Variation of Palatal rugae in Palatal canine impactions amongst young adults- A Pilot Study

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ABSTRACT-

Introduction: Development of Palatal rugae (PR) completes during early intrauterine life, while dental malocclusions in permanent dentition take several years into postnatal life to get established. Research has shown the subtle association between the palatal rugae pattern and malocclusion. Since the palatal rugae are stable structures and follow a common signalling pathway during craniofacial development, they can be helpful for the prediction of dentoskeletal aberrations such as canine impaction.

Aim: To investigate whether an association exists between morphological features of palatal rugae and palatally impacted canines.

Methodology: A cross-sectional study was conducted on pre-treatment dental casts of 16 patients with unilateral palatal canine impactions. The length, pattern, orientation, unification and zone of the three anterior-most primary rugae on both sides (Group 1-impacted and group 2- normal side) were recorded using an integrated rugoscopy chart.

Results: The mean length for 1st and 2nd PR on the impacted side was more, but less for 3rd PR and the results were statistically significant. The wavy pattern was predominant for all three rugae on both the impacted and normal sides. Regarding the orientation and unification, all rugae in Group 1 & 2 were predominantly backward or posteriorly directed without unification.

Conclusion: The present clinical study provides a valuable insight that PR may also be used as additional criteria for predicting canine impactions for the purpose of disaster victim identification as well as predicting future malocclusion in children.

Keywords: Disaster victim identification, Impacted canine, Malocclusion, Palatal rugae, rugoscopy

Introduction:

Palatal rugae or plicae palatinae (PR) are irregular, asymmetric ridges of connective tissue located behind the incisive papilla that never cross the mid-palatal raphe, extend until the mesial of permanent first molars and serve as stable superimposition landmarks with completing during 3rd month intrauterine life.[1] On the other hand, dental malocclusions, with the eruption of permanent dentition, take several years into postnatal life to get established.

Since the PR are stable structures and follow a common signalling pathway during craniofacial development, they may be helpful for the prediction of forthcoming other dentoskeletal aberrations.[2-4] Research has shown the subtle association between various dental malocclusions and PR length, pattern and orientation.[4-9] However no studies

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report the observance of rugae morphology with palatal impacted teeth.

This clinical study aimed to investigate whether an association exists between morphological features of palatal rugae (PR) and palatal canine impactions. We proposed a null hypothesis that palatal canine impactions display no correlation with PR length and PR morphology The objectives of the present study were to assess the PR characteristics (length, pattern, orientation, unification and quadrant) of the three anterior-most primary rugae in cases with unilateral and palatal canine impactions, too compare these characteristics between the impaction side (Group 1) with the opposite normal side (Group 2). The length, pattern, orientation, unification and zone of the three anterior-most primary rugae on both sides (Group 1-impacted; Group 2- normal side) were recorded using an integrated rugoscopy chart.[10] (Fig 3)

Materials and methods:

A cross-sectional study was conducted on photographs of the pre-treatment dental casts of 16 patients with undergoing orthodontic treatment for unilateral palatal canine impactions. Due ethical approval for the study was taken.

Digital photographs of all casts were standardized using ABFO No. 2 scale. [11] (Fig 1). Each dental cast was studied into 2 groups: Group 1-impacted; Group 2- normal side. All measurements were then taken Adobe photoshop 7.0 (Fig 2 a-e). The length, pattern, orientation, unification and zone of the three anterior-most primary rugae on both sides were recorded using an integrated rugoscopy chart. [11] (Fig 3)

All data was collected and visually screened for any missing outliers. Statistics were performed in SPSS 17.0 (SPSS, Chicago III). Descriptive statistics (mean and standard deviation) were determined for the length of primary palatal rugae (first, second and third) for each group. One Sample T-test was used to determine variation of length of palatal rugae between the groups Most predominant pattern, orientation, unification and zone of the primary rugae (first, second and third) in each group was studied.

Results:

The mean PR length for 1st and 2nd rugae on the impacted side was more than normal side. The difference for PR length between the two groups were highly significant statistically according to one-sample T test. (Table 1)

1st PR characteristics on the impacted side were predominantly wavy, backward, and without unification while on normal side were predominantly straight, backward, and without unification. 2nd and 3rd PR characteristics on the impacted side as well as normal sided

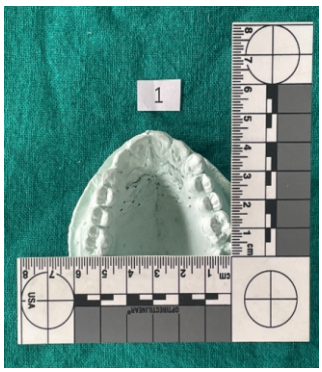

Figure 1: Digitization and standardization of the dental casts using ABFO No. 2 scale.[11]

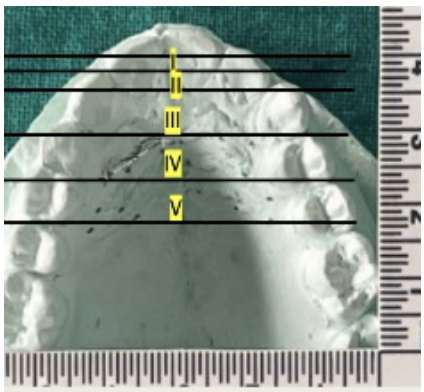

Figure 2: Measurement of Rugae parameters according to integrated rugoscopy chart Length b) pattern c) orientation d) unification and e) quadrant/ zone

INTEGRATED RUGOSCOPY CHART

Model Number	Impacted tooth number	Type of impacted tooth (B/P/T) 1=B;2=P;3=T	Position Side (left/right) 1=R; 2=L	1st Length(in mm)	1st Shape 1= Curved(C) / 2= Wavy(W) / 3 Straight(S) / 4= Circular (Cr)	1st Direction 1= Forward(F) / 2= Backward(B) /3= Perpendicular(P)	1st Unification 0= No unification/ 1= Diverging(D) / 2= Converging(C)	1st Quadrant (I-V)	2nd Length	2nd Shape 1= Curved(C) / 2= Wavy(W) / 3 Straight(S) / 4= Circular (Cr)	2nd Direction 1= Forward(F) / 2= Backward(B) /3= Perpendicular (P)	2nd Unification 1= Diverging(D) / 2= Converging(C)	2nd Quadrant (I-V)	3rd Length	3rd Shape 1= Curved(C) / 2= Wavy(W) / 3 Straight(S) / 4= Circular (Cr)	3rd Direction 1= Forward(F) / 2= Backward(B) /3= Perpendicular(P)	3rd Unification 1= Diverging(D) / 2= Converging(C)	3rd Quadrant (I-V)
PR1	13	2	1		2	2	0	II	2.59	1	2	0	IV	2.83	2	2	2	V
			2		1	1	1	II	1.67	2	2	0	IV	2.46	2	2	2	V
PR2	13	2	1		2	2	0	II	1.92	2	2	0	IV	1.89	2	2	2	V
			2		1	2	0	II	2.08	3	1	0	IV	1.66	2	2	0	V
PR3	13	2	1		2	2	0	II	2.31	2	2	0	IV	2.37	1	2	2	V
			2		1	3	2	II	1.31	2	2	0	IV	1.99	3	2	0	V
PR4	23	2	1		3	2	1	II	1.89	2	2	0	IV	2.5	2	2	0	V
			2		2	2	0	II	1.6	3	2	0	IV	1.84	3	3	2	V

Figure 3: The integrated rugoscopy chart.[10]

were predominantly wavy, backward, and without unification. (Table 2-4) All 1st PR rested in zone III, 2nd PR in Zone IV and 3rd PR in zone V. (Table 5)

Discussion:

Palatal rugae have been used for personal individualization in forensics in numerous studies ever since its introduction in 1889.[12] Subtle association of various malocclusions with palatal rugae number, length and morphology have been documented includingpalatal expansion of constricted maxillary arches.[13] The present clinical study also provides a valuable insight for PR to be used as additional criteria for predicting canine impactions.

Canine impactions occur twice more frequently in the maxilla than in the mandible.[14] Maxillary canines are amongst the second most commonly impacted teeth affecting about 2% of the population and a female preponderance twice as males. [2,14] 8% of patients with maxillary canine impactions have bilateral impactions, the involved maxillary canines are distributed with about one-third of labially and two-thirds palatally. Also being situated anterior part of the palate, we chose to study the palatally impacted canines predicting that palatal bulge may influence the PR morphology. [4-9] Despite canine impactions being common, the only means of diagnosis are 2-D and 3-D radiographs, which cannot be done sequentially for the risk of radiation exposure. Hence, it is important to ascertain supplementary diagnostic criteria for its occurrence which has been tested in the current study.

The results of our pilot study show significant association between the palatal canine impaction and PR morphology, particularly the 1st and 2nd PR length. All 1st PR were located in the zone III as per the Integrated Rugoscopy Chart

Table 1: Comparison between rugae length on impacted side vs normal side

	Impacted side (mean)	Normal side (mean)	P value
PR_1	1.64	1.55	0.0001*
PR_2	1.82	1.63	0.0001*
PR_3	1.72	1.85	0.0001*
*highly significant difference, one sample t test			

Table 2 : Frequency distribution and comparison according to Rugae pattern

Value	PR	1_impacted	1_normal	2_impacted	2_normal	3_impacted	3_normal
0	None	0	0	0	0	2	0
1	Curved	2	6	3	1	1	3
2	Wavy	10	2	6	10	9	10
3	Straight	4	8	7	5	4	3
4	Circular	0	0	0	0	0	0
total		16	16	16	16	16	16
p>0.05, * p< 0.05, Fischer exact test 1= Curved(C) / 2= Wavy(W) / 3 Straight(S) / 4= Circular (Cr)							

Table 3: Frequency distribution and comparison according to Rugae direction

Value	PR	1_impacted	1_normal	2_impacted	2_normal	3_impacted	3_normal
1	Forward	2	1	4	4	5	1
2	Backward	14	10	12	12	11	14
3	Perpendicular	0	5	0	0	0	1
total		16	16	16	16	16	16
p>0.05, Fischer exact test 1= Forward(F) / 2= Backward(B) /3= Perpendicular(P)							

Table 4: Frequency distribution and comparison according to Rugae unification

Value	PR	1_impacted	1_normal	2_impacted	2_normal	3_impacted	3_normal
0	No unification	14	10	12	12	11	14
1	Diverging	0	5	4	0	0	1
2	Converging	2	1	0	4	5	1
total		16	16	16	16	16	16
p>0.05, Fischer exact test 0= No unification/ 1= Diverging(D) / 2= Converging(C)							

Table 5: Frequency according to Rugae Zone

	Impacted side (Zone)	Normal side (Zone)
PR_1	III (n= 16)	III (n= 16)
PR_2	IV (n= 16)	IV (n= 16)
PR_3	V (n= 16)	V (n= 16)

that between lines III (mesial aspect of right and left canines) and line IV (mesial aspect of right and left 1st premolars). All 2nd PR were located in the zone IV as per the Integrated Rugoscopy Chart that between lines IV (mesial aspect of right and left 1st premolars) and line IV (mesial aspect of right and left 2nd premolars). No increase in rugae length was observed with 3rd PR, all of which were located in zone V. Statistically significant increase in PR length in zone III and zone IV on the impacted side indicates that presence of bulge on the palatal aspect due to displaced canine. However the severity (level and angulation) of palatal canine impaction have not been taken into consideration which is the major limitation of the study.

Previous studies in literature also show a mixed pattern of association of pattern, direction and unification with other malocclusion groups although none of them have observed variations in palatal impacted teeth. Our results are in close accordance to a study by Moran et al. that observed no specific pattern of tooth agenesis was associated with the palatal rugae patterns.[8] However, further research on the topic with a larger sample size, age and gender considerations and association with 3-dimenrsional tooth position is necessary to confirm the same.

Clinical importance: PR being unique, stable structures with inalterable pattern, shape and position during life, play special role on forensic identification as well as prediction of malocclusion during disaster victim identification (DVI) especially during traumatic loss of teeth. [12] Unilateral increase in rugae length in this study emphasizes the presence of palatal impacted tooth. Exploration of antemortem records in such cases may aid in confirming DVI. Also, PR length may be used as additional diagnostic criterion for predicting future malocclusion in mixed dentition.

Conclusions:

Palatal Rugae length may be taken up as additional criteria for prognosticating palatal canine impactions as well as confirming DVI from antemortem records. However, no statistically significant predominance for rugae pattern, orientation and unification was observed in this pilot study.

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