ORIGINAL ARTICLE

Applicability of Berry's index in bite mark analysis

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Abstract

Objectives: This study attempts to highlight the usefulness of applying Berry's Index as an adjuvant to support and aid in bite analysis. **Materials and Methods:** This study was conducted among 100 students between the ages of 18–30 from Mar Baselios Dental Collage, Kothamangalam. Out of the 100 subjects, there were 50 males and 50 females. The data obtained was tabulated and analyzed using Statistical Package for Social Sciences, Version 16 (SPSS). **Results:** The mean value of the width of the upper central incisor for male and female was 0.7602 cm and 0.7765 cm respectively. The mean value of the bizygomatic width for male and female was 12.54 cm and 12.42 cm respectively. The correlation between the upper central incisor width and the bizygomatic width was inferred to have a good positive correlation with a value 0f 0.613. Pearson correlation coefficient with greater correlation between the upper central incisor width and the bizygomatic width in female patient (r = 0.678) compared with male patient (r = 0. 525). **Conclusion:** Berry's Index can be a useful adjuvant to bite analysis by providing a means of determining the facial proportions of an individual from the width of the central incisors.

Key words: Anterior teeth, berry's index, bizygomatic width, forensic odontology

Introduction

When considering all the tasks the human race has been confronted with, the one that possibly ranks highest in both difficulty and priority is the identification of an individual from the collected evidence or human remains. One of the many tools used to facilitate this identification process is bite mark analysis.[1]

Bite marks are defined as a representative pattern left in an object or tissue by the dental structure of an animal or a human.[2] The undeniable importance of a bite mark was first recorded in history in the year 1937 when they were used to secure a conviction in a murder trial[3] in which the evidence presented were the bite marks that the victim had inflicted during her struggle for life.[4] Since then the techniques used in bite mark analysis have evolved so as to supply more reliable and reproducible results and played a vital role in many prominent cases such as the identification of Adolf Hitler and Eva Braun at the end of World War II, in mass tragedies such as the New York City, World Trade Center bombing, numerous airplane crashes and natural disasters.[4,5] Bite marks most often appear as elliptical or round areas of contusion or abrasion, occasionally with associated indentations.[6] The verification of a set of bite marks with that of an individual's dentition involves the analysis and measurement of size, shape and position of the individual teeth. The forensic aspect of this analysis comes into play when it is applied to identify teeth marks left on food or in criminal cases when the victim bites the assailant in self defense or when such marks are seen on the victim as left by the assailant in cases like sexual assault.[7]

Access this article online	
Website: www.jfds.org	Quick Response Code
DOI: 10.4103/0975-1475.150299	

In the field of prosthodontics the anterior teeth width and form selection is one of the most important steps in establishing optimum natural aesthetics. The maxillary central incisors are pivotal in the establishment and maintenance of a pleasing appearance. The proportion of facial structures and the relationship between facial measurements and natural teeth is used as a guide in selecting denture teeth.[8] One such method employed for the selection of anterior teeth is by using Berry's Biometric Index. It is an acceptable method that has been seen to ensure a tooth selection that is desirable and harmonious with the overall aesthetics in the absence of any pre-extraction records.[9] The following formula is applied to calculate the width of the maxillary incisor based on the bizygomatic width:

Berry's formula

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

The current literature reveals minimal research in the field of forensic odontology with regard to the mathematical relationship between the width of the face and the width of the central incisor.[10] Consequently this study has been conducted with the aim to illustrate a novel approach done by applying Berry's Biometric Index in the field of forensic odontology so as to aid in the determination of the width of the face of a potential suspect or victim using the mesiodistal dimensions of a maxillary central incisor.

Materials and Methods

This study was conducted among 100 students between the ages of 18-30 from Mar Baselios Dental Collage, Kothamangalam. Out of the 100 subjects, there were 50 males and 50 females. The purpose and procedures regarding the study were explained to all participants and an informal consent was obtained from them. The inclusion criteria for selection of participants were no missing maxillary and mandibular teeth, absence of gingival or periodontal pathology, absence of anterior restoration of any kind and no inter-dental spacing or crowding. The width of the incisor was measured by asking the subject to bite into a sheet of tough modeling wax. The measurement of the incisor width was taken as the distance between the disto-proximal surface of the intendation to the mesio-proximal surface on the intendation of the maxillary right central incisor on the modeling wax.

The greatest bizygomatic width of each subject was taken as the most lateral points on the external surface of the zygomatic arch and was measured using a facebow and a millimeter ruler.

The data obtained was tabulated and analyzed using Statistical Package for Social Sciences, Version 16 (SPSS). Based on these values, the mean and standard deviation (SD) were calculated. The *P* value of 0.05 or less was considered as statically significant.

Results

Table 1 depicts the mean values and SD for the width of upper central incisors and bizygomatic width for both male and female patients.

The mean value of the width of the upper central incisor for male and female was 0.7602 cm and 0.7765 cm respectively. The mean value of the bizygomatic width for male and female was 12.54 cm and 12.42 cm respectively. The student *t*-test revealed no statistically significant difference between males and females for width of upper central incisors and bizygomatic width [Table 1 and Graph 1].

Table 2 illustrates the observations and statistical calculations done for Pearson's Correlation Coefficient (r) between the upper incisal width and the bizygomatic width in all patients.

The Pearson's r is the correlation coefficient which measures the strength of relationship between the two values. From the Table 2 and Graph 2, the correlation between the upper central incisor width and the bizygomatic width was inferred to have a good positive correlation with a Pearson correlation coefficient of 0.613.

Table 3 shows the r between the upper incisal width and the bizygomatic width in males and females separately.

Table 1: The mean values and standard deviation for the width of upper central incisors and bizygomatic width for both male and female patients

Gender	*N*	Mean	Standard deviation	Test of significance	Degree of freedom	Sig. (2-tailed)
Width of uppercentral incisor						
Male	50	0.7602	0.07636	−1.18	96	0.241
Female	50	0.7765	0.05964			
Bizygomatic width						
Male	50	12.5429	0.96285	0.623	96	0.535
Female	50	12.4265	0.8843			

Table 2: Observations and statistical calculations done for pearson's correlation coefficient (r) between the upper incisal width and the bizygomatic width in all patients

Correlations	
	Bizygomatic width
Width of upper central incisor	
Pearson correlation	0.613
Sig. (2-tailed)	<0.001
N	100

Table 3: Correlation Coefficient (r) between the upper incisal width and the bizygomatic width in males and females separately

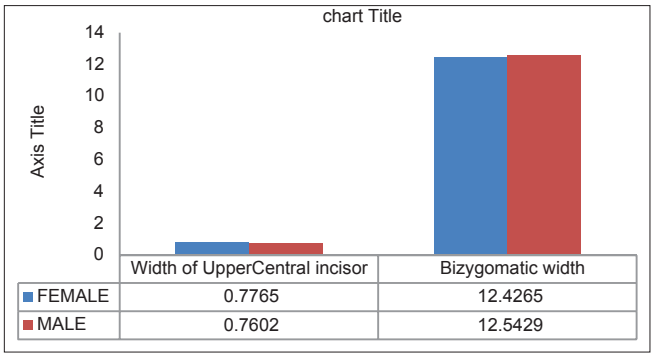
Correlations	
Sex	**Bizygomatic width**
Female	
Width of upper central incisor	
Pearson correlation	0.678
Sig. (2-Tailed)	<0.001
N	50
Male	
Width of upper central incisor	
Pearson correlation	0.525
Sig. (2-tailed)	<0.001
N	50

The result showed a good positive correlation between the upper central incisor width and the bizygomatic width in both male and female patient, with greater correlation between the upper central incisor width and the bizygomatic width in female patient (r = 0.678) compared with male patient (r = 0. 525) [Graph 3].

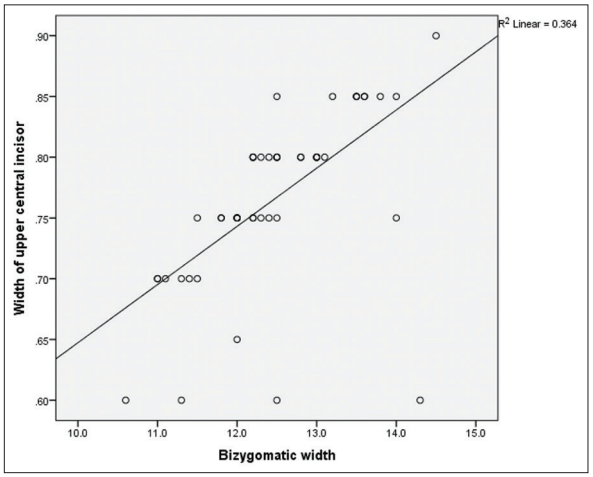
Discussion

Teeth have the benefit of being preserved long after other tissues, even bone have disintegrated and also unlike bones they can be examined directly in living individuals.[11,12] The use of teeth as a mode of identification of an individual has its earliest known record in the case of Lollia Paulina, a rich Roman woman who was associated primarily with Caligula and secondarily with Emperor Nero and was identified after her death through the unique arrangement of her teeth (a discolored anterior tooth or malocclusion served to confirm her identity).[4] In severely damaged bodies, when all other means of identification fail or when it is desirable to obtain additional confirmation of an identity that the dental criteria is used.[13,14] Bite mark analysis has continued to prove its worth as an invaluable tool in forensics. A bite mark has been defined as "a pattern produced by human or animal dentitions and associated structures in any substance capable of being marked by these means".[15] The landmark case that brought the importance of bite marks into public focus was the case of the serial killer Ted Bundy, where the discovery of a bite left by him on his victim played a crucial role in securing his conviction.[16] Despite its widespread use the uniqueness of a bite mark, however, is not such a clear-cut issue as human skin is a very poor bite registration material.[17]

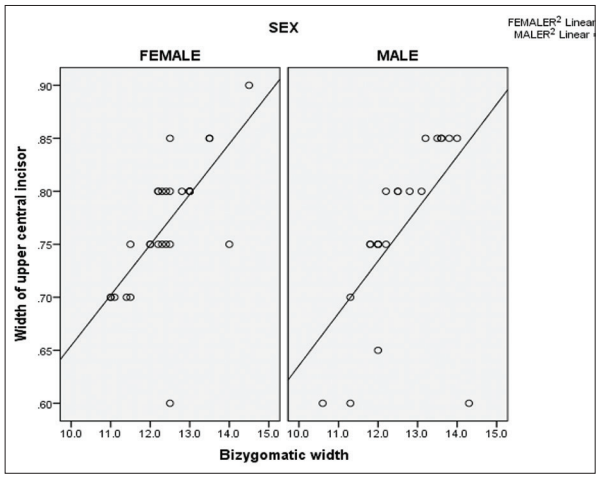
Berry's biometric ratio method was first introduced in 1906.[18] He discovered that the proportions of the upper central incisor tooth had a definite proportional ratio to face proportions. Over the years it has been employed to ascertain the dimensions for the selection of teeth as dictated by specific facial proportions, that is the bizygomatic width. Though it has proved itself valuable in the field of



Graph 1: Graphical representation of the width of the upper central incisor and the bizygomatic width of the study population



Graph 2: Graphical illustration of the correlation between the upper incisal width and the bizygomatic width in the study population



Graph 3: The correlation between the upper incisal width and the bizygomatic width in both males and females in the study population

prosthodontics its application as a tool for identification purposes has yet to be fully explored. This study attempts to showcase the usefulness of applying Berry's Index 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.[19] According to a previous study by Hasanreisoglu *et al*., suggested that the relation between facial width and the width of the maxillary incisors is more relevant when considering the female population.[20] The results showed a good positive correlation between the width of the central incisor and the bizygomatic width in both males and females. This correlation can contribute to the identification of the facial characteristics of a victim or perpetrator of crime and can also provide a simple formula for determining the facial width in case of damaged remains.

Conclusion

Though the importance of bite mark analysis cannot be discounted, it still fails to provide any form of conclusive evidence. Berry's Index attempts to utilize the measurements obtained in the bite analysis and further elucidate information regarding the individual. Our study has shown that using the incisal width obtained from a bite mark one can possibly form an impression regarding the facial width of the individual. Based on these results we propose the use of Berry's Index as a method to supplement the evidence provided by bite mark analysis and increase its value as a forensic tool.

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How to cite this article: Antony PJ, Pillai KS, George GB, Varghese T, Puthalath MS, Arakkal LJ. Applicability of Berry's index in bite mark analysis. J Forensic Dent Sci 2015;7:28-31.

Source of Support: Nil, **Conflict of Interest:** None declared