Original Research Paper

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Subjective and Quantifiable Analysis of Palatal Rugae Pattern in Punjab Population

Abstract

Background: - Palatal Rugae are irregular, asymmetric ridges of mucous membrane extending laterally from incisive papillae and anterior part of palatal raphe. Palatal rugae patterns are relatively unique to individuals and are well protected by lips, buccal pad of fat and teeth.

Aims & Objectives: - The aim of the study was to identify pattern of palatal rugae in terms of number, size, and shape and also to compare rugae patterns in males and females of Punjab population.

Materials & Methods: - A total of 280 maxillary casts that were randomly collected and were examined using graphite pencil and magnifying glass under adequate light with equal number of males & females. Statistical analysis was done by T-test using SPSS software version 20.

Results: - The mean rugae were found to be more in females than males. Most prevalent form on basis of shape is found to be straight and on basis of size is primary form. Statistically, significant values were found in curved and secondary type, both more in females than males.

Conclusion: - Palatal rugae pattern is definitely a sufficient characteristic to discriminate between the genders. The present study highlighted the prevalence of palatal rugae in individuals of Punjab population. It is unique to an individual and can be used successfully in identification.

Keywords: Forensic Odontology, Palatoscopy, Rugae

Introduction:

Forensic Odontology is a speciality in dentistry which plays a vital role among all the methods related to medico-legal identification. Forensic odontology (1998) can be defined as a branch of dentistry which deals with the appropriate handling and examination of dental evidence and with proper evaluation and presentation of dental findings in the interest of justice. [1].The use of forensic odontology is being done in cases of mass disasters where the identification of an individual becomes difficult. In such cases fingerprints and DNA matching are of prime importance. DNA testing is the gold standard in forensics but it is very costly and cannot be conducted for everybody. Sometimes when this is not possible, other human remains are considered like the temporomandibular joint; condylar and coronoid linear parameters, gonial angles and palatal rugae.

According to the glossary of prosthodontic term-8, Rugae are anatomical folds or wrinkles (usually used in the plural sense); the irregular fibrous connective tissue located on the anterior third of the palate. They are also "plica palatinae" or "rugae palatine". [2]

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Palatoscopy or palatal rugoscopy is the name given to study of palatal rugae in order to establish a person's identity. The palatal rugae, like fingerprints, do not change during the life of the individual. They are protected from trauma and high temperatures because of their internal position in the oral cavity, surrounded and protected by lips, cheeks, tongue, teeth and bone. Palatine rugae are unique to each individual and are reasonably stable during the person's growth. Once formed, it only changes in length, due to normal growth, staying in same position throughout the life of a person.[3,4].They can withstand thermal effects in burn victims and decomposition changes for up to seven days after death. Due to the uniqueness of the difference in the pattern for every individual, these rugae are being increasingly considered in the forensic investigations particularly in aeronautical accidents for identification of pilots by making use of ante mortem data.[3]

Palatal rugae are irregular transverse ridges of the mucosa in the anterior third of the palate, radiating from the palatine raphe behind the incisive papillae.[5].During the early intrauterine life period from 12th to 14th week they are formed and it will remain stable throughout the person's life and will not undergo any changes except for increase in length.[6].Physiologically, they are involved in the oral swallowing and improve the relationship between food and taste receptors in the dorsal surface of the tongue.[7]

History

In 1732, Winslow had described palatal rugae as permanent features of hard palate. Santorin in 1775 in Tabula VII of his septemdecimtabulae, depicted a drawing of three continuous wavy lines, which crosses the palate. [8]In 1889 Harrison Allen first suggested the use of palatal rugae as an alternative method of identification.[9].The first palatal classification system was given by Goria in 1911. He defined rugae as a ridge extending to atleast one half the distances from the median palatal raphe to the dental arch. Ritter.R(1943) even between twins, the studies indicated that the patterns are similar but not identical.

Classification:

Classification of Rugae Pattern given by different authors is illustrated. (Chart 1)

Chart 1: Classification of Rugae Pattern given by different authors

<table>
<tr><th>S. No.</th><th>Classification</th><th>YEAR</th><th>Rugae types</th></tr>
<tr><td>1.</td><td>GORIA</td><td>1911</td><td>Rugae pattern was divided into two types-
Specifying the number of rugae
Specifying the extent of rugal zone relative to the teeth.
Further distinguished rugae into 2 types-
Simple or primitive
More developed</td></tr>
<tr><td>2.</td><td>TROBO</td><td>1932</td><td>Palatal rugae were divided into two groups-
Simple rugae - where rugae shapes are well defined and divided further as type A,B,C,D,E,F
Compound rugae- rugae are formed by union of two or more simple rugae and were classified as “Type X” or Polymorphic type.
<table><tr><th>Classification</th><th>Rugae type</th></tr><tr><td>Type A</td><td>Point</td></tr><tr><td>Type B</td><td>Line</td></tr><tr><td>Type C</td><td>Curve</td></tr><tr><td>Type D</td><td>Angle</td></tr><tr><td>Type E</td><td>Sinuous</td></tr><tr><td>Type F</td><td>Circle</td></tr></table></td></tr>
<tr><td>3.</td><td>LYSELL</td><td>1955</td><td>Primary- 5mm or more
Secondary- 3-5mm
Fragmentary- 2-3mm(8)
Rugae smaller than 2mm are disregarded</td></tr>
<tr><td>4.</td><td>KAPALI</td><td>1997</td><td>Curved
Wavy
Straight
Circular
Modification Of Kapali’s Classification
Converging
Diverging
Curved
Wavy
Straight
Circular</td></tr>
<tr><td>5.</td><td>DA SILVA</td><td></td><td>Palatal rugae classified into two types-
Simple- numbered from 1-6
Composed- resulting from combination of 2 or more rugae patterns
<table><tr><th>Classification</th><th>Rugae type</th></tr><tr><td>1</td><td>Line</td></tr><tr><td>2</td><td>Curve</td></tr><tr><td>3</td><td>Angle</td></tr><tr><td>4</td><td>Circle</td></tr><tr><td>5</td><td>Wavy</td></tr><tr><td>6</td><td>Point</td></tr></table></td></tr>
<tr><td>6.</td><td>RUGAE UNIFICATION PATTERN</td><td></td><td>Converging
Diverging</td></tr>
</table>

Aims and objectives

The study was aimed to-

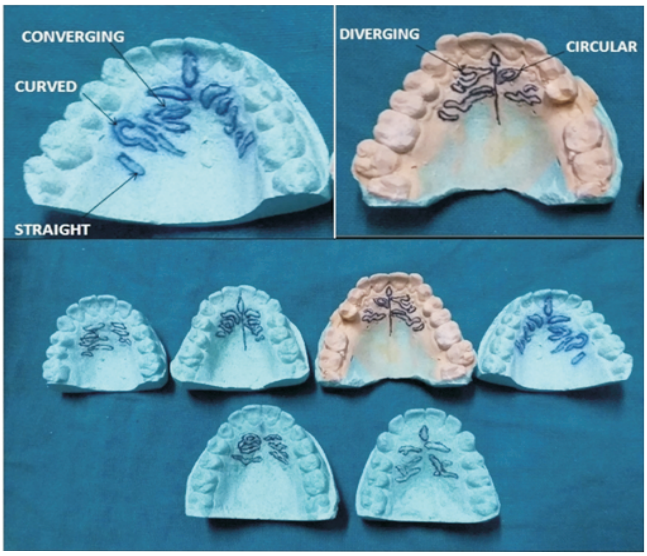
1. Identify the patterns of palatal rugae(in terms of number, shape and size of palatal rugae) in individuals of Punjab population.
2. To compare rugae patterns in male and female

The uniqueness of palatal rugae as an aid of personal identification was the sole objective of this study.

Materials and methods

This study was done on the population of Punjab which consisted maxillary casts of 280 subjects divided as 140 males and 140 females. Maxillary Casts already poured in dental stone were randomly collected according to the inclusion criteria with age range of 21-40years with age and sex written on posterior surface. A midline was drawn using

graphite pencil from the mid palatine raphe up to the incisive papillae to the most posterior extent of rugae on palate(4-5mm beyond) thereby dividing the rugae and palate into 2 halves. The rugae were highlighted using sharp graphite pencil and magnifying glass under adequate light on the cast. The pattern of rugae were then determined and classified according to Lysell classification given in 1955and modified Kapali classification in year 1997(Fig 1).



The Statistical analysis was done by t- test using SPSS Software version 20.

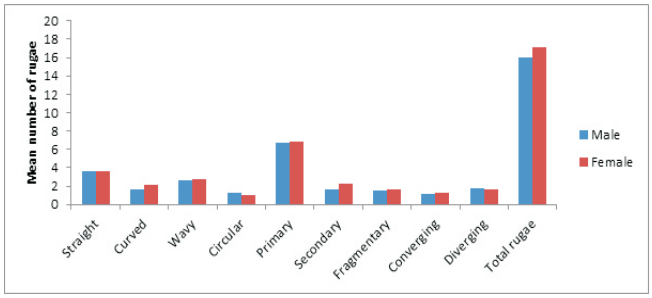
Results and observation :

The prevalence of different types of rugae in males and females is described in Table 1 which is statistically analyzed by T test using SPSS Software. The mean rugae in females were significantly more than in males (graph 1 and table 1).

Table 1: Comparative assessment of rugae pattern according to gender

	Number of rugae (Mean ± SD)		p-value	Total rugae (Mean ± SD)
	Males	Females		
Shape				
Straight	3.66 ± 1.87	3.58 ± 1.88	0.741	3.62 ± 1.87
Curved	1.67 ± 0.81	2.18 ± 1.05	0.002*	1.95 ± 0.99
Wavy	2.68 ± 1.44	2.69 ± 1.56	0.936	2.69 ± 1.5
Circular	1.25 ± 0.68	1.00 ± 0.00	0.079	1.1 ± 0.44
Length				
Primary	6.76 ± 1.63	6.8 ± 1.44	0.816	6.78 ± 1.53
Secondary	1.6 ± 0.95	2.2 ± 1.41	0.001*	1.92 ± 1.25
Fragmentary	1.45 ± 0.67	1.63 ± 1.15	0.568	1.53 ± 0.89
Unification				
Converging	1.2 ± 0.41	1.3 ± 0.61	0.37	1.26 ± 0.54
Diverging	1.76 ± 0.85	1.66 ± 0.88	0.437	1.71 ± 0.86
Total rugae	16.00 ± 3.35	17.16 ± 3.93	0.009*	16.58 ± 3.69

Test applied: Independent t test, *indicates statistically significant difference



The most prevalent forms on basis of shape in both the genders were straight type followed by wavy, curved, and circular. Curved forms were significantly more in females than in males.

Rugae were also observed on the basis of their length. Most prevalent size of rugae in males and females was primary, followed by secondary and tertiary or fragmentary. Out of which secondary rugae size was significantly more in females than in males.

A total of 2,310 rugae were observed in 280 subjects almost equally divided into right and left side of the median palatine raphe. Average number of rugae found in each individual was 8.25 of which 4-5 were on each side of the palate. In 140 females, total numbers of 1,198 rugae were identified with a mean value of 17.16± 3.93(mean ± SD), while in 140 males a total number of 1,112 rugae were observed with a mean value of 16.00± 3.35 (mean ±SD). Statistically, significant difference (p= 0.009) was observed in the number of rugae in males and females [table 1]. Also no significant differences were found in left and right side of the palate.

Out of 2310 rugae found in 280 individuals, based on shape 940(38.9%) were of straight type, which were maximum in number followed by wave type found in 648(43.2%) rugae, diverging type found in 310(13.41%)rugae, curved type found in 284(12.29%) rugae, converging type found in 108(4.67%) rugae and circular type found in 44(1.3%) rugae. In males as well as females, the mean proportion of the straight type was observed to be maximum (mean value in males being 3.66, while in females 3.58), followed by wave type(mean value in males being 2.68 and in females 2.69), curved type(mean value in males being 1.67, while in females 2.18), circular type(mean value in males being 1.25, while in females 1.00), diverging type(mean value in males 1.76, while in females 1.66) and converging type(mean value in males being 1.20, while in females 1.30). Curved type rugae based on shape was found statistically significant with p-

value 0.002 under independent t-test and also found more in females than males.

The most prevalent rugae on the basis of length were primary rugae(mean value in males being 6.76, while in females 6.80) followed by secondary rugae(mean value in males being 1.60, while in females being 2.20) and tertiary type(mean value in males being 1.45, while in females 1.63). Secondary rugae were found statistically significant which is more in females than in males (p value= 0.001)

Discussion:

Establishing a person's identity can be a very difficult process. Fingerprints and dental means represent the most scientifically reliable methods of identification. In the field of forensic odontology, rugoscopy is still in its infancy. [5] Despite the ongoing problem of describing palatal rugae pattern, quantitatively and qualitatively, their uniqueness to individuals has been recognized clearly as providing a potentially reliable source of identification. [3,5,8,10,11]. The present study was an attempt to identify the patterns of palatal rugae (in terms of number, shape and size of palatal rugae) in individuals of Punjab population and to compare rugae patterns in male and females.

In our study most prevalent size of rugae in males and females combined was primary followed secondary and then tertiary out of which secondary was statistically significantly and more in females with p-value of 0. 001.This observation was partly correlating to that of Shwetha et al [12], who reported that Mysorean males and Tibetan females had more primary rugae than their respective counterparts[12]. Kashima et al. compared the palatine rugae and shape of the hard palate among the Japanese and Indian children and reported that Japanese children had more primary rugaethan the Indian children and the palatal raphe of the Japanese childrenwerewiderthanthoseoftheIndianchildren[11].Similarly,the primary rugae were the most frequent type of rugae length in the adult Egyptian population [13]. Our study showed results which were contrary to the study done by Selvamani et al [14] in which there was no statistically significant difference in the length of palatal rugae between males and females of Kerala.

The present study found that straight shape was predominant in both genders followed by curved shape which was seen more in females than males. But the curved type showed statistically significant with p-value of 0.002. These findings were similar to by Eboh who found that the straight shape was the commonest palatal rugae shape followed by wavy shape among the Nigerian population. Also, previous studies on other populations found wavy shape as the predominant shape in Caucasian, Aboriginal Australians [10], Indian population [6,16,17] and Chilean population [18]similarly, as reported by Abdellatif et al. [19] who investigated the palatine rugae pattern in the Egyptian and Saudi children. They found that the most common rugae shape in Egyptians was wavy shape while the curved shape was most common rugae shape in Saudi children, followed by straight rugae in both the groups. The study conducted by Paliwal [20]and Kallianpur,[21] said that the predominant shape was wavy and study by Nitin Gautam[22]. stated that straight type was predominant in male population both showed contray results to our study.

In our study, statistically difference in mean of total number of rugae in females is more as compared to males and also no difference between left and right side rugae. Our results did partially correlate with study done among north and south Indian population of Devanagari city which stated that North Indian Males had more number of rugae and South Indian females had more number of rugae than their counterparts[23]Similar results were found in the study conducted by Falsal M Fahmi.[24] In contrast to our study, Dohke and Osato[25]reported that among the Japanese ,the females had fewer rugae than males. Study by Babuetal[26] found no significant difference between males and females in the length and shape of palatal rugae, but females were found to have greater number of rugae than males and Also, they reported that, the converging pattern was morefrequentinmaleswhiledivergingpatternwasmorefrequentinfemales.But results of our study correlated Babu et. al only in terms of greater number of rugae found in females rest all entities were contrary, as our study had curved rugae and secondary rugae more in females and diverging rugae were more males than females.

Population differences of rugae patterns have been reported by several comparative studies. This raises the question about the role of genetic differences and environmental effects on racial differences. Previous studies reported that, environmental factors are unlikely to affect formation of rugae and rugae shape is genetically controlled. This was enforced by subsequent twin studies which have revealed rugae pattern has an underlying genetic basis.[27]

Palatal rugae develop as localized regions of epithelial proliferation and thickening during the early intrauterine life even before elevation of palatal shelves. Subsequently, fibroblast and collagen fibers accumulate in the connective tissue beneath the thickened epithelium and assume a unique orientation. Palatal rugae orientation is achieved by running of collagen fibers antero-posteriorly within the curve and in concentric curves across the base of each rugae. Therefore, prominent rugae occupy most of the length of the palatal shelves at the time of their elevation in human embryos. [28]This process is believed to be affected by genes during embryogenesis and postnatal growth which may result in differences in rugae pattern between different population. [29]

Conclusion

Palatal rugae pattern is definitely a sufficient characteristic to discriminate between the genders. Located in the anterior half of the roof of the mouth, palatal rugae serve as a reference landmark in various dental treatment modalities and could be used in the identification of submucosal clefts. Palatine rugae can be used to assess the amount of anteroposterior tooth movement, because they remain stable during a person's life. Moreover, the previous studies showed a significant association between rugae forms and different races. In this study, mean value of rugae is seen more in females than males. Also, rugae pattern on basis of shape(curved type) and on basis of size(secondary type) both statistically significant and found more in females. It is unique to an individual and can be used successfully in identification. This is a preliminary study on localized Indian population. Scope still exists for further studies to determine gender as well as personal identification.

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