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Original Research Article

PALATOMETRY IN SOUTH INDIAN SKULLS AND ITS CLINICAL IMPLICATIONS

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ABSTRACT

Background: A systematised measurement of bony palate of human skull is called as Palatometry. It is part of Craniometry, measurement of human skull. Palatometry has wide applications in the fields of orthodontic surgeries, palatal implants, repair of cleft palate, and treatment of obstructive sleep apnoea syndrome. The present study aims at assessing the palatal parameters in South Indian Human skulls.

Materials and Methods: Two hundred and eight hard palates of South Indian human adult skulls were studied at DR. B. R. Ambedkar medical college. Palatal length, breadth, index and size were calculated.

Results: Mean palatal length, breadth, index and size were 40.4mm, 44.2mm, 109.3 and 1.78 sq cm respectively. 86.9% of palates were Brachystaphylin type (broad palate).

Conclusion: The results of the present study are useful in the fields of forensic anthropology, taxonomy, and palaeoanthropology and population distance analysis. The data obtained is of value to determine race, age and sex of human skull. It is also useful for orthodontic procedures such as surgical repair of cleft palate and for peripheral block of maxillary nerve for the maxillo-facial surgery.

KEY WORDS: Palatal length, Palatal breadth, Palatal index, Palatal size.

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INTRODUCTION

Palate is osseo-membranous partition between roof of mouth and floor of nasal cavity [1]. Anterior 2/3rd of palate is bony, formed by palatal processes of maxilla and horizontal plates of palatine bone. A systematised measurement of bony palate of human skull is called as Palatometry. Measurements of palate have gained attention in various anthropological studies because of its relation to masticatory,dietary, and technological changes in prehistoric period. Assessment of hard palate has wide applications in the fields of forensic anthropology, orthodontic surgeries, palatal implants, repair of cleft palate, and treatment of obstructive sleep apnoea syndrome [2]. The present study aims at analysing the palatal parameters.Objectives are to calculate palatal index and size, to categorize palate based on palatal index, to provide reference data of palatal measurements of South Indian Skulls.

MATERIALS AND METHODS

Ethical committee clearance was obtained from institutional ethical review board. Two hundred and eight adult hard palates of South Indian human skulls were collected from osteology collection of first year medical and dental students at DR. B. R. Ambedkar medical college. Neonatal and new born skulls, skulls with disrupted palates were excluded from the study. Palatal length and breadth were measured using Vernier callipers to the nearest millimetre.

Measurements [3]:

Palatal length (Orale- Staphylion) was measured as the straight distance between Orale (The point on the anterior margin of the hard palate. Orale cuts the imaginary line drawn across two posterior margins of the alveolar margin of the middle incisors, in the midsagittal plane) and Staphylion (The point where a straight line joining the deepest notches of the posterior margin of the palate cut the midsagittal plane).

Palatal breadth was measured as the straight distance between two Endomolars (The middle of the inner margin of the alveolar on second molar). (Figure 1)

Palatal index was calculated using the formula:

$$\frac{\text{Maximum Palatal width}}{\text{Maximum palatal length}} \times 100$$

Palatal size [4] was assessed with the formula:

$$\frac{\text{Maximum palatal length} \times \text{Maximum palatal breadth}}{100}$$

Based on Palatal indices, palates were categorized according to Martin and Saller Range variation as:

- Leptostaphylin/Narrow palate _ X-79.9
- Mesostaphylin/ Medium palate _ 80.0-84.9
- Brachystaphylin/Broad palate _ 85.0-X

RESULTS

Range of palatal length, breadth and index and size were 24-56mm, 31-69mm, 60.7-162.5 and 0.768-3.105cm respectively. Mean palatal length, breadth, index and size were 40.4mm, 44.2mm, 111.6 and 1.78sqcm respectively. 179(86.9%) of palates were Brachystaphylin type (broad palate), Leptostaphylin (Narrow palate) were 24(11.6%) and Mesostaphylin (Medium palate) were 3(1.4%).

To assess the normal distribution of all measurements within each group of subjects, the skewness and kurtosis were calculated. No large deviations from normality were found (Table 1). The skewness ranged between +7.5 and -0.69, and kurtosis between 0.10 and 3.72.

Linear regression analysis was done using data of palatal length to estimate the predictive value of palatal breadth (Graph 1).

Palatal breadth=0.1756x palatal length+ 35.381. R^2 = 0.9019, p value 0.000598, statistically significant.

Fig. 1: Base of anterior part of adult skull showing palatal dimensions.

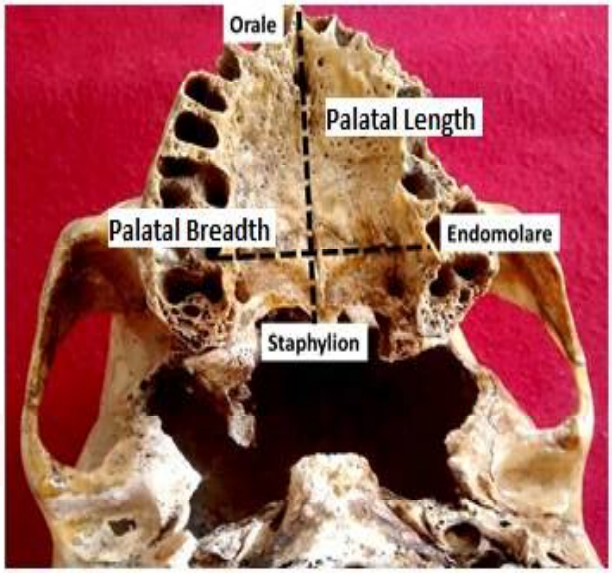
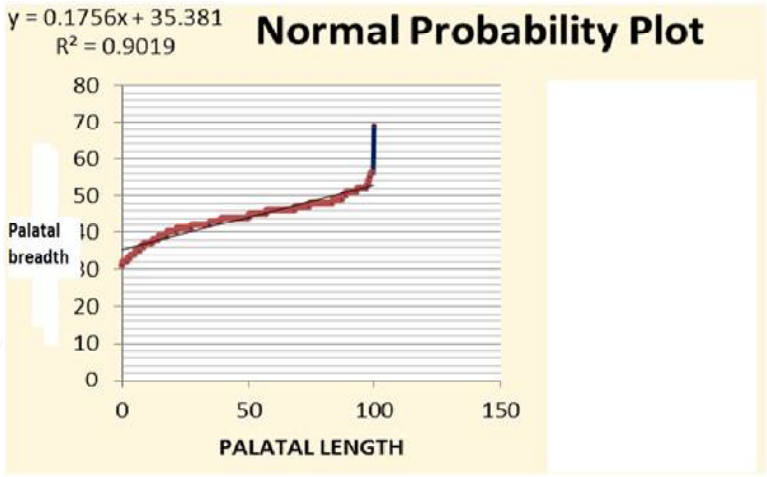


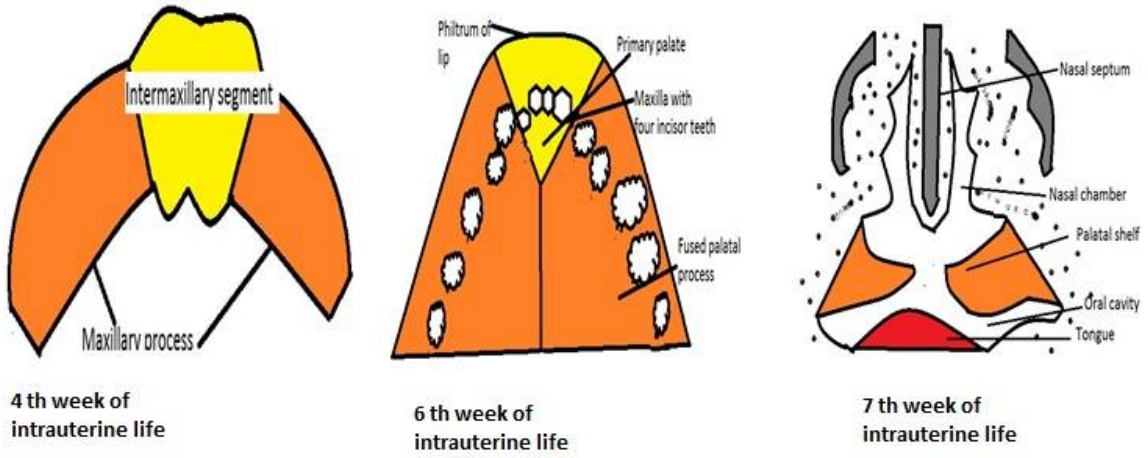
Table 1: Descriptive statistics of Palatal Parameters.

Descriptive Statistics	Palatal length	Palatal breadth	Palatal index	Palatal size
Mean	40.42	44.15	111.6	1.78
Standard Error	0.4	0.37	1.41	0.01
Median	40	44	115.7	1.78
Mode	38	44	121.05	1.56
Standard Deviation	5.7	5.34	20.36	0.28
Sample Variance	33.12	28.62	414.5	0.08
Kurtosis	0.98	1.71	0.1	3.72
Skewness	0.75	0.13	-0.69	0.2
Range	32	38	101.7	2.34
Minimum	24	31	60.71	0.77
Maximum	56	69	162.5	3.11
Confidence Level (95.0%)	0.78	0.73	2.78	0.04



Graph 1: Linear regression analysis for palatal parameters

Fig. 2: Frontal section through head at 4th to 7th week of embryonic life showing development of Palate [18].



DISCUSSION

Palatal index of the present study showed that 57.69% of the skulls had narrow (leptostaphylin), 24.36% had intermediate (mesostaphylin), and 17.95% had wide (brachystaphylin) type. This is similar to palatal index of 63% as narrow (leptostaphylin), 24% as intermediate (mesostaphylin), and 13% as wide (brachystaphylin) reported by Dave et al, 2013 [4]. Mean Palatal index in Central Indians was 74.2 **(**Leptostaphylin/Narrow palate**)** [5]**.** Previous study done by Robertman S Sandman showed mean palatal length in males 51.8± 3.28 mm, in females 49.6± 3.03mm, mean palatal width was 34.6 ±3.03mm in males and 32.6 ± 2.8mm [6]. Study done on Central Indian palates showed that mean palatal length in males were 50.28 ±3.56, females 47.45 ±3.68, mean palatal width in males was 37.17 ±2.88 mm and 35.50 ±3.07 in females [5].

The findings of the present study are also in general agreement with study on Kenyan African skulls by Hassanali [7], the palatine index being brachystaphylin (43.2% of the total skulls) and study done by Mamatha , 2012 [2] with 40% of total sample of skulls being wide (brachystaphylin). Mitesh R Dave, 2013 at Rajkot reported incidence of 61.5% of Leptostaphylin type of skulls [8].

Study by Erli Sarilita, 2015 on morphology of the hard palate showed that palatal breadth, 37.97 ± 3.32 mm; palatal length, 52.2 ± 3.2 mm; skulls (53 out of 63, 84%) had a leptostaphylin type of palatine index [9].

The data obtained is of importance to determine race of human skull. It is also useful for orthodontic procedures, surgical repair of cleft palate, for peripheral block of maxillary nerve for the maxillo-facial surgery etc., [10]. Palatal breadth can be estimated using the formula.

$$\text{Sum of upper 4 incisors} \times \frac{100}{65}$$

The size of palate is important for sex determination. The size of palate can be graded into small – (<35); medium – (35-39) and large – (>39) [11]. In a study done at Queensland and Coastal New South Wales, it was noted that if the grades were given values of one to three for size, the mean values of the sexes were 1.30 for females and 2.27 for males in Queensland series compared with 1.55 for females and 2.69 for males in the Coastal New South Wales series. Stepwise discriminant function analysis when done had shown that the size of palate was the best variable for sex determination with accuracy of 70% [12]. Palatal size and shape were significantly modiûed by the presence of hypohidrotic ectodermal dysplasia [13].

Study done by Luana Cristina Berwig, 2011 has shown that mouth breathing children present narrower hard palate in the second premolars and first molars compared to nasal breathing children. It was also evident that an increase in the hard palate depth in the canine teeth in habitual mouth-breathing children. Thus quantitative assessment of dimensions of hard palate would help in diagnosis of morphological changes in hard palate [14].

Clinical implications: Birth prevalence of clefts is between 27,000 and 33,000 clefts per year in Indian population. Posterior crossbite is frequent malocclusion in orthodontics [15]. Mendelian mode of inheritance producing cleft lip/palate are Kallmann syndrome (FGFR1), ectrodactyly-ectodermal dysplasia/clefting (TP63), X linked ankyloglossia / clefting (TBX22), Gorlin Syndrome (PTCH), and heterozygotes for the Margarita Island clefting syndrome (PVRL1) [16]. Palatal measurements form fundamental basis for orthodontic planning such as upper tooth extraction, maxillary dental implants, hemi- maxillectomy, orthognathic surgery, Le Fort fracture management, and cleft palate surgery [9]. Palatometry is also useful for pre-operative evaluation of patients with uvulopalatopharyngoplasty [17].

Embryology: At the end of 4th week, facial prominences such as frontonasal process, maxillary and mandibular processes appear from first pair of pharyngeal arches. Due to medial growth of maxillary prominences, the two medial nasal processes merge with maxillary process both with surface and deeper part. This structure formed by merged processes is called as inter maxillary segment. It has a labial component which forms philtrum of upper lip, upper jaw component (premaxilla) which forms sockets for upper four incisor teeth and a palatal component which forms a small element of triangular primary palate. The intermaxillary segment is continuous with the rostral portion of the nasal septum which is formed by the frontal prominence. Secondary / definitive palate is formed by two shelves like outgrowths from the maxillary prominences which appear at 6th week of intrauterine life. These palatal shelves attain a horizontal position above the tongue and fuse together forming secondary palate by 7th week of intrauterine life. The secondary palate fuses with the intermaxillary segment anteriorly, and with the nasal septum cranially [18].

Comparative anatomy: In Teleosts, premaxilla are enlarged, maxilla may be toothless, reduced or absent. In Urodeles maxilla is absent. In birds, premaxilla is greatly elongated to form beak. In bony fishes brain case is girded by membranous bone which forms primary palate contributed by vomer, paired palatine and unpaired parasphenoid bones. Teeth occur in bones of primary palate. In reptiles and birds secondary palate appears in addition to primary palate. Secondary palate is a feature of reptiles, birds and mammals as a horizontal partition separating nasal and oral passages.

In crocodiles, long secondary palate is formed by pterygoid bones (endopterygoid and ectopterygoid). Cleft palate is a normal trait of turtles and birds. Von Goethe, German scientist discovered premaxilla in human embryos. In mammals, pterygoid area fails to ossify and becomes soft palate [19].

CONCLUSION

Brachystaphylin/broad palate is the common type of hard palate of South Indian skulls. The results of the present study are useful in the fields of forensic anthropology, taxonomy, and palaeoanthropology and population distance analysis.

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Conflicts of Interests: None

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