skin related to stiffness of the tissues. When the teeth pierce loose tissues such as breasts and thighs, the distance in the teeth mark increases mesiodistally, angles of rotation get flattened, and there is lengthening of intercanine distance whereas the opposite is true for tight tissues such as forearm and shoulders.[3] Sheets revealed that during bite-mark analysis distortion was predominantly seen in the arch width creating an error around 7–28 times.

Access this article online	
Website: www.jfds.org	Quick Response Code
DOI: 10.4103/jfo.jfds_99_16	

How to cite this article: Bhagat S, Gupta V, Tyagi N, Sharma E, Gupta S, Dadu M. Berry's index: Adjuvant to bite marks. J Forensic Dent Sci 2018;10:45-9.

The bite patterns of maxillary and mandibular dentition are also different from each other indicating distortion in shape and size of bite mark.[4] Other limiting factors pertaining to bite-mark analysis are elasticity, curvature of the skin and edema caused due to the assault. Due to this subjective nature and limited work published on bite-mark analysis, these evidence are subjected to criticism in the court proceedings.[5]

Thus, other possibilities of body identification need to be evaluated which are significant enough to be presented as concrete proof against the convicted. This study is one such approach to evaluate the role of bite marks in conjugation with other significant means of identification which would give important information regarding the culprit.

Berry's Biometric Index is a method employed to select anterior teeth in a prosthodontics set up. It is a standard method to ensure desirable tooth selection as per the face of the individual and is calculated as follows:

Berry's formula

$$\text{Width of the maxillary central incisor} = \frac{\text{Bizygomatic width}}{16}$$

On searching the available literature through PubMed, we found only a few articles in regard to using Berry's Index (BI) in forensic odontology. Thus, this study has been undertaken to explore the correlation between the two. The results that we obtained inferred to significant relationship between the mesiodistal width of the upper central incisor and the bizygomatic width in both male and female patients which could serve as a useful tool in forensics where the gender of the corpses are to be identified.

Materials and Methods

The study in the present article was approved by the Ethical Governance and Approval System of Institute of dental studies and technology (IDST), and all participants were given a written informed consent and were treated in accordance with the ethical standards expressed in the declaration. The study was conducted in our institute, IDST Kadrabad, Uttar Pradesh, among 300 individuals which included 149 males and 151 females. The procedure of the study and the purpose was explained to every subject, and then consent was obtained. The study was continued further with the approval from the Ethical Committee of the Institute. The selection of the individuals was based on following criteria that the study subject should have:

- No missing maxillary and mandibular teeth
- Absence of any gingival or periodontal pathology
- Absence of anterior restoration of any kind and
- No interdental spacing or crowding.

The width of the right central incisor of the individuals was measured by requesting the subject to bite onto a sheet of tough modeling wax. The maximum width of the incisor was established by measuring the distance between the most distal points of the surface of bite mark to the most mesial surface on the bite mark of the maxillary right central incisor on the modeling wax. The bizygomatic width of each subject was calculated with the help of a sliding and anthropometrical caliper (in millimeter) by taking the most prominent area of the zygomatic arch as the reference point bilaterally.

Each subject was asked to sit in a dental chair with the head upright supported by the headrest, which will enable them to face forward on the horizon, and the patient was asked to bite onto a folded sheet of modeling wax with the occlusal plane of the maxillary teeth parallel to the floor. Bizygomatic width is measured between the two most prominent points on the zygomatic bone with the help of vernier caliper [Figure 1].

The data obtained in the study were tabulated and analyzed using Statistical Package for Social Sciences, Version 19 (SPSS) (IBM, Uttar Pradesh, India). Based on the values obtained, the mean and standard deviation (SD) was calculated. The $P = 0.05$ or less was considered as statistically significant.

Results

While calculating incisal width, the mean (±SD) was calculated to be 0.803 (±0.0697) with a mean standard error

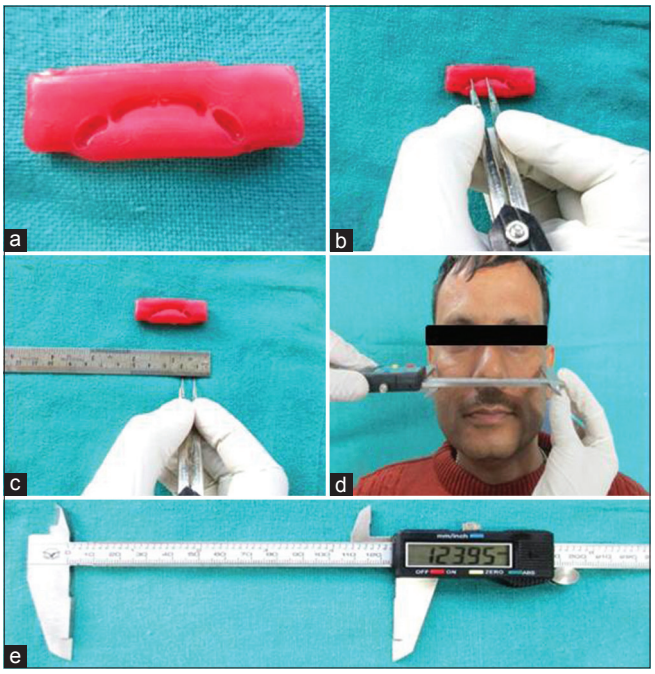


Figure 1: Photographs showing the procedure of measurements in the study

of 0.0057 for males, whereas for females, it was 0.813 (±0.676) with mean standard error of 0.0055. The mean (±SD) when measuring bizygomatic width for males was 111.26 (±5.03) and that for females was 112.48 (±6.96) with standard mean error of 0.41 and 0.56, respectively. The *P* value was not found to be statistically significant between males and females for the width of upper central incisor and bizygomatic width [Table 1 and Graph 1a, b].

A statically significant correlation (*P* value) was observed between the upper central incisor width and bizygomatic width. On applying Pearson's correlation coefficient, positive correlation was found between the width of upper central incisors and bizygomatic width in female patients. On applying the same to male patients, we found a good positive correlation between their insisal and bizygomatic widths [Table 2 and Graph 2].

The results showed a good positive correlation between the mesiodistal width of the upper central incisor and the bizygomatic width in both male and female patients, with a higher value of correlation between the upper central incisor width and the net bizygomatic width in female patients. This can further be utilized to identify the gender of the individual.

Discussion

Forensic odontology helps in the identification of human remains with the interpretation of dental records at the crime scene. With the help of dental records, one can access the physical injuries or the abuses (ranging from scratch to laceration to tear and also to biting off) caused to the victim and can help in determining the gender and the age of the culprit (whether living or dead) which further helps in the court of law if presented as forensic evidence. The capability of the dental tissues to endure extreme environmental assaults and to still retain their original structural form is the property which is exploited to solve many forensic cases. Tooth prints, radiographs, photographs and studies such as rugoscopy and cheiloscopy, are utilized by Forensic Odontologists.[1]

Bite-mark examination has continued to prove its value as an important tool in forensics.[6]

It may be defined as a representative pattern which is left in tissue or an object by the dentition of a human or an animal.[7]

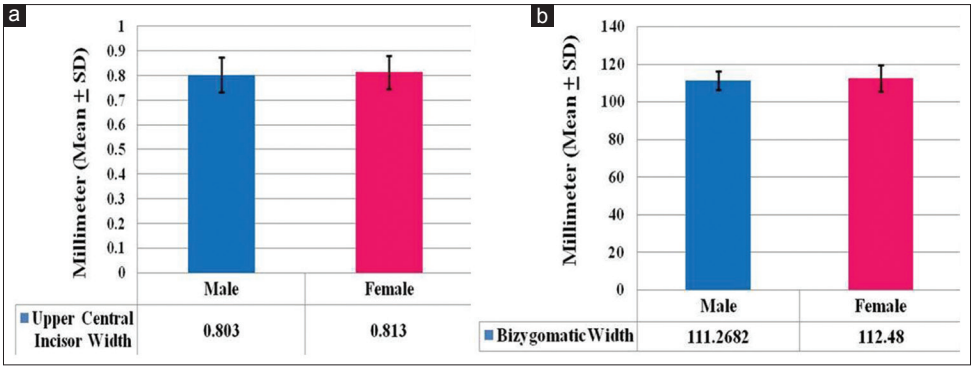
Bite patterns may be left on the victims skin by pressure against cloth or wire grates or by cloth intervened between the skin and the teeth. Partial bite marks can be observed in conditions where the victim had moved during the bite, so the bite becomes partial or incomplete. Only in few individuals, teeth marks show missing teeth which could also occur due to the uneven pressure. Bite marks change in appearance from the time they are made, both in the living and in the dead.[2]

In prosthodontics, the maxillary central incisor holds the key in creating a highly esthetic frontal profile of the individual, and therefore, appropriate selection of the tooth is of extreme significance in the restoration of the anterior segment of teeth in completely or partially edentulous patients.[8]

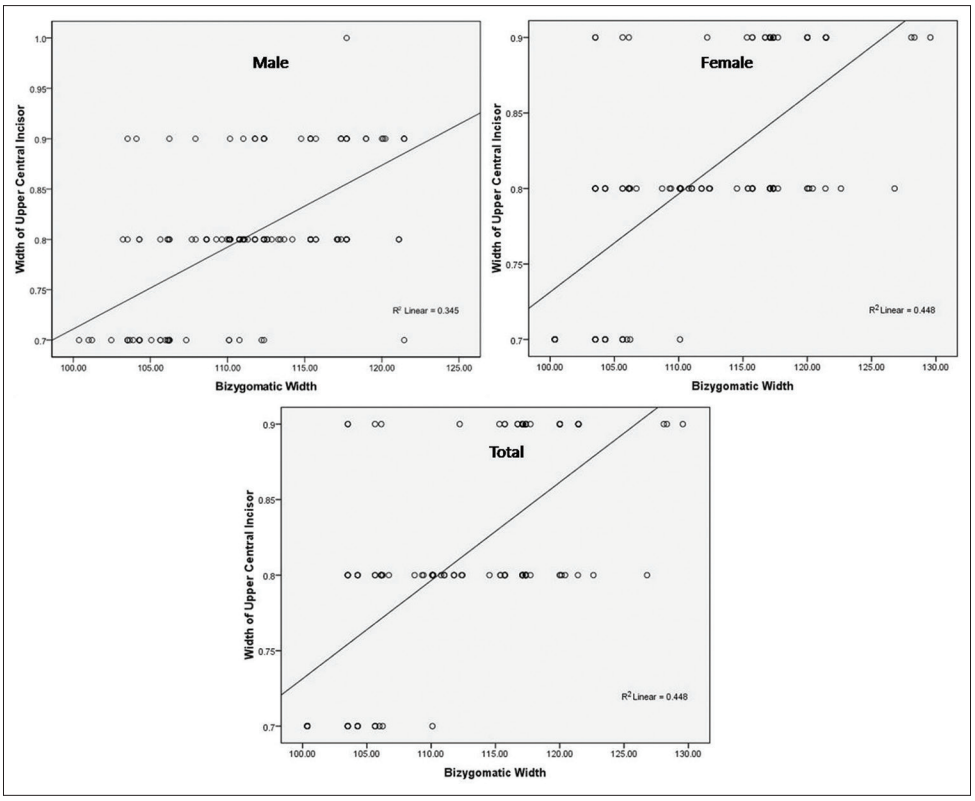
Table 1: Group statistics of incisal and bizygomatic widths of both males and females

	Sex	*n*	Mean±SD	SEM	95% CI		Test of significance	Degree of freedom	*P*
					Lower	Upper			
Incisal	Male	149	0.803±0.0697	0.0057	0.791	0.814	−1.24	298	0.213
	Female	151	0.813±0.0676	0.0055	0.802	0.823			
Bizygomatic	Male	149	111.2682±5.03870	0.41279	110.4525	112.0839	−1.729	298	0.085
	Female	151	112.4800±6.96029	0.56642	111.3608	113.5992			

CI: Confidence interval, SD: Standard deviation, SEM: Standard error of mean



Graph 1: Showing mean values and standard deviation for (a) the width of upper central incisor and (b) bizygomatic width in both males and females



Graph 2: Correlation between the width of central incisor and bizygomatic width in males, females, and all individuals

Table 2: Correlation between width of upper central incisor and bizygomatic width in male patients, female patients, and in all subjects

	Width of upper central incisor	Bizygomatic width	*P*
Male (*n*=149)	Pearson correlation	0.588	<0.001**
Female (*n*=151)	Pearson correlation	0.669	<0.001**
Total (*n*=300)	Pearson correlation	0.628	<0.001**

**Correlation is significant at the 0.01 level

Berry discovered an intimate relationship between the dimension of the upper central incisor tooth and proportional ratio of the face in dimensions. Over the years, this property has been used to ascertain the dimensions for the selection of teeth as dictated by facial proportions in relation to the bizygomatic width. Although valuable in prosthodontics its application has yet not been tested as a tool for identification purposes in forensic odontology. This study attempts to explore the usefulness of applying BI as an adjuvant to support and aid in bite analysis. The bizygomatic width is an important measurement in craniometry and in forensic facial reconstruction for determining facial width.[9,10] This could further be used in determining the lip fullness which is an important landmark in forensic facial reconstruction.[11]

In this study, we found that the widths of the maxillary right central incisors and bizygomatic width were more in females. The results for width of incisor are in correlation with the study done by Antony *et al*. in 2015, but those of bizygomatic width were opposite to their results. We found a positive correlation existing between the two widths (incisal width and bizygomatic width) that was in accordance with Antony *et al*.'s study 2015.[6] These results can further be used in gender identification through facial features at the crime scene.

Conclusion

Although the significance of bite-mark analysis cannot be objected, it has few drawbacks to itself. BI attempts to use the measurements calculated with the help of bite mark and gather important and significant information about the individual. From our study, we deduce that BI along with bite-mark analysis could help in forming a general impression regarding a person based on their facial width. On the basis of the results obtained, we advocate the use of BI as a valuable forensic tool.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Selvajothi P, Lavanya C, Joshua E, Rao UK, Ranganathan K. Awareness of forensic odontology among legal professionals, Chennai, India. N Am J Med Sci 2014;6:553-7.
2. Senn DR, Stimson PG. Forensic Dentistry. 2nd ed. Jammu: CRC Press; 2001.
3. Bush MA, Thorsrud K, Miller RG, Dorion RB, Bush PJ. The response of skin to applied stress: Investigation of bitemark distortion in a cadaver model. J Forensic Sci 2010;55:71-6.
4. Sheets HD, Bush PJ, Bush MA. Bitemarks: Distortion and covariation of the maxillary and mandibular dentition as impressed in human skin. Forensic Sci Int 2012;223:202-7.
5. Sweet D, Pretty IA. A look at forensic dentistry – Part 2: Teeth as weapons of violence – Identification of bitemark perpetrators. Br Dent J 2001;190:415-8.
6. Antony PJ, Pillai KS, George GB, Varghese T, Puthalath MS, Arakkal LJ, *et al.* Applicability of berry's index in bite mark analysis. J Forensic Dent Sci 2015;7:28-31.
7. Hinchliffe J. Forensic odontology, part 4. Human bite marks. Br Dent J 2011;210:363-8.
8. Shetty K, Kumar M, Palagiri K, Amanna S, Shetty S. Facial measurements as predictors of the length of the maxillary central incisor in a cross section of the Indian population – A clinical study. Oral Hyg Health 2013;1:1-4.
9. Berry FH. Study of prosthetic art. Dent Mag 1905;1:405-6.
10. Oksam CL, Premachandra IM, Dias GJ. Bizygomatic breadth determination in damaged skulls. Int J Osteoarchaeol 2010;20:540-8.
11. Lee WJ, Wilkinson CM, Hwang HS. An accuracy assessment of forensic computerized facial reconstruction employing cone-beam computed tomography from live subjects. J Forensic Sci 2012;57:318-27.