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ORTHODONTIC FORENSIC SCIENCE: THE UNSEEN PERSPECTIVE

Orthodontology

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ABSTRACT

The teeth have long played an important, if not the most important, role in physical anthropologic identification of hominoid and prehistoric human skulls. In addition to other causes of death that require identification of victims, forensic odontology has assumed increasing importance.
The study sample comprised 400 dental casts, which were divided into two groups: males (50%) and females (50%) aged 18–50 years old.
The palatal length, depth and width was higher in males as compared to females. Central incisors and the anterior border of the incisive papilla and the posterior border of the incisive papilla had the difference between both the groups was highly statistically significant ($p \leq 0.001$) with respect to only size of incisive papilla. Pear shaped was most common (89.5%) amongst males and irregular type was most common (85%) amongst females.
These findings might be potentially relevant to anthropological studies aiming at individual and/or sex identification.

KEYWORDS

Forensic Science, morphological assessment, hard palate, size and shape of the incisive papilla, sexual dimorphism

INTRODUCTION

The tissues of the face typically develop from either side and fuse in the midline and the development of the upper lip and the palate takes place within the first 30 to 60 days of pregnancy. Some degree of sexual dimorphism of the human skeleton is seen in almost all elements[1-4]. Krogman and Iscan[5] described 14 indicators with an accuracy of 90% for helping with sex determination, and one of these indicators is the shape of the palate. Palatal morphology might be used for sex determination has been suggested by other recent reports because it has many characteristic anatomical points, which allow easy and reproducible measurements[6-7]. Further work in this area has led researchers to propose those metric measurements of the palate that might be reliable for sex determinants. The value of forensic dentistry in sex estimation and individual identification is beyond debate[8-10]. The value of forensic dentistry in human identification is corroborated by the fact that palatal structures resist post-mortem decomposition for several days and more so for the dental tissue[11].

AIM

To study the morphological assessment of the hard palate, size and shape of the incisive papilla and the distance between the labial surface of central incisors and the incisive papilla with sexual dimorphism and its relevance to dental and forensic sciences.

MATERIALS AND METHOD

- The study sample comprised 400 dental casts, which were divided into two groups: 200 casts from males (50%) and 200 females (50%) aged 18–50 years old. Impressions of the upper jaw was made with silicon material, and casts immediately poured in type II dental stone to minimize dimensional changes.
- A digital calliper was used to measure palatal dimensions (depth and width), as well as the distance between the labial surface of the central incisors and the anterior border of the incisive papilla (CAIP) and the distance between the labial surface of the central incisors and the posterior border of the incisive papilla (CPIP), and the size of the incisive papillae (SIP) for each cast.
- The length was measured as the linear distance between the orale (the point at the anterior end of the incisive suture located between the sockets of the two central maxillary incisors) anteriorly to the midpoint of the linear distance between the distal surfaces of upper second molars in adult casts posteriorly.
- The width was the distance between the inner borders of the sockets of the upper second molars in adult casts.
- The depth was the distance between the inner border of the socket of the upper second molar and the highest point of the palatal arch.
- The borders of the incisive papilla were marked on each cast, and the shape of the incisive papilla was identified.
- The labial surface of the central incisor and the anterior and posterior borders of the incisive papilla were also marked on each cast.
- Then, the distance between the labial surface of the maxillary central incisor and the anterior border of incisive papilla (CAIP) and the distance between the labial surface of central incisor and the posterior border of incisive papilla (CPIP) were measured.

RESULTS

The mean values of palatal arch dimensions with respect to length, depth and width; size of incisive papilla and distance between the labial surfaces of the central incisors and the anterior & posterior borders of the incisive papilla were calculated along with their standard deviations using descriptive statistics. **(Table 1 & Table 3)**

The statistical analysis was done using the Statistical Package for the Social Science (SPSS version 22, Armonk, NY: IBM Corp).

Palatal arch dimensions

Table 1, fig.1 shows descriptive statistics depicting the mean palatal arch dimensions amongst the adults. The mean values of length of hard palate were 41.96 ± 3.2 for males and 31.90 ± 2.1 for females. The mean values of depth of hard palate were 18.39 ± 2.2 for males and 13.42 ± 3.0 for females. The mean values of width of hard palate were 46.53 ± 5.8 for males followed by 42.57 ± 2.7 for females. The recorded values of aforementioned parameters were compared between males and females using Students t-test to determine whether there are any significant differences between both the groups. The "p" values were considered significant at or below 0.05.

Table 2 shows the comparison of these aforementioned parameters between males and females using Students t-test. It was observed that the palatal length, depth and width was higher in males as compared to females and this difference between both the groups was highly statistically significant ($p \leq 0.001$).

Size of papilla, CAIP and CPIP

Table 3, fig 2 shows descriptive statistics depicting the mean values of the size of incisive papilla, and distance between the labial surfaces of the central incisors and the anterior & posterior borders of the incisive papilla amongst the adults.

- **Size of incisive papilla:** The mean values of size of incisive papilla was greater amongst males 7.83 ± 2.2 followed by 4.9 ± 3.9 amongst females.
- **CAIP:** The mean values of distance between the labial surfaces of the central incisors and the anterior border of the incisive papilla was 4.93 ± 3.9 amongst males and 5.02 ± 3.8 amongst females.
- **CPIP:** The mean values of distance between the labial surfaces of the central incisors and the posterior border of the incisive papilla was equivalent amongst both the groups as 4.69 ± 2.4.

Table 4 shows the comparison of size of incisive papilla, CAIP, and CPIP between males and females using Students t-test. It was observed that the difference between both the groups was highly statistically significant ($p \leq 0.001$) with respect to only size of incisive papilla whereas CAIP and CPIP were not significant.

Shape of incisive papilla

Table 5, fig. 3 &4 shows distribution of four different shapes of incisive papilla that were seen namely pear, oval, irregular and triangular amongst the adults. Of these, pear shaped was most common (89.5%) amongst males and irregular type was most common (85%) amongst females.

Table 1. Descriptive statistics showing the mean palatal arch dimensions amongst the adults

Palatal arch dimensions	Gender	N	Mean	Standard deviation
Length	Males	200	41.96	3.2
	Females	200	31.90	2.1
Depth	Males	200	18.39	2.2
	Females	200	13.42	3.0
Width	Males	200	46.53	5.8
	Females	200	42.57	2.7

Table 2. Comparison of palatal arch dimensions amongst the adults

Palatal arch dimensions	T	Df	p-value
Length	36.92	398	0.001*
Depth	18.60	398	0.001*
Width	8.68	398	0.001*

*p≤0.001 highly significant using Students t-test; df, degrees of freedom

Table 3. Descriptive statistics showing the size of incisive papilla, CAIP and CPIP amongst the adults

Variables	Gender	N	Mean	Standard deviation
Size of incisive papilla	Males	200	7.83	2.2
	Females	200	4.90	3.9
CAIP	Males	200	4.93	3.9
	Females	200	5.02	3.8
CPIP	Males	200	4.69	2.4
	Females	200	4.69	2.4

CAIP, distance between the labial surfaces of the central incisors and the anterior border of the incisive papilla; CPIP, distance between the labial surfaces of the central incisors and the posterior border of the incisive papilla.

Table 4. Comparison of size of incisive papilla, CAIP and CPIP amongst the adults

Shape of incisive papilla	Males (%)	Females (%)
Pear	179 (89.5)	7 (3.5)
Oval	7 (3.5)	21 (10.5)
Irregular	14 (7)	170 (85)
Triangular	0	2 (1)

*p≤0.001 highly significant using Students t-test; df, degrees of freedom; NS, not significant; CAIP, distance between the labial surfaces of the central incisors and the anterior border of the incisive papilla; CPIP, distance between the labial surfaces of the central incisors and the posterior border of the incisive papilla.

Table 5. Distribution of different shapes of incisive papilla amongst the adults

Variables	T	df	p-value
Size of incisive papilla	9.17	398	0.001*
CAIP	-0.23	398	0.8 (NS)
CPIP	0.02	398	0.9 (NS)

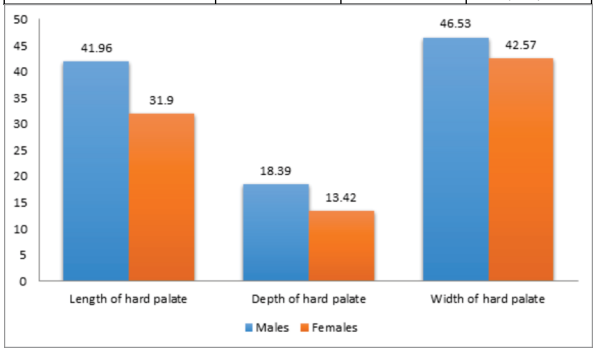

Fig 1. Distribution of mean palatal arch dimensions amongst the adults

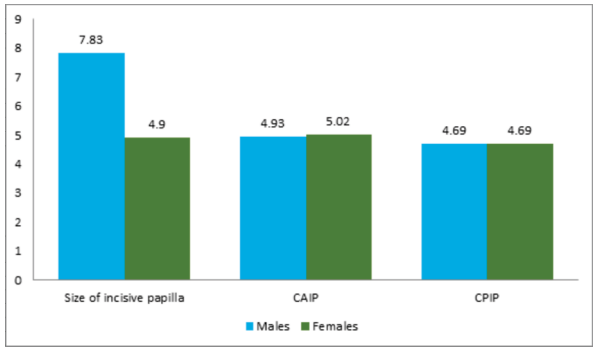

Fig 2. Distribution of size of incisive papilla, CAIP and CPIP amongst the adults

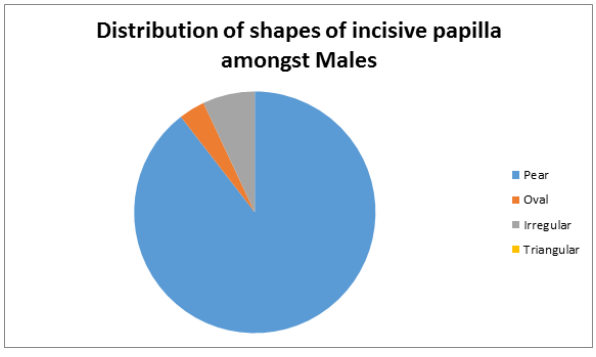

Fig. 3 Distribution of shapes of incisive papilla amongst Males

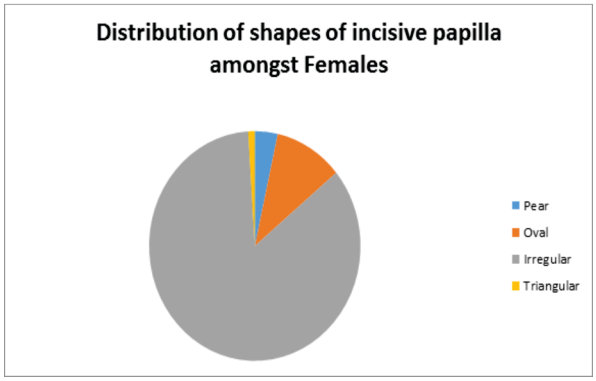

Fig. 4 Distribution of shapes of incisive papilla amongst Females

DISCUSSION

The palatal dimensions were significantly higher in males was concluded by the study performed on South Indian dry skulls and were hence sexually dimorphic[12]. Bigoni et al. reported significant sex differences in a European sample within the palatal dimensions comparable results[13]. Moreover, Sumati and Phatak also found that among five hard palate variables the size of the palate was the best determinant of sex in a sample from the North Indian population[5]. Moreover, another Brazilian research group studied the widths of dental arches and concluded that the maxillary arch width is larger in males as compared to females[14]. Grave and Becker suggested that the labial surfaces of the maxillary central incisors should be 12 – 13 mm from of the posterior border of the papilla in the horizontal direction[15]. Other researchers agreed comparable but different values regarding the distance between the incisive papilla and the anterior teeth in both dentate and denture-wearing individuals. Additionally, some researchers studied the anatomical location of the incisive papilla by measuring the distance between the centre of the papilla and the labial surface of central incisors[16-20]. Restoring the natural dentolabial relations with the overall facial appearance is essential during complete denture fabrication, as it guarantee successful treatment for edentulous patients not only in terms of function but also in terms of esthetics[21].

CONCLUSION

Some palatal dimensions display sexual dimorphism and can be used as predictors of sex In addition to the palatal dimensions, the incisive papilla size and morphology display some degree of sexual dimorphism. Moreover, some of the studied parameters including the size of incisive papilla, the distance between the labial surface of the central incisors and the anterior border of the incisive papilla, and the distance between the labial surface of the central incisors and the posterior border of the incisive papilla might be helpful in improving the stability and aesthetics of maxillary dentures for edentulous patients. The main limitation of the study is that it was restricted to people seeking dental treatment in central India population. It would add to the value and validity of the results if the study would have been performed on a large-scale.

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