

# Analysis of Palatal Rugae pattern in Indian and Nepalese population- a comparative study

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## ABSTRACT:

**Background:** Human identification is an important aspect in forensic science. Palatal rugae are unique in each individual and they remain consistent in shape and size during one's life time. Certain rugae patterns are specific to particular population and vary geographically.

**Objective:** To assess and compare the palatal rugae pattern in Indian and Nepalese population situated in Vadodara, India.

**Methods:** A cross sectional study was conducted on 200 healthy participants- 100 Indian & 100 Nepalese situated in Vadodara district. All the participants were above 16 years of age and with presence of all the teeth. The origins of parents for the participants were Indian and Nepalese respectively. Maxillary impression of each participant was taken in rubber base material and a cast was prepared in type IV dental stone. With the help of black marker pencil, the outline of palatal rugae was delineated. The More et al classification was used. The details were recorded. The collected data was statistically analyzed by using SPSS software version 16 and the test applied were Pearson chi square and independent 't' test.

**Results:** Out of total 200 participants, 81 were females and 119 were males. The age ranged from 16-65 yrs. with a mean age of  $28.82 \pm 11.81$  yrs. The mean of total number of palatal rugae in Indian and Nepalese participants was  $8.30 \pm 1.43$  &  $8.28 \pm 1.37$  respectively; which was statistically not significant ( $p > 0.05$ ). The most common type of palatal rugae in both the group was primary type, which was statistically not significant ( $p > 0.05$ ). The faint type of rugae thickness was statistically highly significant ( $p < 0.05$ ). 'Line' type was the most common shape seen in both the groups. The backwardly directed rugae was commonly seen in study groups and was statistically not significant ( $p > 0.05$ ). A new type of shape 'H' was noted and the location of rugae was different in both the groups.

**Conclusion:** The palatal rugae pattern is one of the important aid in personal identification. The present study concludes that the shape in Indian and Nepalese participants were more or less similar except the location of rugae.

**Keywords:** Anthropometry, Forensic odontology, Palatoscopy, Palatal rugae, Rugoscopy.

## INTRODUCTION

The identity of an individual is always in question in the present world of simulation and impersonation. Several incidences occur in every individuals life between *womb to the tomb*; may be destructions like earthquake, volcanic eruptions, tsunami, plane crash, vehicular, ship & train accidents, terrorist attacks, etc.<sup>1,2</sup> Correct recognition of deceased is important for certifying death and for personal, social and legal reasons. Human identification in such incidences is based on scientific principles primarily involving dental records, finger prints and DNA analysis. The oro-facial structure play an important role in personal identification and one such is palatal rugae, because of its uniqueness and its characteristic nature.<sup>3</sup> During the fetal development, the rugae appear around the third month from the connective tissue in the palatal process of maxillary bone. The palate of every individual is different in configuration and the pattern does not alter due to growth.<sup>4</sup>

The palatal rugae, except in size, remain consistent in shape, pattern, direction & location

throughout life of every human being and even several days after the death.<sup>1</sup>The rugae pattern differ geographically and is specific to particular population.<sup>4,5</sup>The substantial migrant population from Nepal, Taiwan, Bhutan, Bangladesh etc. are settled in different parts of India. The present study was intended to assess and correlate the palatal rugae pattern in Indian and Nepalese population so as to know whether any difference exists.

## MATERIALS AND METHODS

The cross sectional study was conducted on 200 participants -100 Indian & 100 Nepalese situated in Vadodara district, which were above 16 years of age and having all permanent maxillary teeth except third molar. The origin of parents was of respective countries. Participants with tobacco smoking, history of facial trauma, craniofacial abnormalities and of interracial origin were excluded from the study. The permission to conduct the study was obtained from Sumandeep Vidyapeeth Institutional Ethics Committee bearing no. SVIEC/ ON/DENT/ RP/15025 dated: 09-04-2015.

After obtaining the informed consent form, each participant was subjected to maxillary impression taking with rubber base impression material and dental cast were prepared in type IV dental stone. A black marker pencil was used to outline the palatal rugae. The palatal rugae were assessed jointly by the authors, using More & Gupta classification (Figure no. 01) and Thomas & Kotze's classification.<sup>6</sup> The details were recorded and statistically analyzed by using SPSS software version 16.0 and the tests applied were Pearson chi square and independent 't' test.

## RESULTS AND OBSERVATION

Out of total 200 participants, 81 were females and 119 were males. The participants age ranged from 16-65 yrs. with a mean age of  $28.82 \pm 11.81$  yrs. The maximum number of the participants were between the age group of 16-30 yrs. The present study considered number, type, pattern, thickness and direction of palatal rugae. (Table no. 01)

When the number of palatal rugae in Group I participants were studied, it was observed that the mean value on right & left side was  $4.07 \pm 0.987$  &  $4.23 \pm 0.802$  respectively; Whereas in Group II, the mean value on right & left side was  $4.07 \pm 0.935$  &  $4.21 \pm 0.808$  respectively. The mean of total number of rugae in Indian and Nepalese population was  $8.30 \pm 1.43$  &  $8.28 \pm 1.37$  respectively. After applying Independent 't' test to all these values, the statistical analysis was not significant ( $p > 0.05$ ). (Table no. 02)

The three types of palatal rugae- primary, secondary and fragmentary were studied. In primary type, the mean value in Group I was  $7.10 \pm 1.62$  & Group II was  $7.15 \pm 1.36$ . In secondary type, the mean value in Group I was  $0.95 \pm 1.27$  & Group II was  $0.79 \pm 1.10$ . In fragmentary type, the mean value in Group I was  $0.30 \pm 0.65$  & Group II was  $0.36 \pm$

$0.68$ . Independent 't' test was applied to all these values and the statistical analysis, was found to be not significant ( $p > 0.05$ ). (Table no. 03)

The two types of thickness - prominent and faint were considered in the present study. In case of prominent rugae, the mean value in Group I was  $7.75 \pm 2.10$  & Group II was  $7.99 \pm 1.71$ ; whereas in faint type of rugae, the mean value in Group I was  $0.60 \pm 1.11$  & Group II was  $0.33 \pm 0.69$ . Statistical analysis was performed by using Independent 't' test. The probability value was not significant in prominent type ( $p > 0.05$ ), but was highly significant in faint type ( $p < 0.05$ ). (Table no.03)

When the shape of palatal rugae were studied, it was significantly observed that the rugae patterns were similar in both groups. The most common pattern in group I ( $3.07 \pm 1.05$ ) and group II ( $3.17 \pm 1.02$ ) was 'line'. (Table no.04)

The directions of palatal rugae were studied. In forward direction, the mean value in Group I was  $1.53 \pm 1.893$  & Group II was  $1.35 \pm 1.925$ . In Backward direction, the mean value in Group I was  $6.11 \pm 2.318$  & Group II was  $6.39 \pm 2.247$ . In perpendicular direction, the mean value in Group I was  $0.68 \pm 1.254$  & Group II was  $0.61 \pm 0.205$ . The statistical analysis was performed by using Independent 't' test and the probability value was not significant ( $p > 0.05$ ). (Table no. 03)

The two types of rugae unification- divergence and convergence were studied. In group I and group II, the divergence type was observed in 43 & 45 participants respectively; whereas the convergence type was observed in 21 & 22 participants respectively. The statistical analysis was performed using Independent 't' test and the probability value was not significant ( $p > 0.05$ ). (Table no.05)

S.N.	Shape	Diagram
1.	DOT	
2.	LINE	
3.	CRESCENT	
4.	ANGULAR	
5.	WAVY	
6.	RING	
7.	X-TYPE	
8.	SPINDLE SHAPE	
9.	CIRCULAR	
10.	SERPENGENOUS	
11.	H-TYPE	

Figure 1: Chandramani More & Swati Gupta's classification for Shape of Palatal rugae.

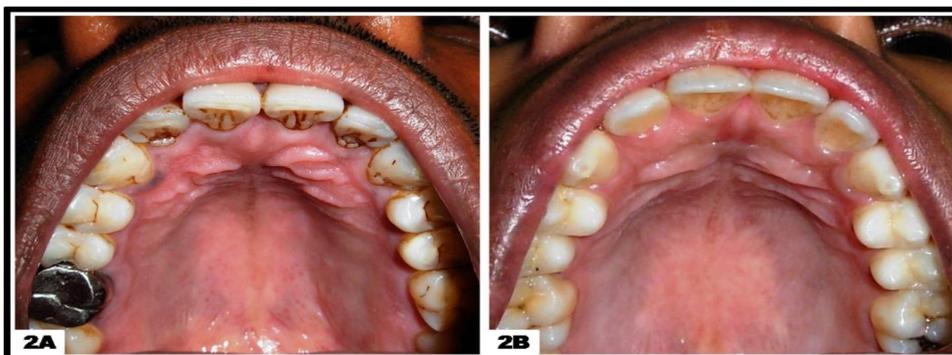


Figure 2: Clinical photograph of palatal rugae (a) Indian (b) Nepalese participant.

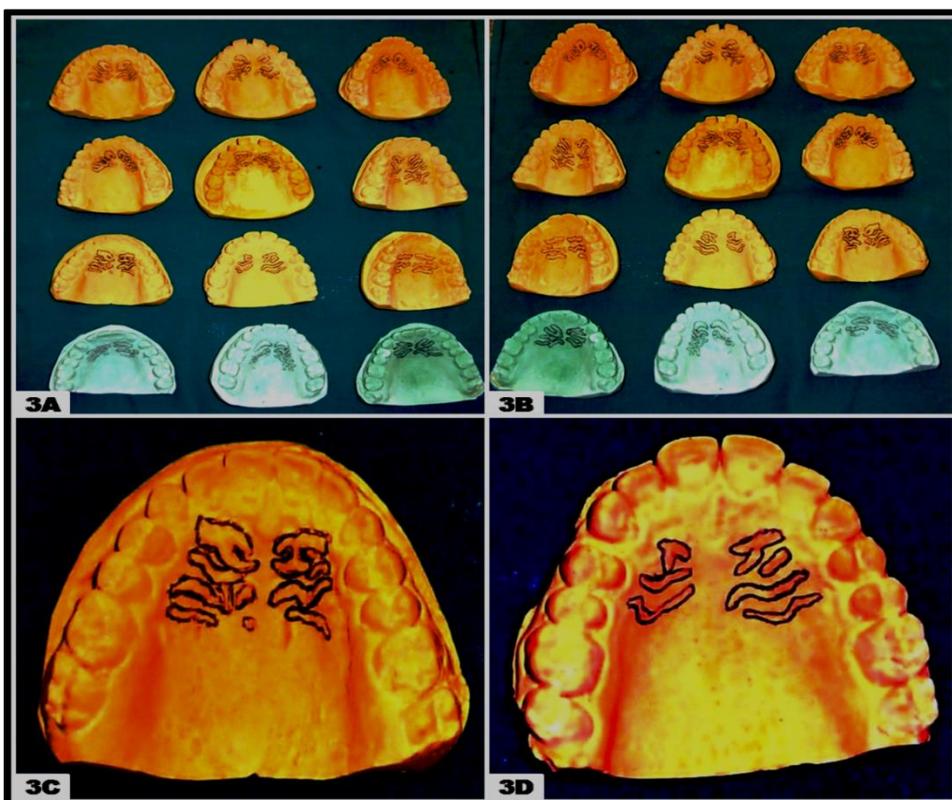


Figure 3: Dental stone cast showing- (3A): Cast models of Indian participants (3B): Cast models of Nepalese participants. (3C): Delineated palatal rugae in Indian participant. (3D): Delineated palatal rugae Nepalese participant.

Table 1: Distribution of participants according to Age group

Age group (in yrs.)	Group		Percentage (%)
	I	II	
16- 20	56	6	31.0%
21-30	43	22	32.5%
31-40	1	25	13.0%
41-50	0	38	19.0%
51-60	0	6	3.0%
60-70	0	3	1.5%
Minimum age (in yrs.)	16	16	-
Maximum age (in yrs.)	34	65	-

(Group I- Indian, Group II- Nepalese, yrs.= Years,)

**Table 2: Distribution of Total number of palatal rugae**

Group	Number of rugae (Mean $\pm$ SD)		Obtained 'p' value	Total rugae	Obtained 'p' value
	Right	Left			
I	4.07 $\pm$ 0.987	4.23 $\pm$ 0.802	1.00 NS (p<0.05)	8.30 $\pm$ 1.432	0.920 NS (p<0.05)
II	4.07 $\pm$ 0.935	4.21 $\pm$ 0.808	0.861 NS (p<0.05)	8.28 $\pm$ 1.371	

(Group I- Indian, Group II- Nepalese, NS=Not significant, p=probability value, SD= Standard deviation)

**Table 3: Distribution according to Length, Thickness and Direction of palatal rugae**

Variable	Type	Group I (n) (Mean $\pm$ SD)	Group II (n) (Mean $\pm$ SD)	Obtained 'p' value
Length	Primary	7.10 $\pm$ 1.62	7.15 $\pm$ 1.36	0.814 NS (p<0.05)
	Secondary	0.95 $\pm$ 1.27	0.79 $\pm$ 1.10	0.344 NS (p<0.05)
	Fragmentary	0.30 $\pm$ 0.65	0.36 $\pm$ 0.68	0.530 NS (p<0.05)
Thickness	Prominent	7.75 $\pm$ 2.10	7.99 $\pm$ 1.71	0.377 NS (p<0.05)
	Faint	0.60 $\pm$ 1.11	0.33 $\pm$ 0.69	0.042 HS (p<0.05)
Direction	Forward	1.53 $\pm$ 1.893	1.35 $\pm$ 1.925	0.506 NS (p<0.05)
	Backward	6.11 $\pm$ 2.318	6.39 $\pm$ 2.247	0.387 NS (p<0.05)
	Perpendicular	0.68 $\pm$ 1.254	0.61 $\pm$ .205	0.688 NS (p<0.05)

(Group I- Indian, Group II- Nepalese, n= number, NS=Not significant, HS= Highly significant p=probability value, SD= Standard deviation)

**Table 4: Distribution according to Shape of Palatal rugae**

Shape	Group I (n)				Group II (n)			
	Right	Left	Total	Mean $\pm$ SD	Right	Left	Total	Mean $\pm$ SD
Dot	17	10	27	0.13 $\pm$ 0.46	14	10	24	0.12 $\pm$ 0.45
Line	310	305	615	3.07 $\pm$ 1.05	320	314	634	3.17 $\pm$ 1.02
Crescent	09	07	16	0.81 $\pm$ 0.27	07	04	11	0.55 $\pm$ 0.22
Angular	06	10	16	0.35 $\pm$ 0.32	05	12	17	0.31 $\pm$ 0.33
Wavy	36	46	82	0.41 $\pm$ 0.56	29	40	69	0.35 $\pm$ 0.33
Ring	01	18	19	0.14 $\pm$ 0.24	02	18	20	0.19 $\pm$ 0.26
Circular	00	04	04	0.04 $\pm$ 0.20	00	02	02	0.20 $\pm$ 0.14
Serpengeno us	10	15	25	0.12 $\pm$ 0.33	10	11	21	0.10 $\pm$ 0.33
H Type	00	02	02	0.02 $\pm$ 0.14	00	04	04	0.04 $\pm$ 0.19

(Group I- Indian, Group II- Nepalese, n= number, SD= Standard deviation)

**Table 5: Distribution according to Unification of Palatal rugae-**

Unification	Group (n)		Obtained 'p value'
	I	II	
Type 1 (Divergence)	43	45	0.776 NS (p<0.05)
Type 2 (Convergence)	21	22	0.863 NS (p<0.05)

(Group I- Indian, Group II- Nepalese, n= number, NS=Not significant=probability value)

## DISCUSSION

Palatal rugae are also called as plica palatinae, rugae palatine or transverse palatal fold.<sup>7,8</sup> They are irregular elevations of the mucosa and unique and stable topographical structures on the anterior third of the palate running laterally from the mid sagittal plane.<sup>3,4,9</sup> Palatoscopy or palatal rugoscopy is the study of palatal rugae, mainly used for personal identification in forensic science. It was in 1889, when Allen suggested this method.<sup>5</sup> The palatal rugae, like fingerprints, remain constant throughout person's life time. Due to its location, it is shielded from trauma and temperature gradients and protected by lips, teeth, bone, cheeks, tongue and oral prosthesis.<sup>5,7,10</sup> Different races tend to have specific anthropologic characteristics based on geographical area. Globally, most of the continents have substantial migrant population due to various reasons. India continent is not spared from this.<sup>4</sup>

The present study comprised of Indian and Nepalese participants with 81 females & 119 males and between the age group of 16-65 yrs.

The number of palatal rugae may differ geographically, gender wise and in races.<sup>4,5</sup> Even the number of rugae may vary on either side of the midline in each individual. The total rugae in every individual may be around 4-10. There may be slight variation in the number of rugae due to orthodontic treatment and extraction of maxillary anterior teeth.<sup>7</sup> The present study revealed more or less equal number of rugae in both Indian ( $8.30 \pm 1.43$ ) and Nepalese ( $8.28 \pm 1.37$ ) participants; although statistically it was not significant ( $p > 0.05$ ). This observation matched with the findings of Kallianpur S et al<sup>4</sup> but did not match with the findings of Dipshikha B et al<sup>3</sup>.

Palatal rugae have significant characteristic shape/pattern in every individual and remain stable after development till the oral structures are degenerated. Several studies have proved individualistic nature of shape and differences do occur between races and gender. Different Shapes of palatal rugae have been noted in various studies.<sup>4,11</sup> Several classifications are laid down based on shape of rugae.<sup>11</sup> For the present study, More & Gupta's classification on shape and thickness of palatal rugae was used. In the present study, out of various shapes,

the 'Line' type was most commonly observed in Indian and Nepalese participants. This finding was contrary to the findings of Dipshikha B et al<sup>3</sup> and Kallianpur S et al.<sup>4</sup> It is important to note here that we observed a 'H' type of rugae in significant number of participants in both the groups. This shape of rugae is not mentioned in the existing literature.

The thickness of palatal rugae remains constant throughout life. The thickness of each rugae will vary in every individual. Based on More & Gupta's classification, they are of two types: prominent and faint. Our study revealed equal presence of prominent type in both the groups; although it was statistically not significant ( $p > 0.05$ ). We observed significant difference of faint type between both the groups. ( $p < 0.05$ ).

Based on Thomas and Kotze's classification, the length, direction and unification of palatal rugae were studied.<sup>6</sup> The three types of length - primary, secondary and fragmentary were studied. The length was measured in a straight line between the origin and termination and grouped accordingly.<sup>6,11</sup> In our study, the primary type was most commonly seen in Indian ( $7.10 \pm 1.62$ ) and Nepalese ( $7.15 \pm 1.36$ ) participants. This findings matched with the findings of Dipshikha B et al<sup>3</sup> and Kallianpur S et al.<sup>4</sup>

The palatal rugae are placed in different directions. They are directed transversely from mid palatine raphae laterally. The direction may be forwardly, backwardly and perpendicular. Each individual may have combination of rugae with different directions.<sup>11</sup> In the present study, backwardly directed rugae were commonly observed in both the groups; which was statistically not significant ( $p > 0.05$ ). This finding contradicted the finding of Kallianpur S et al, wherein they observed forwardly directed rugae more commonly.<sup>4</sup>

Unification means bringing together of two or more things and they form a single unit. Unification of palatal rugae manifests as divergence or convergence or it may be absent. Converged are those where two rugae are originated from the centre and are united towards it. While diverged ones are those rugae which are originated from the centre and diverged away from it.<sup>13</sup> In the present study, the divergence of rugae was most commonly observed

equally in Indian and Nepalese participants, but was not statistically significant ( $p > 0.05$ ).

It is significant to note that, during our study we distinctly observed that the location of palatal rugae in Indian and Nepalese participants was different. In Indian participants the rugae were located between posterior edge of incisive papilla and distal surface of canine, on either side of palatal raphae. But in Nepalese participants the rugae were located between distal surface of lateral incisor and distal surface of second premolar, on either side of palatal raphae and thus the pre-maxillary region was devoid of rugae.

## CONCLUSION

The palatal rugae in Indian and Nepalese participants had no significant difference in number, shape, length, direction and unification. During the study we encountered a new 'H' shape rugae. The location of rugae on palate differed in both Indian and Nepalese participants. Further studies are recommended on larger sample size mainly on shape and location of palatal rugae.

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**Conflict of interest: None**

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