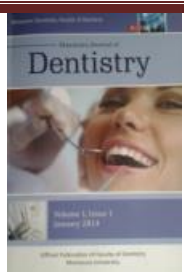
Dimensional changes in palatal rugae Following maxillary canine retraction using laser scanning system, in vitro study.



Ahmad Shawky Abdel Wahed, Dr. Marwa Ali Tawfik Prof. Dr. Ahmed A. El-Bialy

- Dentist, Faculty of Dentistry, Mansoura University
- Lecturer, Department of Orthodontics, Faculty of Dentistry, Mansoura University, Egypt
- Professor, Department of Orthodontics, Faculty of Dentistry, Mansoura University, Egypt

Abstract:

The aim of this study was to assess dimensional changes occurring in palatal rugae area following maxillary canine retraction (CR) using laser scanning system in an in vitro study. **Materials and methods:** It was performed on 40 orthodontics study models for 20 adolescents, (20 before and 20 after C.R). All 40 Casts were scanned by E1 3-shape laser scanner. Transverse, antero-posterior and angular measures before (T1) and after (T2) C.R were measured using the laser scanning system and compared. Data were entered and analyzed using IBM-SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). **Results:** Comparing measures before and after C.R revealed that most of palatal 1st, 2nd and 3rd rugae measures (transverse, antero-posterior and angular) were insignificantly changed by C.R in all dimensions. Changes were not equal on right and left sides. Spearman's rank-order correlation test showed very strong positive correlation between most measures before and after C.R. Conclusion: In this study, 3rd rugae showed the least changes before and after C.R so it can be considered the most stable area in rugae. It also showed different response to C.R between right and left sides.

Keywords: Rugae area, canine retraction, 3-D Laser scanner.

Introduction

Canine retraction (C.R) is a very important step in treatment of patients with crowding or first premolar extraction cases. Correct positioning of canines after retraction is of great important for fuction , stability and esthetics [1,2,3]

Mechanics of C.R is divided into 2 mechanics:- 1- Sliding (frictional) mechanics by moving canines along an arch wire or sliding the arch wire through bracket and tube. 2- Loop (frictionless) mechanics by moving canines without bracket sliding along an arch wire but with the help of loop [4].

Plaster models have been used for orthodontic records for many decades. Dental models provide a three dimensional view and their superimposition helps in appreciating longitudinal dento-alveolar changes. The superimposition of dental casts might be a useful method to study longitudinal dento-alveolar changes related to dento-facial growth or orthodontic therapy as it provides a distinct picture of structural changes that occurs during the process [5]. However, superimposition of dental casts requires stable reference points on the surface of the model. An area in which it is important to describe change during premolar extractions is the palate, especially the palatal rugae.

Palatal rugae, also called plicae palatinae transversae or Rugae palatinae, refer to the ridges on the anterior part of the palatal mucosa. It is seen on either side of the median palatal raphe, behind the incisive papilla and are widely present in mammals. Rugae patterns have been studied for various purposes, published reports being mainly in the fields of Anthropology, Comparative Anatomy, Genetics, Forensic Odontology, Prosthodontics, and Orthodontics. Palatine rugae are irregular, asymmetric ridges of mucous membrane extending laterally from the incisive papilla and the anterior part of the median palatal raphe. There are approximately four rugae on each side of the palate. Slightly more rugae are found in males and on the left side in both genders. Generally, there is no bilateral asymmetry in the number of primary rugae or in their angulation from the midline. The first (anterior) rugae contacts the median palatal raphe, while the rest have their origins lateral to it. Along with the teeth and tongue, rugae take part in mastication by helping to sense, hold and mash the food. Although important changes were observed in their lateral edges after orthodontic treatment with premolar extractions, the median edges of the rugae are considered to be stable and the supposed uniqueness and overall stability of palatal rugae suggest their use as a stable landmark for assessment of degree of tooth movement during treatment [6-8].

So in this study we will measure dimensional changes occurring in Palatal rugae in anteroposterior and transverse dimensions following C.R.

Materials and methods:

The study sample will be consisted of dental casts of 20 adolescents who are already receiving treatment in department of orthodontics/ faculty of dentistry/ Mansoura University .

The parents of the patients signed an informed consent before inclusion in the study in addition to active assent from the adolescents themselves.

Inclusion criteria were: anterior crowding in maxillary arch, fully erupted permanent maxillary canines and 1st molars,

orthodontic treatment plan involving extraction of upper 1st premolars [9].

All patients had Trans palatal arch (TPA) bar fabricated from 0.036 stainless steel wire soldered to previously fit molar bands and cemented to upper 1st molars. The upper canines will be sliding along (0.016X0.016) inch stainless steel wire using an elastomeric chain connected between upper canines and upper 1st molar band hooks.

After space closure, alginate impression was made. The TPA bar is temporarily removed for purpose of impression to allow for clear reproduction of palatal area and rugae. After impression the TPA bar is reinserted and orthodontic treatment is continued as planned for per each patient independent of the study [10, 11].

Digital cast analysis

Before and after retraction maxillary dental casts were de-identified by research support personnel not directly involved in the research.

Patient initials were covered and replaced with serial numbers and an indication of the time point of assessment (T1: before C.R, T2: after C.R). All remaining procedures were carried out by the principal investigator (M.S.) [12, 13].

Rugal and palatal measurements

Digital technique (3 shape laser scanner): Casts have been scanned by 3-shape laser scanner (3Shape A/S, Copenhagen, Denmark) by following steps: Turning on the computer which has been connected to E13D-scanner. Then, double clicking on the 3-shape scanner software. The upper and lower models were scanned individually, followed by the occluded models taking in consideration that anterior teeth should be facing the device.

The anterior, middle, and posterior rugae were numbered 1, 2, and 3, respectively, and the right and left sides identified as R and L. The most medial (m: mR1/mL1, mR2/mL2, mR3/mL3) and most lateral (l: lR1/lL1, lR2/LL2, lR3/lL3) points of the first three rugae were digitized, in addition to the most posterior point of the incisive papilla (IP). [14].

The recorded data was evaluated, compared, and statistically analyzed.

All patients' data was securely preserved on the computer of orthodontics–Mansoura University and can only be reached by the principal investigator.

Results:

Table (1): Comparisons of transverse measures before and after canine retraction

Parameter	T1		T2		Z / t	P value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)		
R1	8.04 ± 1.19	7.74 (7.05 – 9.10)	8.12 ± 1.01	8.08 (7.33 – 9.03)	t = -0.619	0.543
R2	8.46 ± 1.91	7.93 (7.03-9.57)	8.79 ± 1.76	8.53 (7.54-9.85)	Z = -2.576	0.010*
R3	9.48±1.53	9.15(8.10-10.38)	9.92±1.55	9.57(8.67-11.50)	t = -2.847	0.010
L1	8.18±1.33	7.91(7.17-8.88)	8.23±0.94	8.31(7.61-8.51)	t = -0.391	0.700
L2	8.60±1.20	8.27(7.78-9.39)	8.95±1.67	8.54(7.60-9.96)	t = -2.357	0.029
L3	9.96±1.91	9.33(8.20-12)	10.11±1.71	9.63(8.74-11.45)	t = -1.394	0.179
Tm1	3.16±0.77	3(2.63-3.77)	3.07±0.87	2.91(2.24-3.77)	t = 0.850	0.406
Tm2	4.57±1.71	4.14(3.45-5.68)	4.77±1.63	4.21(3.76-5.58)	t = -1.792	0.089
Tm3	**6.28±1.74**	**5.98(4.91-7.68)**	**6.17±1.68**	**6.08(4.87-7.19)**	**t = 1.051**	**0.306**
Tl1	17.23 ± 1.99	16.51 (15.34-18.66)	17.47 ± 1.67	17.21 (16.01-18.75)	Z = -1.120	0.263*
Tl2	18.74 ± 1.46	18.71 (17.42-20.03)	18.98 ± 1.26	19.14 (17.78-19.48)	t = -1.117	0.278
Tl3	20.25 ± 1.49	20.29 (19.45-21.50)	20.30 ± 1.85	20.43 (18.89-21.88)	t = -0.166	0.870

P value by Paired-Samples t-Test or *Wilcoxon's Signed Ranks Test.

Table (1) shows a statistically significantly higher R2, R3 and L2 after C.R as compared to before C.R.

Table (2): Comparisons of anteroposterior measures before and after C.R

Parameter	T1		T2		Z / t	P value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)		
mR1-IP	2.77 ± 0.68	2.80 (2.34-3.39)	2.96 ± 0.63	2.89 (2.50-3.47)	t = -3.788	0.001
mR2-IP	6.17 ± 1.46	5.69 (4.87-7.63)	6.31 ± 1.60	5.50 (5.21-7.97)	Z = -1.456	0.145
mR3-IP	10.14 ± 1.55	10 (9.27-11.67)	10.28 ± 1.59	10.11 (8.78-11.90)	t =-1.131	0.272
mL1-IP	3.30 ± 1.65	2.88 (1.95-4.52)	3.52 ± 1.66	3.17 (2.38-4.28)	t =-2.259	0.036
mL2-IP	6.72 ± 2.97	6.07 (4.97-9.76)	6.93 ± 2.97	6.06 (5.13-9.87)	t =-2.116	0.048
mL3-IP	11.48 ± 3.88	11.56 (8.49-15.18)	11.75 ± 4.16	10.54 (8.68-16.49)	t =-1.476	0.156
lR1-IP	9.10 ± 1.51	8.95 (7.97-9.93)	9.31 ± 1.60	9.52 (8.55-9.81)	t =-1.627	0.120
lR2-IP	11.41 ± 1.96	10.74 (9.79-12.34)	11.64 ± 1.98	10.82 (10.35-13.02)	Z = -0.560	0.575
lR3-IP	15.21 ± 2.34	14.68 (13.44-17.09)	15.31 ± 2.03	15.09 (13.45-17.05)	t =-0.430	0.672
lL1-IP	9.31 ± 1.51	9.15 (8.44-9.95)	9.30 ± 1.13	9.61 (8.44-9.92)	Z = -0.075	0.940
lL2-IP	10.74 ± 1.30	10.59 (9.53-11.99)	11.22 ± 1.23	10.93 (10.17-12.10)	t =-2.311	0.032
lL3-IP	14.11 ± 2.03	13.66 (12.77-15.68)	14.46 ± 2.02	13.87 (13.18-16.19)	t = -1.650	0.115
mR1-2-3	8.21 ± 1.57	8.45 (7.05-9.43)	8.36 ± 1.42	8.57 (7.03-9.52)	t =-1.444	0.165
mL1-2-3	8.93 ± 2.36	8.18 (7.41-10.50)	9.01 ± 2.34	8.13 (7.36-11.04)	Z = -0.784	0.433
lR1-2-3	10.01 ± 3.68	8.48 (7.17-13.80)	9.85 ± 2.62	9.12 (7.67-12.23)	Z = -0.317	0.751
lL1-2-3	8.23 ± 1.60	8.16 (6.80-9.39)	8.61 ± 1.85	7.99 (7.25-10.36)	t =-1.291	0.212

P value by Paired-Samples t-Test or *Wilcoxon's Signed Ranks Test.

Table (2) shows a statistically significantly higher mR1-IP, mL1-IP, mL2-IP and lL2-IP after C.R as compared to before C.R.

Table (3): Comparisons of angular measures before and after C.R

Parameter	T1		T2		Z / t	P value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)		
mR1-IP-mL1	65.53 ± 31.53	57.15 (42.55-100.27)	65.36 ± 30.15	62.20 (37.67-99.57)	Z =-0.486	0.627
mR2-IP-mL2	42.95 ± 13.70	43.90 (32.46-55.38)	43.23 ± 14.06	43.24 (30.95-48.33)	t =-0.163	0.872
mR3-IP-mL3	31.20 ± 9.52	28.97 (24.50-40.80)	31.32 ± 9.42	30 (23.53-39.03)	t =-0.177	0.861
lR1-IP-lL1	136.65 ± 18.62	132.85 (120.60-156.85)	131.15 ± 15.24	126.05 (119.28-147.42)	t =2.744	0.013
lR2-IP-lL2	112.76 ± 15.86	114.01 (99.20-126.94)	106 ± 13.27	105.60 (96.55-114.79)	t =2.919	0.009
lR3-IP-lL3	86.42 ± 13.69	82.75 (73.58-99.67)	85.45 ± 12.18	78.85 (75.42-94.75)	Z =-0.392	0.695

P value by Paired-Samples t-Test or *Wilcoxon's Signed Ranks Test.

Table (4): shows a statistically significantly lower lR1-IP-lL1 and lR2-IP-lL2 after C.R as compared to before intervention.

Correlation:

-Transverse measures:

There is a statistically significant very strong positive correlation between pre-post measures as regards R1- R2- R3- L1- L2- L3- Tm1- Tm2-Tm3 as well as Tl1. For Tl2 and Tl3, correlation was moderate.

-Antero-posterior measures:

There is a statistically significant moderate positive correlation between pre-post measures as regards lR2-IP, lL1-IP, lL2-IP and lL1-2-3. For other measures, it was very strong positive correlation.

-Angular measures:

There is a statistically significant moderate positive correlation between pre-post measures as regards lR1-IP-lL1. For other measures, it was very strong positive correlation.

Discussion:

Based on the principle that rugae area is considered as a stable area to be used for person identification and a reference to measure changes occurring in maxillary dental arch after orthodontic treatment and because there are no studies have been published regarding changes in transverse, antero-posterior and angular dimensions before and after C.R in an Egyptian sample, we conducted this research to assess if there is any significant difference using a 3-D digital models scanned by a laser scanner.

Transverse measures:

In this study, changes in R1-L1-L3 were statistically insignificant. Also, transverse distances between medial points Tm1-Tm2-Tm3 were insignificantly changed. Transverse distances between lateral points Tl1-Tl2-Tl3 were insignificantly changed. On the contrary, there was a statistically significant increase in R2-R3-L2.

Correlation between measures showed a very strong positive correlation between pre and post treatment measures as regards R1-R2-R3-L1-L2-L3-Tm1-Tm2-Tm3-Tl1. Moderate correlation between pre and post treatment measures of Tl2-Tl3 was found.

Antero-posterior measures:

There was a statistically significantly increase in pre and post treatment measures of mR1-IP, mR1-IP, mL2-IP and lL2-IP. Changes in other measurements were statistically insignificant.

Correlation between measures showed a very strong positive correlation between pre and post treatment measures as regards mR1-IP, mR2-IP, mR3-IP, mL1-IP, mL2-IP, mL3-IP, lR1-IP, lR3-IP, lL3-IP, mR1-2-3 and lR1-2-3.

It also showed a moderate positive correlation between pre and post treatment measures of lR2-IP, lL1-IP, lL2-IP and lL1-2-3.

Angular measures:

There was a statistically significant decrease in pre and post measures of the angle lR1-IP-lL1 and lR2-IP-lL2.

All medial angles mR1-IP-mL1, mR2-IP-mL2, mR3-IP-mL3 and the lateral angle lR3-IP-lL3 showed statistically insignificant changes.

Correlation between angular measurements showed a very strong positive correlation between pre and post treatment measures as regards angles mR1-IP-mL1, mR2-IP-mL2, mR3-IP-mL3, lR2-IP-lL2, and lR3-IP-lL3.

The angle lR1-IP-lL1 showed a moderate positive correlation between pre and post treatment measures.

Conclusion:

The results of current study revealed that:

1- 1st rugae:

-Transverse measures:-

No statistically significant difference in length on right or left sides.

No statistically significant difference in distance between the two most medial points.

No statistically significant difference in distance between the two most lateral points.

-Antero-posterior measures:

There is a statistically significant increase in distance between the two most medial points and incisive papilla.

No statistically significant difference in distance between the two most lateral points and incisive papilla.

-Angular measures:

No statistically significant difference in angle between the most medial right point, incisive papilla and the most medial left point.

There is a statistically significant decrease in angle between the most lateral right point, incisive papilla and the most lateral left point.

2- 2nd rugae:

-Transverse measures:

There is a statistically significant increase in length of right and left sides.

No statistically significant difference in distance between the two most medial points.

No statistically significant difference in distance between the two most lateral points.

This means that the increase in length was in a curved way not in a straight direction.

-Antero-posterior measures:

No statistically significant difference in distance between the two right most medial and lateral points and incisive papilla.

There is a statistically significant increase in distance between the two left most medial and lateral points and incisive papilla.

This shows that there is different response between right and left sides to C.R.

-Angular measures:

No statistically significant difference in measures of angle between the most medial right point, incisive papilla and the most medial left point.

There is a statistically significant decrease in measures of angle between the most lateral right point, incisive papilla and the most lateral left point.

3- 3rd rugae:

-Transverse measures:

No statistically significant difference in length of left side, distance between the most medial points or distance between the most lateral points.

There is a statistically significant increase in length of right side.

-Antero-posterior measures:

No statistically significant difference in all measures.

-Angular measures:

No statistically significant difference in all angles.

These results show that 3rd rugae is the most stable portion in rugae area.

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