Characteristics of Palatal Rugae Patterns as a Potential Tool for Sex Discrimination in a Sample of Iranian Children

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KEY WORDS
Palatal Rugae; Rugae Pattern; Forensic Identification; Sex Assessment; Iranian Children; Discriminant Function Analysis;

ABSTRACT

Statement of the Problem: Palatal rugae have been considered equivalent to fingerprints, as they are unique to each individual. It has been shown that palatal rugae are associated with specific racial groups and are known to aid sex identification. Due to the lack of any published data on palatal rugae morphology on Iranian children, the present study was performed.

Purpose: The present study aimed to investigate differences in the morphology of individual palatal in a sample of Iranian children. Additionally, it is intended to develop discriminant function to identify sex, based on rugae morphology.

Materials and Method: A total of 120 pre-orthodontic casts were evaluated for different rugae patterns using the Thomas and Kotze classification. The casts were equally distributed between sexes with an age range of 6-12 years. Rugae length, shape, and associated morphology were recorded and the independent t-test and Chi-square test were used to compare the mean and relationship between the attributes. The discriminant function analysis was applied to the data in order to determine the applicability of palatal rugae patterns as an aid for sex identification.

Results: While the total rugae count showed an insignificant difference between the males and females, the rugae count on the right side of the palates showed a significant difference (p= 0.046). The primary rugae were most common in both sexes, followed by the secondary and fragmentary rugae. The most prevalent rugae shape between both sexes was the wavy rugae followed by the curve and straight shapes in males and the straight and curve shapes in females. A significant difference was observed in the number of the curve rugae between the sexes. Discriminant function analysis allowed sex differentiation with an accuracy of 60.8%.

Conclusion: Palatal rugae shapes are unique to each individual and could be used as a potential tool for sex identification. Further research on a larger sample is required to fully confirm the application of this method (e.g. in forensic medicine) as a complementary technique for sex identification.

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Introduction
In the area posterior to the incisive papilla in both sides of the median palatal raphe are the transverse ridges called “palatal rugae” or “rugae palatinæ.” [1-2] Palatal rugae are the transverse fold of mucosa, which is recorded in maxillary impression and can be observed in the maxillary cast fabrication. [3] These asymmetric bilateral anatomical elevations of variable prominence on the roof of the hard palate are highly individualistic and non-identical even among twins. [4-5] The shape of
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Figure 1: Maxillary upper stone casts of Iranian children showing dissimilar rugae shapes for different individuals

Palatal rugae is stable and consistent throughout the life after the completion of growth. Palatal rugae can resist the incidents of fire and significant trauma due to a proper protection by the lips, cheeks, tongue, buccal fat pad, and teeth. They can also resist decomposition up to seven days. [6-8]

Palatal rugae are formed from the lateral membrane of the incisive papilla in the third month of intrauterine life and are present from birth in the anterior third of the palatal mucosa. [3-4] They show various configurations and are completely unique in every individual due to their design and structure, similar to fingerprints. [9]

The length of palatal rugae increases during normal growth, but their orientation remains the same throughout the lifetime of a person. [10] However, local alteration in the position and direction of palatal rugae might be produced by tooth extraction, finger sucking during childhood and orthodontic treatment, which incur consistent pressure on the tooth and alveolar process. [11-12] In forensic science, the uniqueness of palatal rugae in each individual has been recognized as a potential source of identification of a person. Palatal rugoscopy was primarily proposed by Troban Hemaso in 1932. [13-14]

Since then, various other classifications have been proposed among which Thomas and Kotze [15] classification is the most popular and widely used in many studies. According to the classification by Lysell et al. [1], the length of palatal rugae is categorized into three groups defined as Primary: >5mm, Secondary: 3-5mm, and Fragmented: <3 mm. Rugae less than 2 mm are disregarded. Furthermore, the shape of individual rugae, as classified by Thomas and Kotze, [15] are shown in Figure 1 and 2 and described as (1) Curved; a crescent form with a mild curve, (2) Wavy: a slight curvature at

Figure 2: Maxillary upper stone casts showing different unification rugae shapes
the origin or termination of curved rugae, (3) Straight: they appear straight from their origin to termination of rugae, (4) Circular: a definite continuous ring of rugae, and (5) Unification: when two rugae are joined at their origin or termination. [15]

Unifications, in which two rugae start from the same origin but immediately diverged, are classified as diverging. Rugae with different origins joined on their lateral segment are classified as converging.

It has been claimed that the shape, length, width, and direction of palatal rugae vary significantly amongst different populations and individuals. [15]

Moreover, differences in shape and orientation between the right- and left-side of the palatal rugae was demonstrated, which results in an asymmetrical rugae configuration in most individuals. [13, 16] Considering their physiological function, palatal rugae have a significant role in swallowing, prevention of food loss from the mouth, taste perception, and involvement in food crushing. [17] They also assist speech and suction in children. [18] Due to the specific features of palatal rugae, including uniqueness, post-mortem resistance, and stability, they can be useful in forensic identification.

In addition, rugae pattern, which shows to be unique for different racial groups, can facilitate population identification. [14, 19-20] In addition, there is an agreement amongst researchers that the features of palatal rugae (i.e. length and shape) might represent a specific population. [11, 16-17] Due to the lack of any published data on palatal rugae morphology among the Iranian population, the present study aimed to evaluate the morphology of palatal rugae in a sample of Iranian children. The main objective was to provide preliminary data to assess possible sexual differences in the palatal rugae from length, the number of primary and secondary, and fragmented rugae. Additionally, we aimed to compare the results with those obtained from other populations.

Materials and Method
In the present study, pre-orthodontic maxillary casts of children that referred to the Orthodontics Department, School of Dentistry, Shiraz University of Medical Sciences (Shiraz, Iran) were investigated. The samples were from 120 patients (60 males and 60 females) in the age group of 6-12 years. All children were healthy according to their medical history. The dental casts were coded by the administrative staff to obscure personal information of the patients.

The cast of individuals with congenital anomalies, previous history of orthodontic treatment, bony and soft tissue protuberances, and areas of active lesions, deformity, and scars were excluded from the present study.

As the inclusion criteria in selecting casts, those maxillary arch casts that did not have air bubble or voids, particularly at the anterior third of the palate, were selected. The exclusion criteria were damaged casts and casts on which rugae patterns were not detectable (i.e. without any discrepancies or voids). The palatal rugae were highlighted with a sharp graphite pencil under adequate light and the patterns of the rugae were determined. The number of the rugae on either side of the midline was counted. A digital Vernier caliper, calibrated to 0.01 mm, was used to measure and record the length under magnification; starting point of rugae at mid-palatine raphe to the endpoint of rugae transversely. In case of circular shape, the maximum diameter was taken into consideration.

The number, shape, unification, and length of the rugae between either sides of the palate (left, right) for both sexes were compared for the total number of rugae, number of primary rugae, predominant shape, and the unification of rugae. The counting of rugae and their patterns were performed by two independent examiners who were adequately trained and calibrated to ensure uniform elucidations and concordant registration.

Statistical Analysis
The two-sample t-test and Chi-square test were used to compare the means and the relationship between variables. A significance level of 5% was considered as the critical value. In addition, the obtained data were used for discriminant function analysis to determine the applicability of palatal rugae pattern as an indicator for sex identification.

Results
Based on Kappa statistics, the inter-examiner reliability for the assessment of palatal rugae was found to be 89%. The prevalence of different rugae lengths and shapes in the studied population is presented in Table 1.
The primary rugae were predominant compared to the secondary and fragmented rugae. Considering the shapes, the wavy rugae were the most prevalent form. The distributions of palatal rugae numbers are described in Table 2. Larger number of rugae was reported in males in comparison to females without any statistical significance \((p=0.055)\). On the right side of the palate, the number of rugae was significantly more in males compared to females \((p=0.04)\). However, on the left side, while the number of rugae was higher in males but was not significant.

No significant asymmetry in all rugae lengths was noted in both sexes and the primary rugae on the left side and the secondary rugae on the right side were comparable and similar.

Considering the rugae length (Table 3), the mean number of primary, secondary, and fragmented rugae was greater in males than that of females. However, the mean between sexes did not show significant differences \((p>0.05)\). As shown in Tables 4 and 5, differences in rugae length between left and right side, for both sexes were assessed.

Considering the rugae shape (Table 6), the wavy rugae were the most prevalent form in both sexes. However, the distribution frequency of other rugae shapes differed between male and females. Except for the curved shapes that showed significant differences between sexes were demonstrated \((p=0.049)\), other shapes showed insignificant differences between males and females \((p>0.05)\). The least common shape in both sexes was the circular shape. Females had a higher number of wavy and cross-link rugae compared to males. However, males tended to have more curved rugae.

| Table 1: Descriptive analysis of the total number of rugae |
|-----------------------------------|
| Palatal rugae | N | Rugae number | Mean±SD |
|---------------|---|--------------|---------|
| Total number  | 120 | 1,139 | 9.49±1.86 |
| Primary       | 120 | 1,014 | 8.43±1.54 |
| Secondary     | 120 | 118  | 0.98±1.21 |
| Fragmented    | 120 | 7    | 0.05±0.23 |
| Straight      | 120 | 307  | 2.56±1.69 |
| Wavy          | 120 | 409  | 3.41±1.54 |
| Curved        | 120 | 300  | 2.50±1.62 |
| Diverge       | 120 | 74   | 0.62±0.73 |
| Converge      | 120 | 32   | 0.25±0.54 |
| Cross link    | 120 | 15   | 0.12±0.35 |
| Circular      | 120 | 2    | 0.01±0.13 |

| Table 2: Distribution of palatine rugae numbers in males and females |
|-------------------------------------------|
| Palatal rugae | Sex | N | Rugae number | Mean±SD | \(p\) Value |
|---------------|-----|---|--------------|---------|-------------|
| Right         | Male | 60 | 298 | 4.97±1.13 | 0.046* |
|               | Female | 60 | 277 | 4.62±1.09 | 0.27 |
| Left          | Male | 60 | 285 | 4.72±1.19 | 0.59 |
|               | Female | 60 | 279 | 4.65±0.97 | 0.318 |
| Total         | Female | 60 | 583 | 9.72±1.90 | 0.055 |

| Table 3: Distribution of rugae length in males and females |
|-------------------------------------------|
| Palatal rugae length | Sex | N | Rugae number | Mean±SD | \(p\) Value |
|----------------------|-----|---|--------------|---------|-------------|
| Primary              | Male | 60 | 516 | 8.58±1.64 | 0.194 |
|                      | Female | 60 | 498 | 8.28±1.43 | 0.318 |
| Secondary            | Male | 60 | 61  | 1.02±1.06 | 0.05 |
|                      | Female | 60 | 57  | 0.95±1.35 | 0.052 |
| Fragmented           | Male | 60 | 6   | 0.10±0.30 | 0.049 |
|                      | Female | 60 | 1   | 0.02±0.13 | 0.05 |

| Table 4: Distribution of rugae length on the left side of the palate in males and females |
|-------------------------------------------|
| Palatal rugae (left side) | Sex | N | Rugae number | Mean±SD | \(p\) Value |
|-----------------------------|-----|---|--------------|---------|-------------|
| Primary                     | Male | 60 | 255 | 4.23±0.91 | 0.084 |
|                            | Female | 60 | 256 | 4.27±0.92 | 0.394 |
| Secondary                   | Male | 60 | 27  | 0.45±0.67 | 0.081 |
|                            | Female | 60 | 23  | 0.38±0.71 | 0.056 |
| Fragmented                  | Male | 60 | 3   | 0.05±0.22 | 0.081 |
|                            | Female | 60 | 0   | 0.01±0.13 | 0.056 |

| Table 5: Distribution of rugae length on the right side of the palate in males and females |
|-------------------------------------------|
| Palatal rugae (right side) | Sex | N | Rugae number | Mean±SD | \(p\) Value |
|-----------------------------|-----|---|--------------|---------|-------------|
| Primary                     | Male | 60 | 261 | 4.35±1.09 | 0.108 |
|                            | Female | 60 | 241 | 4.02±0.87 | 0.108 |
| Secondary                   | Male | 60 | 34  | 0.57±0.89 | 0.049 |
|                            | Female | 60 | 34  | 0.57±0.89 | 0.049 |
| Fragmented                  | Male | 60 | 3   | 0.05±0.22 | 0.049 |
|                            | Female | 60 | 1   | 0.02±0.13 | 0.049 |

| Table 6: Distribution of different rugae shapes in males and females |
|-------------------------------------------|
| Palatal rugae Shapes | Sex | N | Rugae number | Mean±SD | \(p\) Value |
|----------------------|-----|---|--------------|---------|-------------|
| Straight             | Male | 60 | 153 | 2.55±1.69 | 0.887 |
|                       | Female | 60 | 154 | 2.57±1.70 | 0.887 |
| Circular             | Male | 60 | 1   | 0.02±0.13 | 1 |
|                       | Female | 60 | 1   | 0.02±0.13 | 1 |
| Curve                | Male | 60 | 168 | 2.80±1.67 | 0.549 |
|                       | Female | 60 | 132 | 2.20±1.53 | 0.549 |
| Wavy                 | Male | 60 | 199 | 3.32±1.67 | 0.496 |
|                       | Female | 60 | 210 | 3.50±1.41 | 0.496 |
| Diverge              | Male | 60 | 38  | 0.63±0.74 | 0.758 |
|                       | Female | 60 | 36  | 0.60±0.74 | 0.758 |
| Converge             | Male | 60 | 19  | 0.32±0.57 | 0.353 |
|                       | Female | 60 | 13  | 0.22±0.49 | 0.353 |
| Cross link           | Male | 60 | 5   | 0.08±0.28 | 0.248 |
|                       | Female | 60 | 10  | 0.17±0.42 | 0.248 |

\*Significant difference
To determine the gender of an unidentified case, to determine sex, length and curve rugae shape have the greatest potential served that variables such as the fragmented rugae of palate in terms of the number of curve patterns in both sexes are summarized in Tables 7 and 8. A significant difference in the shape was found on the right side between males and females. The b-unification rugae were observed between males and females, which was higher than that of females (p = 0.05). Besides, on the left side of palate, the frequency of the rugae shapes was similar in both sexes.

In terms of the three predominant forms, the sequence of rugae shapes on the right side was not similar to the left side. The rugae shape and length were used in the discriminant function analysis. As shown in the standardized coefficients column of Table 9, it was observed that variables such as the fragmented rugae length and curve rugae shape have the greatest potential to determine sex identity among the Iranian children. To determine the gender of an unidentified case, the number of each type of rugae shape is multiplied by the corresponding unstandardized coefficient and then added by a constant (-2.807). If the obtained value is greater than the sectioning point (0.347-0.347/2=0), the individual is tagged as male. Otherwise, if the value is less than the sectioning point, the individual is tagged as female (Table 10). [21]

Hence, the method for calculating an unidentified sex (Z*) among the Iranian children is derived according to the following formula:

\[ Z^* = -2.807+0.18(\text{primary})-0.09(\text{secondary})+2.55(\text{fragmented})+0.42(\text{curve})+1.51(\text{circular})-0.80(\text{cross})+0.04(\text{wavy})-0.07(\text{straight})+1.02(\text{converge})+0.25(\text{diverge}) \]

The accuracy with which the discriminant function can identify the sex is given in Table 11.

**Table 7:** Distribution of different rugae shapes on the left side of the palate in males and females

| Palatal rugae (left side) | Sex | N  | Rugae number | Mean±SD  | p Value |
|---------------------------|-----|----|--------------|----------|---------|
| Straight                  | Male| 60 | 72           | 1.20±1.09| 0.859   |
|                           | Female| 60 | 70           | 1.17±1.06| 0.317   |
| Circular                  | Male| 60 | 0            | 0        | 0.02   |
|                           | Female| 60 | 1            | 0.02±0.13| 0.342   |
| Curve                     | Male| 60 | 87           | 1.45±1.14| 0.347   |
|                           | Female| 60 | 76           | 1.27±1.12| 0.477   |
| Wavy                      | Male| 60 | 97           | 1.06±1.06| 0.477   |
|                           | Female| 60 | 104          | 1.73±0.95| 0.477   |
| Diverge                   | Male| 60 | 18           | 0.30±0.50| 0.270   |
|                           | Female| 60 | 12           | 0.40±0.40| 0.142   |
| Converge                  | Male| 60 | 9            | 0.15±0.36| 1       |
|                           | Female| 60 | 9            | 0.15±0.36| 1       |
| Cross                     | Male| 60 | 2            | 0.18±0.18| 0.12±0.37| 0.142   |

**Table 8:** Distribution of different rugae shapes on the right side of the palate in males and females

| Palatal rugae (right side) | Sex | N  | Rugae number | Mean±SD  | p Value |
|---------------------------|-----|----|--------------|----------|---------|
| Straight                  | Male| 60 | 81           | 1.35±1.25| 0.631   |
|                           | Female| 60 | 84           | 1.40±1.17| 0.631   |
|                           | Male| 60 | 1            | 0.02±0.13| 0.317   |
|                           | Female| 60 | 0            | 0        | 0.02    |
| Curve                     | Male| 60 | 81           | 1.35±1.02| 0.018   |
|                           | Female| 60 | 56           | 0.93±0.97| 0.018   |
| Wavy                      | Male| 60 | 102          | 1.70±1.12| 0.695   |
|                           | Female| 60 | 106          | 1.77±0.98| 0.695   |
| Diverge                   | Male| 60 | 20           | 0.33±0.60| 0.427   |
|                           | Female| 60 | 24           | 0.40±0.59| 0.427   |
| Converge                  | Male| 60 | 10           | 0.17±0.42| 0.074   |
|                           | Female| 60 | 4            | 0.07±0.31| 0.074   |
| Cross                     | Male| 60 | 3            | 0.05±0.22| 1       |
|                           | Female| 60 | 3            | 0.05±0.22| 1       |

*Significant difference

**Table 9:** Discriminant function coefficients for rugae used in the analysis

| Palatal rugae variables | Unstandardized coefficients | Standardized coefficients | Classification function |
|-------------------------|-----------------------------|---------------------------|-------------------------|
| Primary                 | 0.18                        | 0.28                      | Male                      |
| Length Secondary        | -0.09                      | -0.14                     | Female                    |
| Fragmented              | 2.55                       | 0.59                      | Male                      |
| Curve                   | 0.42                       | 0.67                      | Male                      |
| Circular                | 1.51                       | 0.19                      | Female                    |
| Cross link              | -0.80                      | -0.28                     | Male                      |
| Shape                   | Wavy                       | 0.04                      | Female                    |
| Straight                | -0.07                      | -0.12                     | Male                      |
| Converge                | 1.02                       | 0.56                      | Female                    |
| Diverge                 | 0.25                       | 0.18                      | Male                      |

**Table 10:** Function at group centroids

| Sex | Function 1 |
|-----|-------------|
| F   | -0.347      |
| M   | 0.347       |

**Table 11:** Accuracy of the discriminant function analysis in the studied population

|       | Male | Female | Total |
|-------|------|--------|-------|
| Number of cases | 34/60 | 39/60 | 73/120 |
and fragmented rugae in males and females were assessed to determine a possible statistical difference. In this regard, we ensured excellent intra-operator agreement between the two assessors.

Thomas and Kotze [15] classification is the most popular and widely used in many studies. [14, 19-20] This classification method is shown to be the most practical and easy to apply compared with other methods. [2] Hence, in the present study, we also used the Thomas and Kotze [15] classification to differentiate rugae patterns. Moreover, the likelihood of description accuracy is enhanced by using stone casts. [22]

The number of palatal rugae was slightly more in males (mean=9.72) than females (mean=9.27), which was inconsistent with various reports on other populations. [5, 10, 14, 21] Our analysis showed that the distribution of the primary rugae was predominant in both males (88.5%) and females (89.5%). While, no significant difference in the total number of palatal rugae was shown between sexes, significantly higher number of rugae on the right side of the palate in male was reported in comparison to females (p=0.04). Our observation agrees with some studies [26-27] but differs with others. [14, 28-31] In a Libyan cohort study [31], it was shown that the number and shape of the paired palatal rugae were similar to the results yielded by Shetty et al. [20]

The analysis of the number of primary rugae in Australian aborigines failed to reveal any significant differences between the two sides of the palate or between genders. [14] This observation differs with the result of the present study in a significantly greater number of rugae was found on the right side of the palate in males. In contrary to our results, Dhoke et al. [27] observed fewer palatal rugae on right side. It was suggested that this could be the result of regressive evolution dominating the right side of the palate. [27]

The analysis of the rugae shapes of all subjects in the present study showed that the three most prevalent shapes in descending order were the wavy (36%), straight (27%) and curve (26%) rugae, which comprised 89% of the total number of rugae. In a Libyan population, the most prevalent palatal rugae patterns, in decreasing order, were the wavy, curve, cross link, and straight rugae, respectively. There is a general agreement among various studies carried out in different populations that the wavy and curved configurations are the most prevalent palatal rugae morphology. [29, 33]

The wavy and curved palatal rugae were found to comprise 45.85% and 24.41% of the total rugae, in Indian Odisha subjects [33], 55.8% and 23.2%, in Australian aborigines [17], 40.6% and 25.8%, in Caucasian individuals [14], 34.47% and 44.71%, in Western Indians 38.33% and 26.83%, in Southern Indians [29], 29.38% and 35.40%, in Egyptians, [30] 38% and 35.40%, in Saudi children [30], and 38.01% and 24.39%, in Libyan children, respectively. [31]

These findings are to a certain extent in agreement with the results of the present study whereby the wavy and curve palatal rugae configurations were 36% and 26% of the total number of rugae, respectively. However, the frequency of the straight rugae shape (27%) was slightly higher than the curve rugae configuration (26%).

The frequency of the straight rugae pattern (27%) in the present study was markedly higher than that of the Odisha Indians (6.69%), [6] Australian aborigines (3.6%), [14] Caucasians (15.2%), [14] and Libyan children (14.28%). [31] However, it was slightly higher than that of the Egyptians (20.71%) and Saudis (19.71%). [30] In contrary, the frequency of the straight rugae pattern was markedly lower than that of the Andhra Pradesh Indians (37.3%). [33] In the present study, the frequency of diverging unification, converging unification, cross link, and circular was demonstrated to be 6.76%, 2.80%, 1.31%, and 0.17%, respectively.

The frequency of diverging unification was found to be 9.06% in Libyan subjects, while the converging unification and circular palatal rugae were not observed. [31] The circular palatal rugae were the least observed (two cases in the total number of subjects) in the present study. This pattern, while not observed in Libyan subjects, [31] was reported at 2.48% of the total rugae in Egyptians and 1.25% in Saudis, [30] 3.6% in Australian aborigines and 2.9% in Caucasians. [14] The frequency of the cross-link rugae comprised 1.31% of the total number of palatal rugae.

This percentage was markedly less than that of the Libyan subjects (14.96%) [31] and Egyptian (5.31%), [30] while the cross-link rugae were not found in Saudi subjects, [30] Andhra Pradesh and Odisha Indian individuals, [6] Australian aborigines and Caucasian cohorts. [14] The above analysis implies that certain pala-
tal rugae morphology and shapes may be particular to specific population. [1, 4, 6, 16, 20, 27-29, 31, 34] Moreover, it is also observed that some types of palatal patterns are rare or absent in other ethnicities. [31]

Many studies have evaluated the difference in the form of palatal rugae in different populations as well as in both sexes. [13, 15, 19, 33] Differences in rugae shapes have been shown in relatively similar but different population groups, indicating that rugae shape may be specific to racial groups. [14, 20, 34]

Palatal sides comparison of the rugae morphology revealed that such significant difference is due to the higher number of curve rugae on the right side of males than that of females (p=0.018). Some studies reported no sex differences, [14, 32] while others reveal a difference. [27-28] Among the unification patterns, diverging pattern was reported more in both sexes than the converging pattern.

This is consistent with the previous study performed on the Libyan children. [31] In contrast, comparison in the rugae shapes showed statistically significant sex dimorphism in unification type in three South Indian population studies. [35-36] The results of the present study showed that the prevalence of the wavy and straight rugae patterns was more than that of the other rugae patterns.

This finding is in contrast with some other studies, such as the report by Kapali et al. [14] as the prevalence of curve and wavy rugae patterns was more than that of straight and circular patterns. They also found insufficient differences in the mean length of rugae between males and females.

However, on average, females had a higher number of rugae and the diverging unification pattern showed a significant prominence on the left side. Saraf et al. [34] did not find any differences in the number of primary rugae of males and females. However, our results showed a significant difference in the number of rugae between the sexes on the right side of the palate.

Our results conform to those reported by Dohke et al. [27] who indicated that Japanese females had fewer rugae than males. This might be because the secondary and fragmentary rugae were not included by Saraf et al., [34] whereas its inclusion in our study as well as the study by Dohke et al. [27] has resulted in sex differentiation. The result of the present study has shown a significant difference in the frequency and configuration of palatal rugae between the sexes. Consistent with our results, other research studies performed on Japanese and Saudi children (>10 years old), indicated significant differences in the morphology and percentage of palatal rugae between males and females. [28, 30] In contrary, two other studies performed on adult subjects (>20 years old) in Japanese and Saudi populations did not reveal any significant difference in the frequency and configuration of palatal rugae between sexes. In a study by Nayak et al. [29] on the population differentiation using rugae shape, they mentioned that discrete variables such as rugae shape are more appropriate than continuous variables such as rugae length.

This is in line with our finding whereby no significant difference was observed in the length of the rugae between sexes while a difference was noted in the rugae shape. This entails that distinct variables are also better suited for sex differentiation.

Conclusion
Based on the observed differences in palatal rugae length and shape between males and females in the present study, it is concluded that palatal rugae patterns provide an adequate number of characteristics to discriminate between the sexes.

This finding substantiates the hypothesis that palatal rugae are unique and can be used in forensic medicine as a complementary technique for sex identification. The findings of the present study should be viewed as preliminary. Additional studies are required (on larger groups across the whole country) to draw a clearer picture of the morphological variation in palatal rugae pattern in Iranian children.

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Conflict of Interest
None declared

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