ORIGINAL ARTICLE

Evaluation of the Role of Palatal Rugae Application as a Tool for Sex Identification in the Saudi Population

MM Fawzi[1, 2], MA Eldomiaty[3, 4], MK Desouky[3, 5], SA Algaidi[3]

ABSTRACT

Human identification has always been a major challenge for forensic experts, especially when dealing with decomposed and severely mutilated corpses. Palatal rugae are usually preserved in such conditions and thus can be used as a rapid, simple technique where other methods fail to apply. This study aimed to evaluate the role of palatal rugae application as a tool for sex identification in the Saudi population. Three hundred randomly chosen Saudis of both genders were included in the study. Maxillary arch impression casts were prepared and digitally photographed. The palatal rugae count, patterns, length, prominence and median raphe extension were the studied parameters. The rugae count showed higher incidence in males, 63.3%. The rugae patterns study showed that the sinuous was the highest incidence in males, 31.5%, while the curve was the highest in females, 34%. Primary and prominent rugae showed statistical significance while median raphe extension was non-significant. The study revealed the possible application of palatal rugae as a tool for sex identification in the Saudi population. This finding can be helpful in the identification process and is recommended for other populations. Digital archiving of palatoprints by legal authorities may act as reference for criminal and civil cases.

Keywords: Decomposed corpses, forensic odontology, human identification, palatal rugae, sex identification, Saudi population

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INTRODUCTION

Oral cavity examination allows for a vast range of human identification possibilities in forensic practice (1). The study of the hard palate anatomy and its clinical applications as a personal identification tool is called "palatoscopy "or "rugoscopy". Although this technique seems rather unusual and infrequently used, sometimes the forensic expert requests such methods in the face of difficult situations where the ordinarily used tools such as DNA and fingerprinting are inapplicable or unattainable (2, 3). The importance of palatal rugae as a forensic tool is endorsed by the fact that diseases, chemical aggression, trauma and decomposition changes in burn victims with panfacial third degree burns cannot affect the rugae forms, and it can also be used for paternity tests (4–6).

The first classification system for palatal rugae was developed by Lysell in 1955 (7). Carrea's classification divided palatal rugae according to their form, while Martins dos Santos classified them according to their form and position. López de Léon's classification proposed the existence of a link between a person's personality and palatal rugae morphology. Da Silva's classification divided palatal rugae into two groups: simple and composed, naming them by numbers, while Trobo's classification divided them into simple and composed rugae, naming them by letters. Basauri's classification distinguished the rugae into principal anterior one and the accessory rugae, labelled by numbers, whereas the Cormoy system classified palatal rugae according to their size into principal, accessory rugae and fragmental rugae (1, 8, 9). Palatal rugae patterns are sufficiently characteristic to discriminate between individuals and to be legitimately used for identification, even in extreme circumstances (10). Also, gender differences have been studied without definite conclusions (11). This study is the first to be done on the Saudi population, aiming to prove the possible role of palate rugae patterns in sex discrimination.

From: [1]Department of Forensic Medicine and Clinical Toxicology, Taibah University, Medina, KSA, [2]Ain Shams University, Cairo, Egypt, [3]Anatomy Department, Taibah University, Medina, KSA, [4]Tanta University, Tanta, Egypt and [5]Al-Minia University, Al-Minya, Egypt.

Correspondence: Dr MM Fawzi, Department of Forensic Medicine and Clinical Toxicology, Taibah University, Medina, KSA/Ain Shams University, 8 Wagih Street, PO Box 11241, Cairo, Egypt. E-mail: marwamohfawzi@yahoo.com; marwamohfawzi@gmail.com

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This study aimed to evaluate the possible role of palatal rugae application as a tool for sex identification in the Saudi population.

SUBJECTS AND METHODS

This study was carried out in Bakari dental hospital, Medina, Kingdom of Saudi Arabia (KSA). Approval to perform this study was obtained from the ethics committee. Three hundred randomly chosen Saudis of both genders (150 males and 150 females) attending the hospital were included in the study with age ranging from 15–46 years. An informed written consent was obtained from each participant individually after the purpose of the study and procedures were explained. Data collection sheet was constructed to include age, gender, nationality and residence. Patients with chronic illnesses, palatal anomalies, orofacial tumours and/or operations, bone spicules and braces were excluded from the study.

Palatoprint maxillary arch impression casts were prepared for each participant using alginate as a strengthening impression material. The casts were numbered and recorded accordingly [Fig. 1] (12–14). The casts were examined for clearance of the rugae print. The palatal rugae were then highlighted by using a black graphite pencil on the casts. The casts were photographed with a high resolution digital camera (Nikon 300 D 12.5 MP) and examined blindly by the four participating researchers by the Picture Manager and Fax Viewer programmes and results were recorded, guided by cast serial number for each examiner.

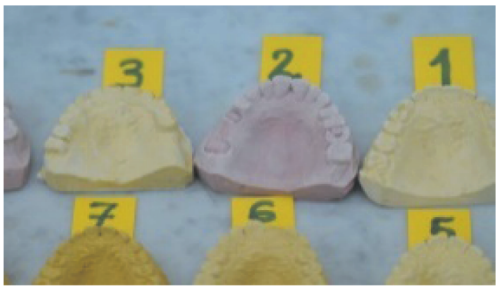

Fig. 1: Maxillary arch impression casts prepared for palatal rugae study.

The studied parameters included:

- Palatal rugae count on both sides of the median raphe.
- Patterns of palate rugae which were classified according to the classification depicted by Indira *et al* into 10 patterns: point, line, curve, angle, circle, sinuous, bifurcated, trifurcated, interrupt and anomaly [Fig. 2] (15).
- Palatal rugae length that was measured directly from the casts using digital sliding callipers with an accuracy of 0.05 mm. Each rugae was measured from its origin near the median palatine raphe to its terminal end transversely, regardless of its shape, and then classified according to length into primary (> 5 mm), secondary (3–5 mm) and fragmentary (< 3 mm). Rugae less than 2 mm were disregarded, after Manjunath *et al* [Fig. 3] (16).

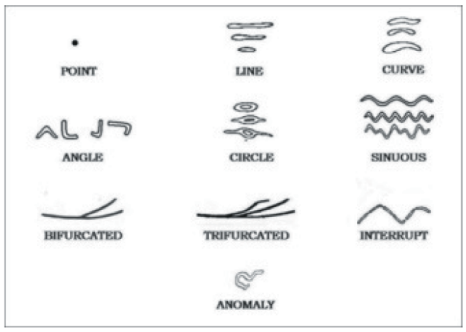

Fig. 2: Patterns of the palatal rugae according to Indira *et al* (15).

Fig. 3: Palatal rugae length measurement in millimetres (mm).

- Prominence of palatal rugae was also assessed (prominent or non-prominent) after Filho *et al* (17).
- The median raphe was examined for its extension into the hard palate and classified as short, medium and long, after Filho *et al* [Fig. 4] (17).

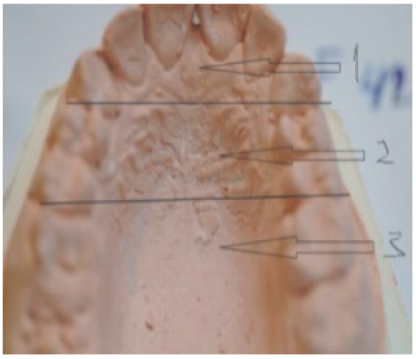

Fig. 4: Median raphe extension in the hard palate in three imaginary subdivisions, after Filho *et al* (17).

The collected data were tabulated and statistically analysed using SPSS statistical package version 19, for determining the mean, standard deviation (SD) and percentage. Student *t*-test and Chi-square tests were applied for comparing the studied parameters in both genders (18).

RESULTS

The palatal rugae count showed statistically significant difference between both genders, with a higher incidence in males, 63.3% (Table 1).

Table 1: Palatal rugae count in both genders

Gender	Rugae count	Mean	SD	*P*-value
Male	587	3.59	0.5	0.00014*
Female	341	3.17	0.4	

*Significance of *t*-test at $p < 0.05$

Palatal rugae pattern study in the Saudi population showed that the sinuous and curve patterns had the highest frequency in both genders; the sinuous pattern had a higher incidence in males, 31.5%, while the curve pattern showed higher incidence in females, 34% (Table 2).

Table 2: Palatal rugae patterns in both genders

Palatal rugae patterns	Male	Female	*P*-value
Sinuous	185 (31.5%)	101 (29.6%)	
Line	77 (13.1%)	41 (12%)	
Curve	107 (18.2%)	116 (34%)	
Circle	26 (4.4%)	11 (3.2%)	
Angle	23 (4%)	7 (2%)	
Point	11 (1.9%)	8 (2.35%)	3.2*
Bifurcated	86 (14.6%)	33 (9.7%)	
Trifurcated	41 (7%)	12 (3.5%)	
Interrupt	21 (3.6%)	9 (2.6%)	
Anomaly	10 (1.7%)	3 (0.98%)	

Significance of Chi-square test; *$p < 0.05$

There was a significant difference in the incidence of rugae length, with the primary rugae being the commonest in both genders, 64.7% (Table 3).

Table 3: Palatal rugae length in both genders

Palatal rugae length	Male	Female	*P*-value
Primary type (> 5 mm)	395 (67.3%)	205 (60.1%)	0.0013*
Secondary type (3–5 mm)	133 (22.7%)	113 (33.1%)	
Fragmentary type (< 3 mm)	59 (10%)	23 (6.8%)	

Significance of Chi-square test; *$p < 0.05$

Prominent rugae displayed a significantly higher incidence in both genders, 93.6% (Table 4). On the other hand, the study of median raphe extension revealed non-significant difference between both genders, with the medium extension showing the highest incidence, 58.3% (Table 5).

Table 4: Palatal rugae prominence in both genders

Palatal rugae prominence	Male	Female	*P*-value
Prominent	560 (95.4%)	309 (90.6%)	0.004*
Non-prominent	27 (4.6%)	32 (9.4%)	

Significance of Chi-square test; *$p < 0.05$

Table 5: Median raphe extension in both genders

Median raphe extension	Male	Female	*P*-value
Short	14 (9.3%)	16 (10.8%)	0.432
Medium	93 (62%)	82 (54.6%)	
Long	43 (28.7)	52 (34.6)	

Significance of Chi-square test; *$p < 0.05$

DISCUSSION

The palatal rugae count in the current study showed a statistically significant difference between both genders in the Saudi population, with a higher incidence in males (Table 1). This conforms with the results of Shetty *et al* on Mysorean and Tibetan populations, who found that males had more rugae count than females (19). Also, Dohke and Osato, on studying Japanese palatoprint, reported the same results (20). In contrast, non-significant difference in rugae count in both genders was found by Saraf *et al* in the Indian population (21), Bharath *et al* in a coastal Andhra population (22) and Surekha *et al* on studying Kerala and Manipuri populations (23).

The importance of using the palatal rugae patterns in human identification has been raised by many researchers. In the current study, the sinuous and curve patterns showed the highest frequencies in both genders, with the sinuous pattern more common in males and the curve pattern more common in females. These data could help in configuring the Saudi palatoprint patterns to assist in personal and sex identification. Indira *et al*, in their study of Bengaluru city, found that the curve form was the most common and suggested their application for population differentiation (15). Nayak *et al* in their study on two Indian populations, Manipuri and Kerala, described the rugae shape as a discrete variable that was more suited for identification than rugae length (24). Kapali *et al*, after studying palatal rugae patterns in Australian Aborigines and Caucasians, documented that the most common patterns in both ethnic groups were the wavy and the curved forms. They reported a statistically significant association between the rugae forms and ethnicity, with the straight forms being more common in Caucasians, while the wavy forms were more common in Aborigines (11). Manjunath *et al* reported a statistically significant sex difference in the incidence of curved and straight rugae among the Indians of Manipal, with a higher frequency in females than in males. They also reported higher incidence

of the wavy rugae among the males (16). The study conducted by Bajracharya *et al* demonstrated that the wavy pattern was the predominant rugae form in Nepalese subjects (25).

In the present study, there was a significant difference regarding rugae length in both genders, with the primary rugae being the commonest. This conforms with the study by Thomas and Kotze, who described the strong discriminatory ability of the secondary and fragmentary rugae in different human populations (26). Dohke and Osato, on studying the Japanese population, reported fewer numbers of secondary rugae in the females than the males and considered their use in sex differentiation (20). On the other hand, Kapali *et al* in their study on the Australian population, and Saraf *et al*, on studying the Indian population, did not reveal any significant differences in the number of primary rugae between males and females (11, 21). This coherent species difference could reflect the importance of studying the palatal rugae in different populations and making correlation studies among them.

Prominent rugae displayed a significantly higher incidence in both genders (Table 4), which is parallel with the study done by Filho *et al* on a Brazilian population that proved that the prominent rugae were higher in percentage (17). While median raphe extension in the current study revealed non-significant difference between both genders, this was in contrast with findings of Filho *et al* who found the long length median raphe extension to be commonest in Brazilian casts by 70% in both genders. This could reflect the little importance of median raphe extension in sex discrimination (17).

CONCLUSIONS AND RECOMMENDATIONS

The study concluded that palatal rugae can be applied as a tool for sex identification in the Saudi population. This finding can be helpful in the personal identification process and sex determination both in civil and criminal cases, burn victims and severely mutilated corpses. Further studies on palatal rugae patterns in different ethnicities are highly recommended.

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REFERENCES

1. Caldas IM, Magalhaes T, Afonso A. Establishing identity using cheiloscopy and palatoscopy. Forensic Sci Int 2007; **165:** 1–9.
2. Gisbert Calabuig JA. Medicina legaly toxicologia. 5th ed. Barcelona: Masson; 1998; 1152–63.
3. Thomas CJ, Van Wyk CW. The palatal rugae in identification. J Forensic Odontostomatol 1998; **6:** 21–5.
4. Pueyo VM, Garrido BR, Sanchez JAS. Odontologia legal y forense. Barcelona: Masson; 1994: 277–92.
5. Limson KS, Julian R. Computerized recording of the palatal rugae pattern and an evaluation of its application in forensic identification. J Forensic Odontostomatol 2004; **22:** 1–4.
6. Thomas CJ, Kotze TJ, Nash JM. The palatal rugae pattern in possible paternity determination. J Forensic Sci 1986; **31:** 288–92.
7. Lysell L. Plicapalatinae transverse and papilla incisive in man: a morphological and genetic study. ActaOdont Scand 1955; **13 (Suppl 18):** 5–137.
8. Santos C, Caldas IM. Palatal rugae pattern in a Portuguese population: a preliminary analysis. J Forensic Sci 2012; **57:** 786–8.
9. Hermosilla VV, San Pedro VJ, Cantin M, Suazo GIC. Palatal rugae: systemic analysis of its shape and dimensions for use in human identification. Int J Morphol 2009; **27:** 819–25.
10. Camargo PM, Melnick PR, Kenney EB. The use of free gingival grafts for aesthetic purposes. Periodontology 2001; **27:** 72–96.
11. Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian Aborigines and Caucasians. Aust Dent J 1997; **42:** 129–33.
12. Burris BG, Harris EF. Identification of race and sex from palate dimensions. J Forensic Sci 1998; **43:** 959–63.
13. Byers SN, Churchill SE, Curran B. Identification of Euro-Americans, Afro-Americans, and Amerindians from palatal dimensions. J Forensic Sci 1997; **42:** 3–9.
14. Vidyashree Nandini V, Vijay Venkatesh K, Chandrasekharan Nair K. Alginate impressions: a practical perspective. J Conserv Dent 2008; **11:** 37–41.
15. Indira AP, Gupta M, David MP. Palatal rugae patterns for establishing individuality. J Forensic Dent Sci 2012; **4:** 2–5.
16. Manjunath S, Bakkannavar SM, Kumar PG, Bhat VJ, Prabhu N, Asha Kamath A et al. Palatal rugae patterns among the Indians at Manipal, India. JPBMS 2012; **20:** 1–5.
17. Filho IE, Sales-Peres SH, Sales-Peres A, Carvalho SP. Palatal rugae patterns as bioindicator of identification in forensic dentistry. RFO 2009; **14:** 227–33.
18. IBM Corp. IBM SPSS Statistics for Windows. Version 19.0. Armonk, NY: IBM Corp; 2010.
19. Shetty SK, Kalia S, Patil K, Mahima VG. Palatal rugae patterns in Mysorean and Tibetan populations. Ind J Dent Res 2005; **16:** 51–5.
20. Dohke M, Osato S. Morphological study of the palatal rugae in Japanese 1. Bilateral differences in the regressive evaluation of the palatal rugae. Jap J Oral Biol 1994; **36:** 125–40.
21. Saraf A, Bedia S, Indurkar A, Degwekar S, Bhowate R. Rugae patterns as an adjunct to sex differentiation in forensic identification. J Forensic Odontostomatol 2011; **29:** 14–9.
22. Bharath ST, Kumar GR, Dhanapal R, Saraswathi T. Sex determination by discriminant function analysis of palatal rugae from a population of coastal Andhra. J Forensic Dent Sci 2011; **3:** 58–62.
23. Surekha R, Anila K, Reddy VS, Hunasgi S, Ravikumar S, Ramesh N. Assessment of palatal rugae patterns in Manipuri and Kerala population. J Forensic Dent Sci 2012; **4:** 93–6.
24. Nayak P, Acharya A, Padmini A, Kaveri H. Differences in the palatal rugae shape in two populations of India. Arch Oral Biol 2007; **52:** 977–82.
25. Bajracharya D, Vaidya A, Thapa S, Shrestha S. Palatal rugae pattern in Nepalese subjects. Orthod J Nepal 2013; **3:** 36–9.
26. Thomas CJ, Kotze TJ. The palatal rugae pattern: a new classification. J Dent Assoc S Afr 1983; **38:** 153–7.

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