

A Comparative Study of Gender Difference in Palatal Rugae Patterns among Bengali Subjects in Murshidabad

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ABSTRACT

Introduction: Palatal rugae pattern is reasonably unique to an individual and remain stable throughout lifetime. It can serve to be an important tool in forensic identification, particularly when, other regular methods of identification become difficult.

Aim: To determine whether or not there exists any gender difference in palatal rugae pattern among Bengali subjects in Murshidabad district of West Bengal.

Materials and Methods: The study was conducted on a total of 68 subjects (n=68) belonging to Murshidabad District of West Bengal. The sample was randomly selected comprising 34 males and 34 females. Alginate impressions of the hard palate of subjects were taken and casted by dental stone. The data were assessed based on the Thomas and Kotze classification

(1983). Association between rugae forms and gender were tested using student's t-test.

Results: Palatal rugae of right side showed higher prevalence in female (3.706 ± 0.676) and the finding is statistically significant. The curved shaped rugae were significantly predominant in females (2.471 ± 0.992) than in males. The backward directed rugae pattern was significantly predominant in females (3.353 ± 1.704) than in males, but the perpendicular rugae pattern was significantly predominant in males (0.824 ± 0.387) than in females.

Conclusion: The current study reveals significant gender difference in palatal rugae pattern. This unique rugae pattern and gender difference can be used as a reliable aid for identification of subjects in Murshidabad population.

Keywords: Alginate impressions, Forensic Odontology, Palatoscopy

INTRODUCTION

Palatal rugae have been considered relevant for human identification due to its stability and uniqueness for each individual and often being considered equivalent to the fingerprints [1]. Like dermatoglyphics, each individual has a unique palatal rugae configuration that remains unchanged from womb to tomb except in the dimension in proportion to the growth of an individual. Rugae are highly protected configurations because of their internal positions and largely remain insulated by tongue and buccal fat pads. Palatoscopy has gained importance because it can be applied where no finger-prints are available. It can be applied to decomposed bodies, burnt bodies and in cases of missing upper limbs [2,3]. The method is fast, simple, inexpensive and produces no trauma during recordings. Rugae patterns can be analysed very quickly using standardised procedure.

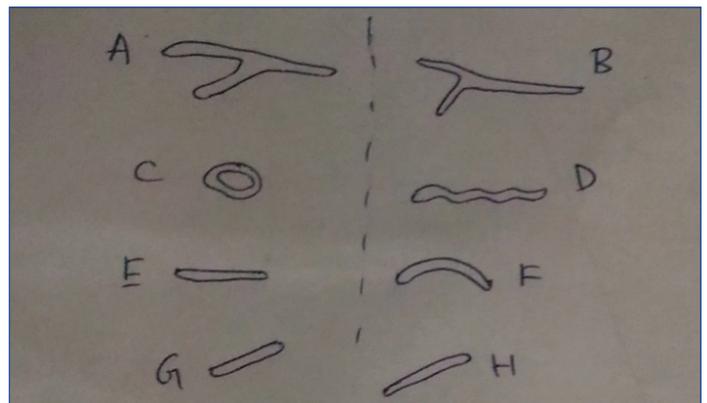
Palatal rugae pattern are unique in every human and often considered equivalent to finger prints. Authors of the current study did not found any comprehensive study on palatal rugae pattern of Bengali people. So, the present study was designed to evaluate the role of palatoscopy in personal identification and sex determination of human subjects in Murshidabad district of West Bengal. The study will aid to create a local database which can be used as important tool for forensic identification.

MATERIALS AND METHODS

The study was a population based cross sectional study conducted in Department of Anatomy, Murshidabad Medical College, Murshidabad, West Bengal, India. Hundred patients attending Dental OPD of Murshidabad medical college were randomly selected and after consideration of exclusion criteria, 68 patients were finally selected for this study. The total duration of study was one year, extending from February 2016 to January 2017. Palatal impression models were collected from all participants. Person without removable and fixed partial dentures and without braces were included in the study. Persons with palate and lip anomalies

(cleft lip, cleft palate etc.,) or injured hard palates were excluded from the present study. Persons residing outside Murshidabad or those unwilling to give consent were also kept out of the present study. Informed consent was taken from all participants.

The oral cavity of subject was rinsed with chlorhexidine (0.12%) mouth wash. An alginate impression of the hard palate of subject was taken and casted by dental stone. The rugae patterns were marked with black permanent marker pen and then were analysed by using the easiest, most practical and standardised technique of Thomas and Kotze classification [4]. This classification is based on the parameters like total number of rugae, number of primary rugae, predominant shape of rugae, predominant direction of rugae and their unifications. Length of rugae was evaluated as primary (>5 mm), secondary (3-5 mm) and fragmentary (<3 mm). Rugae less than 2 mm were not included. Shape of rugae was recorded as curved, wavy, straight and circular [Table/Fig-1]. The direction of rugae was evaluated by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median raphe and



[Table/Fig-1]: Various types of rugae. A- Converging, B- Diverging, C-circular, D- wavy, E-straight & perpendicular, F-curved, G-forward, H-backward.

classified as forwardly directed rugae, backwardly directed rugae and perpendicular rugae. Unification of rugae in the samples was recorded as diverging or converging rugae.

Statistical analysis was done by Student's t-test to evaluate the gender difference in rugae patterns in the current sample.

The entire procedure followed during the study was in accordance with the ethical standards of the Institutional Ethical Committee.

RESULTS

All the dental casts (34 male and 34 female, total of 68) were thoroughly examined and statistically analysed.

The data shows that the total number of rugae on the right side of hard palate was higher in female than in male and the observed difference was found to be statistically significant [Table/Fig-2]. On the contrary, the difference in the values of total number of rugae on the left side of hard palate was not significant [Table/Fig-3]. When total number of primary rugae was analysed it was found that there was no statistically significant difference in the number between male and female samples [Table/Fig-4]. While analysing the shape of the palatal rugae [Table/Fig-5,6], it was observed that the predominant shape of rugae was curved in males and females followed by wavy, straight and circular shapes [Table/Fig-7].

Gender	Number	Mean	Standard deviation	t-value	p-value	Remarks
Male	34	3.412	0.499	2.042	<0.05	Significant
Female	34	3.706	0.676			

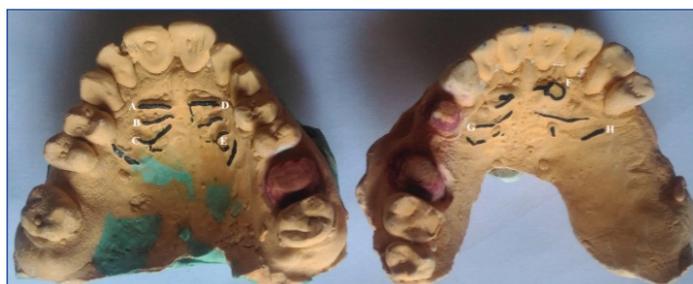
[Table/Fig-2]: Total number of rugae (right side) among the males and females.

Gender	Number	Mean	Standard deviation	t-value	p-value	Remarks
Male	34	3.412	0.988	0.532	>0.05	Not significant
Female	34	3.294	0.836			

[Table/Fig-3]: Total number of rugae (left side) among the males and females.

Gender	Number	Mean	Standard deviation	t-value	p-value	Remarks
Male	34	4.647	1.515	1.833	>0.05	Not significant
Female	34	4	1.393			

[Table/Fig-4]: Total number of primary rugae in relation to gender.



[Table/Fig-5]: Cast showing various types of rugae. A- straight and perpendicular, B- wavy, C- diverging, D- curved, E- converging, F- circular, G- forward, H- backward.



[Table/Fig-6]: Palatal rugae.

Gender	Curved		Wavy		Straight		Circular	
	Male	Female	Male	Female	Male	Female	Male	Female
Mean	1.588	2.471	1.412	1.706	1.235	1.118	0.235	0.118
Standard deviation	1.104	0.992	1.258	1.088	0.955	1.095	0.431	0.239
T value	3.463		1.032		0.47		1.376	
p-value	<0.05		>0.05		>0.05		>0.05	
remarks	Significant		Not significant		Not significant		Not significant	

[Table/Fig-7]: Number of the various shapes of rugae among the males and females.

Females exhibited a higher mean value of the number of curved rugae as compared to males and the difference was statistically significant [Table/Fig-8]. Mean values for other shapes were not significantly different in between the samples. While studying the direction of palatal rugae it was observed that the numbers of backward directed rugae was higher in females and the difference was statistically significant. On the contrary, the numbers of perpendicular rugae was significantly higher in males [Table/Fig-8]. However, there was no statistically significant difference in the number of unifications of palatal rugae in male and female samples [Table/Fig-9].

Gender	Forwardly directed		Backward directed		Perpendicular	
	Male	Female	Male	Female	Male	Female
Mean	1.118	1.177	2.177	3.353	0.824	0.529
Standard deviation	0.978	0.387	1.527	1.704	0.387	0.507
t-value	0.328		3		24.583	
p-value	>0.05		<0.05		<0.05	
Remarks	Not significant		Significant		Significant	

[Table/Fig-8]: Total number of the various directions of rugae among the males and females.

Gender	Converging		Diverging	
	Male	Female	Male	Female
Mean	0.765	1	0.412	0.353
Standard deviation	0.654	0.603	0.499	0.597
T value	1.536		0.444	
p-value	>0.05		>0.05	
Remarks	Not significant		Not significant	

[Table/Fig-9]: Total number of the unifications of rugae among the males and females.

DISCUSSION

Palatoscopy, the study of palatal rugae pattern, is considered to be an important tool in sex determination, Forensic odontology and Orthodontics. Study of palatal rugae pattern can be taken as a useful adjunct for human identification beside other known methods like finger prints, dental records and DNA studies. Present study was designed to compare the pattern between male and female subjects in Murshidabad districts of West Bengal, to identify and assess the predominating patterns in them and to see whether they can be used as reliable tool for identification. Many studies have been carried out in past on rugae patterns and it is an established fact that no two palates are alike in their configuration. The palatal rugae are unique.

In the present study, it is observed that the total number of rugae on the right side of palate shows a statistically significant difference among sexes in the study population. However, the total number of rugae on the left did not show any statistically significant differences among the sexes so as the total number of primary rugae. [Table/Fig-10] represents a comparative view of the present study with other similar studies on palatal rugae pattern in India [5-28].

In the present study, it was found no sexual dimorphism in terms of total number of primary rugae. In a study on evaluation of rugae pattern in individuals of Jammu and Kashmir aged 17-25, it was

Author	Place and Year	Study Setting	Findings
Hosmanii J et al., [5]	Karnataka, India, 2018.	50 Indian and 50 Tibetan aged between 20-40 years. Each group contains 25 male and 25 female.	Higher number of total rugae in Indian population compared to Tibetan. Predominant rugae were straight and wavy in Indians, curved in Tibetans.
Babaji P et al., [6]	Shimoga, Karnataka, India 2018.	30 school children, 15 male and 15 females aged 8 to 15 years from OPD of sharavathi dental College, shimoga.	Significantly higher primary rugae pattern among boys over girls. Circular rugae 7 secondary rugae were more among girls over boys.
Oberoi IS et al., [7]	Jammu and Kashmir, India, 2017.	120 students, 60 male and 60 female, aged between 17 to 25 years belonging to Jammu and Kashmir.	Mean palatal primary rugae were significantly more in males (7.52±2.67) than females (6.43±1.91).
Srikala P et al., [8]	Karnataka, India, 2017.	100 subjects, 50 male and females aged 18 to 25 years from S. N. Dental college, Kalaburgi.	Both males and females showed predominantly wavy rugae shape followed by straight, curved and circular rugae. More number of rugae found on the left side of the palate.
Panda S et al., [9]	Odisha, India, 2017	21 pairs of monozygotoc and 12 pairs of dizygotoc twins aged 8-64 years	Existence of mirror Imaging in number and shape of palatal rugae in monozygotoc and dizygotoc twins.
Khajuria RR et al., [10]	Jammu, India, 2017	50 students, 25 male and 25 female from high school of Jammu.	Number of palatal rugae was more among males. Straight type rugae were most prevalent among both sexes.
Gadicherla P et al., [11]	Bengaluru, India, 2017	100 plaster casts, 50 male and 50 females aged 4 to 16 years from Bengaluru population.	Wavy and curvy type of rugae were most prevalent in both sexes and there was no significant unification pattern among sexes
Ramniwas M Kumawat et al., [12]	Central India, 2017	300 individuals (150 males and 50 females) aged 17 to 25 years selected from rural and urban areas of central India.	Number and pattern of rugae not associated with gender. But rugae length was significantly different between male and female.
Mohamabzowharsazid et al., [13]	India, 2016	180 palatal casts, 75 male and 75 female from 5 families and 5 pairs of identical twins aged 14 years and above from Indian population.	No similarity in pattern suggesting that heredity does not a play role in determining the rugae pattern in any individual.
Kalyani KR et al., [14]	Andhra Pradesh, India, 2016	100 subjects aged 17 to 25 from coastal Andhra Pradesh and Telengana	Divergent and wavy rugae patterns were more in males
Dwivedi N et al., [15]	Jabalpur, India, 2016	500 subjects, 250 male and 250 female from OPD of Hitkarini Dental College and Hospital, Jabalpur.	Males showed more number of rugae than females
Pillai J et al., [16]	Gujrat, India, 2016	100 patients 17-25-years-old	No gender discrimination in relation to palatal rugae. 56% showed asymmetry in rugae count between left and right.
Swetha S et al., [17]	North India, 2015	60 patients, 30 male and 30 female aged between 18 to 35 years from North and South Indian population.	Primary rugae were more in males where as secondary and tertiary rugae were more among females.
Nallamilli SM et al., [18]	Andhra Pradesh, India, 2015	200 subjects divided into two groups of 100 each based upon gender from OPD of a dental college.	Curved type rugae found to be higher in males, wavy type in females.
Harchandani N et al., [19]	Western and northern India, 2015	100 subjects, 50 each from 2 groups of Western and Northern Indian population.	A significant difference exists in the number and shape of rugae between the genders. Females had more curved shaped rugae.
Balgi P et al., [20]	Pune, India, 2014	50 patients, 25 male and 25 females aged 30 to 50 from OPD of Sinhgad Dental College and Hospital, Pune.	Average length of rugae was greater in males than in females however the average number of rugae were same in both sexes
Asdullah M et al., [21]	Lucknow, India, 2014	100 subjects, 50 male and 50 female aged between 18-40.	Mean rugae number in female is more than male. Straight and curved forms were significantly more in number in female than in male.
Hunasgi S et al., [22]	Karnataka, India, 2014	100 BDS students, 50 each from Kerala and Manipur aged 17 to 21 years.	There exist no association between lip print and palatal rugae pattern.
Shubha C et al., [23]	Karnataka, India, 2013	150 students aged 17-23 years in two groups each from north Indian and South Indian population.	No difference in number of rugae between population. Percentage of curved rugae was more in North Indians, wavy and circular shape more common in South Indians.
Madhankumar S et al., [24]	Chennai, India, 2013.	135 students, 62 male and 73 females aged 17 to 25 from Sri Ramchandra University, Chennai.	A statistically significant difference in terms of total number and number of unification type of rugae in males and females exists. However, there was no difference in rugae patterns between sexes.
Kumar S et al., [25]	Puducherry, India, 2012.	100 male and female patient between the age group 20-35 years.	Wavy pattern was most predominant followed by curved, straight, branched and circular in both male and female.
Kamala R et al., [26]	Lucknow, India, 2011	1000 subjects divided in 5 age groups from OPD of SPPGIDMS, Lucknow.	33.1% of total rugae shapes were curved in both sexes followed by wave and straight type comprising 27.9% and 25 % respectively.
Pateria AH et al., [27]	Akola, Maharashtra, India, 2011	30 pre and post treatment cast collected from a dental clinic in Akola, central India.	Size and shape of rugae did not change even after orthodontic treatment.
Nayak P et al., [28]	India, 2007	30 plastered cast having equal sex distribution and similar age group from two Indian population.	Showed lack of sexual dimorphism of palatal rugae among two Indian populations.
Present Study (Refer [Table/Fig-2-4,7-9])	Murshidabad, West Bengal, India. 2017.	Selected OPD patients from Murshidabad Medical College and Hospital, Berhampore, Murshidabad, West Bengal. Sample size 68, 34 male and 34 female.	Total number of rugae on the right side of hard palate was higher in female than in male [Table/Fig-2]. No difference in the total number of rugae on left side between male and female [Table/Fig-3]. No sexual dimorphism in terms of total no. of primary rugae [Table/Fig-4]. Predominant shape of rugae was curved in males and females followed by wavy, straight and circular shapes. Females exhibited a higher number of curved rugae than males [Table/Fig-7]. Female had higher numbers of backward directed rugae. Perpendicular rugae were significantly higher in males [Table/Fig-8]. No difference in the number of unifications of palatal rugae in male and female [Table/Fig-9].

[Table/Fig-10]: Comparison of the current study on palatal rugae pattern with other similar studies in India [5-28].

found that average number of palatal primary rugae was significantly more in males (7.52±2.67) than females (6.43±1.91) [7], In another study conducted in a sample from Bosnia no significant difference

was found in the total number of palatal rugae between the sexes [29] which matches the present findings. The occurrence of primary rugae was found to be more in males where as secondary and tertiary

rugae were more in females in another study in India conducted on North Indian and south Indian population [17]. A similar study done in Jabalpur, India has reported that males showed more number of rugae than females [15]. Another study performed by Nayak P et al., showed lack of sexual dimorphism among two Indian populations, similar to current observation on Bengali population [28]. A study conducted on students of Jammu city showed that number of palatal rugae was more among males, and straight type rugae were most prevalent among both sexes [10], which differ from the present findings. A study conducted in outpatient Department at Sinhgad Dental College and Hospital revealed that the average number of rugae was same in both sexes similar to the present study [20].

The present study shows that the predominant shape of rugae was curved in males and females followed by wavy, straight and circular shapes. This can be compared to a study on Indian population in Lucknow which stated that 33.1% of total rugae shapes were curved in both sexes followed by wave and straight type comprising 27.9% and 25 % respectively [26]. In a study conducted on male and female population in Chile, it was observed that the most common type of palatal rugae was sinuous and curves. Most of the rugae were found in E quadrant. Larger palatal rugae were of sinuous type and average number of rugae was more in males [30] unlike the present study. Another Indian study on coastal ethnic population of Andhra Pradesh of Telengana reported that curved rugae pattern was significantly more in coastal Andhra [14] which matches with our result. In the same study, divergent and wavy rugae pattern were found to be more in males which however does not match with current findings. A Saudi Arabian study concluded that there was an increased incidence of circular shaped rugae among Saudi females than males [31]. A study on the Saudi population revealed that the sinuous type was found more in males and curve type was more in females [32]. Unlike present study where the curved rugae was most common irrespective of sexes. A study conducted on population sample from Upper Egypt revealed higher proportion of angle and point patterns in male, where in our study, we found perpendicular rugae to be significantly higher in males compared to females. We also observed that the numbers of backward directed rugae was higher in females and the difference was statistically significant. On the contrary, we found that the numbers of perpendicular rugae was significantly higher in males. The Egyptian study also reported that the length of rugae and its number did not differ in relation to either age or gender [33].

In present study it was observed that there is no sexual dimorphism in unification pattern of primary rugae. This observation is unlike the Lucknow study [26], which stated that females had significantly higher mean proportion of unification converging rugae as compared with males. The Saudi study on rugae pattern also confirmed that females showed a higher significance in the unification converging type [31]. A study conducted in Bengaluru showed that wavy and curved type of rugae were most prevalent in both sexes and there was no significant unification pattern among sexes [11] which matches with the present findings. A study performed on student population in Chennai showed that there was a statistically significant difference in terms of total number and unification type of rugae in males and females; however, there was no difference in rugae patterns between sexes [24].

A Study conducted in Akola showed that size and shape of rugae did not change even after orthodontic treatment suggesting that rugoscopy can be a potential powerful tool in forensic identification [27].

In a study conducted in Kalaburgi, Karnataka, it was reported that, there exist a correlation between rugae pattern and blood group in both male and females [8]. A study of rugae pattern on identical twins and family members reported no similarity in pattern suggesting that heredity may not play role in determining the rugae pattern in any individual [13]. A study conducted by Hunasgi S et al., reported that

palatal rugae and blood group was associated in a population of Karnataka and Kerala, however there exist no association between lip print and palatal rugae pattern [22]. Current Study of palatal rugae pattern in Murshidabad reconfirms the reliability of the tool for identification purpose owing to its uniqueness and stability.

The present study has echoed the findings of earlier studies on various ethnic groups in establishing the potential of rugae pattern in sex identification. It must be understood in the current context that such identification depends largely on the availability of antemortem records of rugae pattern in various forms.

LIMITATION

Unfortunately, the data base in India is scanty and improper and thus limits the potential of this tool in forensic study. The present study was carried out without any financial support from any sponsoring agency. As this study had a limited sample size of 68 subjects, it will be beneficial to conduct similar studies with larger samples and on various ethnic groups. Creation of a data bank comprising antemortem data on palatal rugae pattern will overcome the limitation of using the method in human identification.

CONCLUSION

The present study on palatal rugae pattern in Murshidabad reestablishes the potential of rugae pattern as important tool in identification of humans. The study reported a unique pattern in the population where the total number of rugae in right side of palate showed a statistically significant difference among sexes. The incidence of curved rugae was more in females. The incidence of perpendicularly directed rugae were more in males and backwardly directed rugae were more in females in the current sample. However, no significant gender difference in the total number of primary rugae could be found.

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Date of Submission: **Mar 06, 2018**

Date of Peer Review: **May 21, 2018**

Date of Acceptance: **Dec 01, 2018**

Date of Publishing: **Jan 01, 2019**

FINANCIAL OR OTHER COMPETING INTERESTS: None.