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RESEARCH ARTICLE
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NEW GATEWAY TO IDENTIFICATION, PALATAL RUGAE

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Abstract
Identification is one of the most important criteria among living and dead humans and is the forefront of all medicolegal cases. Even with advanced technology and latest gadgets it is considered to be a problematic area for forensic personals. Multiple tools are in vogue which individually and majority of times collectively are used to resolve the problem of identification especially in cases when the person is unknown or in case of death when whole corpse is not available. Conventionally, dactylography, anthropometry and some other traditional methods of identification are in use, a very simple, cost effective and reliable method to add in the list is palatal rugae. When used with other methods of identification it becomes highly effective and helps to resolve almost impossible cases as it is unique to each person and will remain as such throughout the life of a person.

Key words: Identification, Forensic Medicine, Palatal Rugae, Dactylography, Forensic Dentistry.

Introduction
Identification of a person have always been of paramount importance in forensic medicine, this issue becomes very important when identification needs to be done in case of unknown person which is commonly observed in mass disasters, causalities, plane crash etc., when some remains of the corpse are available and identification need be very accurate and resources are limited. Identification with the help of finger prints have long been used and still remains at the front line of all available methods of identifications as it is very cheap, simple and does not require too much expertise. Problem, arises when finger prints are not available and one have to rely on some other methods of identification which are equally reliable and simple as dactylography.

In the recent past forensic dentistry has emerged as a new discipline to resolve many unsettled issues regarding identification of a person. Dentistry has been limited to diagnose and treat dental problems and its use from forensic point of view particularly identification from different aspects have never been discussed so extensively. With repeated exposures in medicolegal cases it has emerged as a new

discipline and is gaining popularity with time. In the present study researcher has focused on the palatal rugae as a method to identification and tried to evaluate its accuracy as that it can be used as an effective tool for future unresolved conflicts. The importance of palatal rugae in identification has gained popularity due to the fact that these rugae remains unchanged during life time of a person just like fingerprints and can be used with fairly good accuracy in identification. Palatal rugae are unique and are stable during life time of a person which shows its effectiveness as a tool in identification not only independently but also collectively with other methods of identification.
In the present study, two population groups were focused, people of different ethnic group in Punjab and Sind irrespective for how long they have been residing in that province. This study provides an opportunity not only to observe the character of the palatal rugae independently but also to compare the distribution of its various types, number and shape in that population group.

Materials and Methods
The material used was starch thickener, impression tray, spatula, bowel geometric divider. Participant of the study were chosen from two different dental centers, one from Punjab and other from Sind who came there for dental treatment. Consent was taken from all the participants and purpose of the study was clearly explained to all of them. The criteria for inclusion in the study is shown in Table-I

Table-I Criteria for participants to be included in the study

Inclusion criteria	**Exclusion criteria**
18-25 years	Below 18 years or above 25 years
Complete denture	Incomplete denture
Healthy teeth with no trauma	Diseased teeth or traumatic tooth

Participant below 18 years and above 25 years of age were not included in the study, those participants who have complete denture without any trauma to it were also included, anybody with diseased tooth or incomplete denture was excluded from the study.

The study consisted of two groups one from each province, each group consisted of 60 participants, these groups consisted of 30 males and 30 females, in total 120 participants were included in the study. This figure came out after thorough screening. Initially, the number of participants was 150, 30 participants were excluded from the study because they did not fall under the criteria set before the start of the study. 10 participants were below the required age group and 5 were above the desired age. 7 did not consented for the study. 8 were having multiple intraocular lesions. The geometric divider and scale were used to measure the length of the palatine rugae. Each participant was coded uniquely. The rugae on left and right side were counted. Thomas and Kotze classification were used to record the number, type and unification of the rugae. Kapali classification was used to record the shape of the rugae table-II

Table-II Palatal rugae pattern assessment under Thomas and Kotze classification

Rugae shape	**Description**	**Incidence**	**Unification**
Curved	Crescent shape and curving gently	More than 5 mm	Origin of diverging rugae same, bur branched immediately
Wavy	Slight curve at the origin or termination	3-5 mm	Converging rugae with different origins, joined on their lateral portions
Straight	Straight from origin to termination	Less than 3 mm	
Circular	Form a continuous ring		

Statistical analysis

Analysis of the data was done by using SPSS software, *t* test was used for comparative study for number and type of rugae between two groups. Chi-square test was used for comparison between shape and unification between two groups. For gender discrimination number and type of rugae *t* test was used. In the same group chi-square test was used for comparative study of shape and unification.

Results

Thomas and Kotze classification were used to compare the results of Punjab and Sind population.

Table-III Number of rugae in two provinces of Pakistan i.e. Punjab and Sindh

Provinces	Mean	Standard deviation	Degree of freedom	Confidence interval (95% confidence interval)		*P*-value
Punjab	9.49	1.08	97	-0.251	0.807	0.289
Sindh	9.19	1.49				

Standard deviation and mean were recorded for individual group and gender. The difference between the group and gender were determined by *t* test and chi-square. Number of rugae between two population groups was done for comparison, *t* test was non-significant as shown in table IV. P-value was non-significant after using chi-square test it is shown in table V.

Table –IV Rugae type in Punjab and Sindh population

Rugae type	Mean	Standard deviation	Degree of freedom	Confidence level		*P*-value
				Lower	Upper	
More than 5 mm			97	-0.161	0.601	0.252
Punjab	8.11	0.95				
Sindh	7.91	0.94				
3-5 mm			97	-0.514	0.154	0.290
Punjab	0.72	0.83				
Sindh	0.89	0.86				
Less than 3mm			97	-0.150	0.430	0.340
Punjab	0.63	0.77				
Sindh	0.51	0.67				

Table-V Unification pattern of rugae in Punjab and Sindh

Unification	Punjab (n=60) (%)	Sindh (n=60) (%)	Degree of freedom	*P*-value
Convergent	31 (62)	28 (56)	1	0.549
Divergent	29 (58)	32 (64)		
Total	60 (120)	60 (120)		

Comparison between two groups was done to determine the shape of the rugae, in this case high significance of p-value was observed table VI. Participants of the Punjab had straight and wavy shape rugae whereas Sind population showed wavy and curved rugae.

Table-VI Rugae shape pattern in Punjab and Sindh

Rugae shape	Punjab	Sindh	Degree of freedom	*P*-value
Straight	26 (52)	10 (20)	2	0.001
Wavy	26 (52)	20 (40)		
Curve	8 (16)	30 (60)		
Total	60 (120)	60 (120)		

According to Thomas and Kotze classification comparison between Punjab and Sindh population was made for gender. Comparison was made between gender of Punjab and Sindh population regarding number of rugae. High significance was observed in p-value as shown in table VII.

Table-VII Distribution of rugae pattern based on gender in Punjab and Sindh

Population	Mean	Standard deviation	Degree of freedom	Confidence interval (95% confidence interval)		*P*-value
				Lower	Upper	
Punjab			97	0.81	1.849	0.001
Male	10.1	0.95				
Female	8.9	0.74				
Sindh			97	2.101	3.019	0.001
Male	10.4	0.81				
Female	7.8	0.78				

In both study groups among male and female population, the average number of rugae differed significantly. Male population showed high significance in the number of rugae as compared to that of females. No gross significance was observed in the type of rugae when compared in male and female gender, hence p-value was non-significant table VIII.

Table-VIII Rugae type based on gender in Punjab and Sindh

Rugae type based on gender	Mean	Standard deviation	Degree of freedom	Confidence interval		*P*-value
				Lower	Upper	
More than 5mm						
Punjab			47	1.187	1.851	0.000
Male	8.89	0.665				
Female	7.35	0.491				
Sindh			47	1.032	1.766	0.000
Male	8.61	0.706				
Female	7.21	0.578				
3-5 mm						
Punjab			47	0.754	0.194	0.241
Male	0.55	0.820				
Female	0.83	0.851				
Sindh			47	0.188	1.092	0.005
Male	1.21	0.865				
Female	0.55	0.711				
Less than 3 mm						
Punjab			47	0.202	0.682	0.278
Male	0.77	0.722				
Female	0.51	0.824				
Sindh			47	0.162	0.878	0.004
Male	0.77	0.155				
Female	0.25	0.088				

Unification pattern of the rugae was compared between genders of Punjab. P-value of 0.001 was obtained using chi-square test, which is highly significant table IX. Unification pattern of rugae was compared between genders of Sindh. P-value of 0.011 was obtained using chi-square test, which is quite significant. Comparative study between both groups show that male rugae are more divergent as compared to females which have convergent unification pattern.

Table-IX Unification of rugae distribution on gender bases in Punjab and Sindh population

Unification	Punjab			Sindh			
	Male	Female	*P*-value	Male	Female	Degree of freedom	*P*-value
Convergent	8 (30.0)	25 (94.0)	0.001	10 (38.0)	19 (74.0)	1	0.011
Divergent	22 (90)	5 (26.0)		20 (82.0)	11 (46.0)		

In each group the shape of rugae differed grossly in male and female population as shown in the p-value using chi-square test table X.

Table-X Shape of rugae on gender bases in Punjab and Sindh

Shape		Punjab			Sindh			
	Male	Female	Degree of freedom	*P*-value	Male	Female	Degree of freedom	*P*-value
Straight	0	25 (98)	47	0.001	3 (13)	8 (30)	47	0.001
Wavy	21 (86.0)	5 (22)			19(78)	0		
Curved	9 (34.0)	0			8 (29)	22 (90)		

Discussion

Identification have been one of the main stream topics of forensic medicine, this issue becomes more important in cases when the deceased is unknown such as commonly observed in cases of mass disaster, major causalities, plane crashes which are far more common now, it is supported by a study conducted in 1997 by Perrot R and another study conducted in 2017 by Saxena V, Jain M, Tiwari V, Santha B, Khare A, Shah R who studied dental pulp for identification supports our study(1, 2).

Human identification in the above mentioned scenario have gained importance and the branches of forensic medicine such as dactylography, DNA typing, forensic odontology paly their role in all such cases, a study conducted by Prajapati G, Sarode SC, Sarode GS, Shelke P, Awan KH, Patil S in 2018 highlights the importance of forensic odontology in identification(3). In cases when complete dead body is not available such as fragmentary remains or deformed face is only available, uroscopy becomes a tool of paramount importance in identification of the corpse a study conducted in 2017 by Mahfouz MR, Mustafa A, Fatah EEA, Herrmann NP, Langley NR and another study conducted by Urbanová P, Ross AH, Jurda M, Šplíchalová I in 2017 shows importance of human identification in unknown cases(4, 5).

The rugae on the palate assume importance when major parts of the body are missing and not available for identification a study conducted in 2018 by Gibelli D, De Angelis D, Pucciarelli V, Riboli F, Ferrario VF, Dolci C, et al supports the use of palatal rugae in identification(6). These rugae are unique to each person and do not change with time, various classification of these rugae have been given, in the present study two classifications are followed, Thomas and Kotze for number, type and unification. For shape, Kapali et al classification has been used, a study conducted in 2017 by Gadicherla P, Saini D, Bhaskar M highlights the importance of palatal rugae in identification and another study conducted by Sheikhi M, Zandi M, Ghazizadeh M in 2018 supports our study(7, 8).

The present study was conducted at two major dental centers in two largest provinces of the country i.e. Punjab and Sindh. Initially 150 participants were included in the study, later on after screening 120 participants were chosen 60 from each province which were further subdivided in to equal half i.e. 30 males and 30 females from each province.

In the present study, the shape of rugae among the participants of Punjab were straight and wavy, however, there were significant differences between gender, males showed wavy shape as compared to that of females where straight shape was more common a study conducted in 2019 while studying

various rugae pattern by Selvamani M, Bindiya P, Bhojaraju N, Bastian T, Suhana H, Mathew M among Dravidian population supports our study(9). Among the Sindh population wavy and curved shaped rugae were more common a study conducted in 2020 by Chong JA, Mohamed AMFS, Pau A supports this study(10). Wavy pattern is more prevalent in males whereas females are more inclined toward curved pattern among participants of Sindh a study conducted in 2021 by Sanggaya DK, Krishnan M, Sanggaya DK, Krishnan M supports this study(11). Current study highlighted gender differences in unification, females predominantly have converging type whereas divergent type is more common in males a cross sectional study of palatal rugae by Sherif AF, Hashim AA, Al Hanafy MA, Soliman EM in 2018 is in support of our study (12).

In the present study it is observed that gender discrimination could be done by evaluating the number of rugae a study conducted by Oberoi IS, Chalkoo AH, Dhingra K in 2017 in evaluating rugae pattern supports our study(13). Another prominent parameter helpful in gender determination is variation in shape. When unification was considered alone among both populations there was a clear demarcation in the pattern of unification in relation to gender a study conducted in 2017 by Saadeh M, Ghafari JG, Haddad RV, Ayoub F is in support of our study(14). The present study is unique of its kind which have so far not been done among different provinces of Pakistan. The thing which strengthens the study is its simplicity, low cost and reliability, however, one of its limitations is in postmortem cases where identification could not be possible if antemortem data is not available.

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