Indian Journal of Basic & Applied Medical Research; March 2013: Issue-6, Vol.-2, P. 594-607

"DYNAMIC SMILE ANALYSIS: CHANGES WITH AGE IN GUJARATI POPULATION"

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Abstract:

Introduction: The objective of this study was to define age-related changes in the human smile. The areas of interest were upper lip length at smile and repose, upper lip thickness at smile and repose, maxillary incisal display at smile, interlabial gap height at smile, smile index, percent buccal corridors, intercommisural width at rest, smile height, and smile arc.

Materials and Method: Video equipment was used to capture video for 150 subjects. Two frames for each subject were selected; one frame representing the lips at rest and the second representing the widest smile. After excluding 50 subjects the data for the remaining 100 subjects was analyzed with equal number of males and females.

Results: There was a decrease in the maxillary incisor display during smile in both males and females, with increase in age. Smile index significantly increased with increase in age. Most subjects displayed an average smile height. No subjects in the 50 and over age group displayed a high smile while no subjects in the 15-19 year old age group presented with a low smile. All the dynamic measures indicated there was a pattern of decreasing change from rest to smile especially evident after the 30-39 year old age group.

Conclusions: This study helps to establish age related dynamic changes. As the person ages the smile gets narrower vertically and wider transversely.

Key words : Dynamic changes, smile,Lip length, Maxillary incisal display.

Introduction: Smile analysis and smile design have become key elements of orthodontic diagnosis and treatment planning over the last decade.[1-3]According to Hulsey, "Smile is one of the most effective means by which people convey their emotions."[4] Majority of orthodontic literature and diagnosis is based on patient's profile and lips at rest while analyzing a static photograph and / or lateral cephalogram.[5-18] The reason that smiles had not been readily studied in the past could be due to the difficulty in capturing a reliable, repeatable smile.[19-21] Although these orientations provide an adequate amount of diagnostic information, they do not contain all of the information needed for smile visualization and quantification. The records needed for contemporary smile visualization and quantification can be divided into 2 groups: static and dynamic. The dynamic recording of smile can be accomplished with digital Videography. Videography allows us to capture standardized/reproducible smile, thus minimizing the error when studying one snapshot. Digital video and computer technology enables the clinician to record anterior tooth display during speech and smiling at the equivalent of 30 frames per second.

The videos are recorded in standardized fashion with the camera at a fixed distance from the subject.[20, 21] Patients and parents on orthodontic treatment demand and appreciate more of aesthetic harmony, so along with functionally efficient and balanced occlusion, good esthetics – dynamic smile has become one of the treatment goals of the orthodontist. Recently, time has been recognized as the fourth dimension. The growth, maturation, and aging of the perioral soft tissues have a profound effect on the appearance of both the resting and smiling presentations. It is nevertheless a consequence of getting older. [20, 21]

The orthodontist must work with 2 dynamics. The first is that of soft tissue repose and animation assessed at the patient's examination and includes how the lips animate on smile, gingival display, crown length, and other attributes of the smile. The second is the facial change throughout a patient's lifetime—the impact of skeletal and soft tissue maturational and aging characteristics, which are well documented. [20] Hence, this study is carried out to check age related changes in smile captured with Videography. The present study was planned to understand the dynamic smile analysis and changes with age with to study the anatomic and physiologic perioral age-related changes of the upper lip.

MATERIAL AND METHODS

I. SUBJECT RECRUITMENT:

Gujarati students/residents, staff, faculty, patients, and parents/guardians visiting the Government dental college and hospital, Ahmedabad were screened and chosen based upon the selection criteria. It was explained to potential subjects that this was a study on lip movements and their involvement would be anonymous, capturing chin to nose only, and involve a short questionnaire followed by a 5 second video clip.

Inclusion criteria:

1. All subjects were over 15 years of age.
2. They had no history of previous orthodontic treatment.
3. Angles class I malocclusion with no apparent anomalies either in skeletal or soft tissue.
4. Ability to understand their voluntary involvement in the study and to answer questions on the questionnaire.

Exclusion criteria:

1. Missing tooth visible in smile
2. Prosthodontic work on teeth/tooth visible in smile
3. Gross facial asymmetries
4. Excessive dental attrition
5. Crowding or spacing of the teeth
6. Lip irregularities or history of lip surgery
7. Inability to determine natural head position, occlusal plane, or any measurements

Exclusion criteria while viewing video:

1. Anterior prosthodontics
2. Video error
3. Did not smile
4. Head position off
5. Lip enhancements
6. Lip irregularity
7. Lips not at rest

After screening about 150 subjects, 100 subjects were selected for the study who fulfilled all the requirements. The subjects were separated into two groups. 1. Male 2. Female. Each group (G) was again subdivided into five subgroups with the following age ranges:

1. G1 (15-19 years)
2. G2 (20-29 years)
3. G3 (30-39 years)
4. G4 (40-49 years)
5. G5 (50 years and older)

In each subgroup 10 subjects' data were collected.

II. ARMAMENTARIUM:

Following armamentarium were used in this cross-sectional study.

1. Sony camera (Model no. DCR – HC52E)
2. 15.6" Dell Inspiron 1545 laptop
3. EDIUS 5.0 software
4. Adobe Photoshop CS2
5. A stand prepared with rulers secured horizontally and vertically for various measurements.

III. METHOD OF DATA COLLECTION:

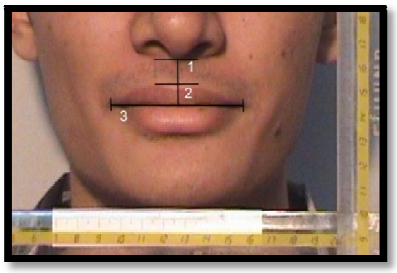
First, the subjects who agreed to voluntarily participate in the study were asked to fill up the questionnaire and consent form. A Sony video camera (Model no. DCR – HC52E) was set on a tripod approximately 4 feet away from the standing subject. The subjects were instructed to hold their head in natural head position by looking straight into an imaginary mirror. The camera lens was adjusted parallel to the apparent occlusal plane and the camera focused only on the mouth (from the nose to the chin) so as to capture the smile while protecting person's identity. The rulers were secured in a cross configuration mounted on the stand.

A stand with ruler was held close to the subject chin. The subjects were instructed to say*: "Subject number ____, Chester eats cheesecake by the Chesapeake, relax, and then smile".* Recording began about 1 second before the subject began speaking and ended after the smile.

The video clip was then downloaded to a Dell computer and uploaded to EDIUS 5.0 software, a video editing program. Repeat shot, if required. One second frame is divided into 30 frames with EDIUS 5.0 software. Each frame was analyzed and two frames were captured for the study. First, the one that represented the subjects lips at rest or relaxed lip position and second, the frame representing the subjects' widest commissure to commissure posed smile. The captured frames were converted into a JPEG file by EDIUS 5.0 and then renamed within Microsoft Windows 7 ultimate with appropriate subject number and rest/smile frame (example: 1101 R, 1101 s, etc.).Each file was opened in Adobe Photoshop CS2 (San Jose, CA) and adjusted using the millimeter ruler in the frame.

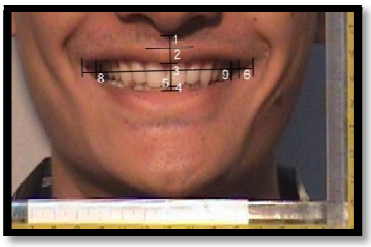
For all analyses an alpha level of 0.05 was used. To examine whether there were age differences in smile height and smile arc, $\chi 2$ (chi-square) analyses were conducted. Smile height and smile arc were measured on a categorical scale with four levels, while age represents an interval-level variable.

Measurements on Rest Frame (Figure 1):



1	**Upper lip length:**	**From subnasale to stomion superius**
2	Upper lip thickness:	Vertical distance from the most superior point of cupid's bow to the most inferior portion of the tubercle of the upper lip
3	Inter-commissural width:	Distance between the corner of lips

Measurements on Smile Frame (Figure 2):



1	**Upper lip length:**	**Subnasale to stomion superius**
2	Upper lip thickness:	Vertical distance from the most superior point of cupid's bow to the most inferior portion of the tubercle of the upper lip
3	Maxillary incisor display:	Stomion superius to maxillary incisor edge. If the central incisors were not the same levels two measurements were taken and the average was used for that subject
4	Maxillary incisal edge to upper part of lower lip:	Stomion inferius to maxillary incisor edge
5	Interlabial gap at smile:	Direct measurement only taken if lower lip covers maxillary incisal edge, otherwise

		measurement #3 plus #4 is used
6	Outer inter-commissural width:	Distance between the most lateral aspect of oral commissures
7	Smile index:	The smile index was determined by dividing the outer inter-commissural width by the interlabial height during smile
8	Inner inter-commissural width:	Distance between the most medial aspect of oral commissures
9	Visible maxillary dental width:	Distance between the most lateral aspect of visible maxillary teeth in smile
10	Buccal corridor percentage:	The difference between visible maxillary dentition width and inner-commissure width divided by inner-commissural width reported as a percentage. This percentage represents the amount of the inner commissure width occupied by the buccal corridor

OBSERVATIONS AND RESULTS:

Upper Lip Length at Rest: There was statistically non-significant **increase** in pattern of the upper lip length at rest of about 2.68 mm for male (p=0.0876) and 1.43 mm for female (p=0.668) from age G1 To G5.

Table 1: Upper lip length at rest for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	11.37	2.025	11.0000	1.66779
2 (20-29)	12.59	1.789	11.6240	1.34425
3 (30-39)	12.48	2.144	11.5370	0.99374
4 (40-49)	13.57	2.819	12.2780	1.79426
5 (≥50)	14.05	2.286	12.4340	4.46229
P value	0.0876		0.668	

Upper Lip Thickness at Rest: **Statistically significant decrease** in pattern of the upper lip thickness at rest of about 2.27 mm for male (p=0.025) and 2.246 mm for female (p=0.016) from G1 to G5.

Table 2: Upper lip thickness at rest for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	10.744	1.1912	9.628	2.0321
2 (20-29)	10.044	1.2348	9.149	0.7292
3 (30-39)	9.855	1.9114	9.053	1.7245
4 (40-49)	9.613	1.7921	8.683	1.2850
5 (≥50)	8.474	1.1294	7.382	1.1150
P value	0.025		0.016	

Inter-commissural Width at Rest: Increase in pattern of the Inter-commissural Width at rest of about 3.34 mm for male (p=0.1484) and 3.885 mm for female (p=0.0049) from G1 to G5. (Statistically non-significant for males and significant for females)

Table 3: Inter-commissural width at rest for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	50.80	2.837	49.347	2.24747
2 (20-29)	51.59	4.495	50.201	2.25522
3 (30-39)	52.86	4.178	50.802	2.11668
4 (40-49)	54.01	1.938	51.293	4.65553
5 (≥50)	54.14	3.472	53.232	2.14064
P value	0.1484		0.049	

Upper Lip Length at Smile: Non significant **increase** in pattern of the Upper Lip Length at Smile of about 2.534 mm for male (p=0.0603) and 2.244 mm for female (p=0.070) from G1 to G5. In male G3 is marginally less than G2.

Table 4: Upper lip length at smile for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	6.561	2.465	6.4580	0.74405
2 (20-29)	7.46	1.327	7.0540	1.13673
3 (30-39)	7.349	1.854	7.6920	0.86461
4 (40-49)	8.966	3.329	7.9910	2.11637
5 (≥50)	9.095	1.575	8.7020	2.97430
P value	0.0603		0.070	

Upper lip thickness at smile: **Non-significant decrease** in pattern of the Upper Lip thickness at Smile of about 1.209 mm for male (p=0.245) and 0.965 mm for female (p=0.216) from age G1 to G5.

Table 5: Upper lip thickness at smile for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	7.3740	1.47041	7.0850	1.01153
2 (20-29)	7.3080	2.07304	6.9550	1.08444
3 (30-39)	8.0990	1.33345	7.0030	1.00460
4 (40-49)	7.1780	1.65712	6.4360	1.05298
5 (≥50)	6.1650	2.44511	6.1200	1.24922
P value	0.245		0.216	

Maxillary Incisor Display: **Statistically significant decrease** in pattern of the Maxillary Incisor Display of about 4.092 mm for male (p=0.019) and 2.477 mm for female (p=0.027) from G1 to G5.

Table 6: Maxillary incisor display for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	10.890	1.9830	11.488	1.2413
2 (20-29)	9.466	3.0301	10.876	1.5353
3 (30-39)	8.712	2.3785	10.048	1.4395
4 (40-49)	8.935	2.7522	9.661	2.3053
5 (≥50)	6.798	2.6244	9.011	2.1481
P value	0.019		0.027	

Interlabial Gap Height: Decrease in pattern of the Interlabial Gap Height of about 3.087 mm for male (p=0.111) and 3.061 mm for female (p=0.027) from G1 to G5.(For females it was statistically significant)

Table 7: Interlabial gap height for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	14.0000	2.09109	13.8380	1.63973
2 (20-29)	11.1250	1.72478	12.1630	1.79891
3 (30-39)	12.0310	3.26092	11.6060	1.74442
4 (40-49)	11.6920	2.91581	11.5290	2.84406
5 (≥50)	10.9130	3.35491	10.7770	1.77047
P value	0.111		0.020	

Smile Index: Statistically significant increase in pattern of the Smile Index of about 2.1221 mm for male (p=0.046) and 1.6395 mm for female (p=0.050) from G1 to G5.

Table 8: Smile index for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	4.7125	0.66972	4.5447	0.47635
2 (20-29)	6.1905	0.94919	5.2707	0.71735
3 (30-39)	6.0442	1.77925	5.6300	0.93583
4 (40-49)	6.1668	1.57454	5.9838	2.16949
5 (≥50)	6.8346	2.11887	6.1842	1.34540
P value	0.046		0.050	

Percent Buccal Corridor: Statistically significant increase in pattern of the percent buccal corridor of about 5.37 % for male (p=0.0212) and 4.66 % for female (p=0.009) from G1 to G5.

Table 9: Percent buccal corridor male and female.

GROUP	MALE		FEMALE	
	Mean (%)	SD	Mean (%)	SD
1 (15-19)	9.056	2.62	10.93	3.416
2 (20-29)	11.11	5.529	12.09	3.352
3 (30-39)	13.25	2.984	14.34	2.723
4 (40-49)	13.28	4.749	14.72	3.426
5 (≥50)	14.43	1.545	15.59	2.761
P value	0.0212		0.009	

Change in upper lip length: In both male and female **decrease** in value occurs from G2 to G5. In female G1 and G2 are almost similar. (Statistically non-significant)

Table 10: Change in upper lip length for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	4.812	1.635	4.542	1.202
2 (20-29)	5.129	1.914	4.57	1.449
3 (30-39)	5.129	2.434	3.845	1.485
4 (40-49)	4.607	2.333	4.287	1.777
5 (≥50)	4.959	1.267	3.732	2.134
P value	0.9713		0.6907	

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Change in upper lip thickness: In both male and female **decrease** in change in upper lip thickness from G1 to G5. This decrease is statistically non significant.

Table 11: Change in upper lip thickness for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	3.37	1.430	2.543	1.634
2 (20-29)	2.736	1.910	2.194	0.6566
3 (30-39)	1.756	1.587	2.050	1.143
4 (40-49)	2.435	1.809	2.247	1.213
5 (≥50)	2.309	2.250	1.262	1.149
P value	0.7186		0.1901	

Change in intercommisural width: **Decrease** in pattern for change in inter-commissural width from G2 to G5 in male and from G1 to G5 in female. This change is non significant.

Table 12: Change in inter-commissural width for male and female.

GROUP	MALE		FEMALE	
	Mean (mm)	SD	Mean (mm)	SD
1 (15-19)	14.04	3.646	12.98	2.698
2 (20-29)	16.32	5.981	12.83	2.395
3 (30-39)	15.32	7.483	12.86	2.674
4 (40-49)	14.21	5.987	12.7	3.536
5 (≥50)	14.32	3.923	11.36	3.945
P value	0.8777		0.7606	

Smile Height: 66% of male and 74% of female show average smile height.

Smile Arc: 68% of male and 60% female represent flat smile arc.

Table 13: Smile height for male.

SMILE HEIGHT	G1	G2	G3	G4	G5	Total
High	30%	10%	10%	10%	0	12%
Average	70%	80%	60%	80%	40%	66.0%
Low	0	10%	30%	10%	60%	22.0%
No display	0	0	0	0	0	0%

Table 14: Smile height for female.

SMILE HEIGHT	G1	G2	G3	G4	G5	Total
High	10%	40%	10%	50%	0%	22%
Average	90%	90%	90%	40%	90%	74%
Low	0%	0%	0%	10%	10%	4%
No display	0%	%	0%	0%	0%	0%

DISCUSSION:

Atrophy of muscles resulted in decreased lip volume, loss of lip architecture, and lip lengthening. [22] The decrease in upper lip thickness quantified the empirical observations of thinning lips by many researchers and practitioners[23]. Increase in inter-commissural width could be due to loss of skin elasticity and volume which increases the wrinkles at the corners of the lip. Generally, wrinkles at the corners of the lips at rest create a situation where it was difficult to identify the commissures. These results were consistent with the idea that activity and function of the muscles involved in smile decrease with age. Loss of skin elasticity and volume can also contribute to increased wrinkles at the corners of the lip, making it difficult to identify the commissures.

Maxillary incisor display was decreasing with age due to increase in lip length and also somewhat with attrition of teeth. [24]Smile index had increased because inter-commissural width had increased with age and interlabial gap had decreased with age. The aging smile gets wider transversely and narrower vertically. [25]With advancing age, there was a decrease in the muscles ability to raise the upper lip. Consequently, the isometric and dynamic strengths declined and the time to peak tension was significantly prolonged with increasing age.[26-30]

In this study, 66% male and 74% female had average smile height. 22% female showed high smile height while 12% male showed high smile height. High smile height was more commonly seen in female.Of all the different kinds of smile arc, the flat one was the most common for male (68%) and female (60%).

Though the results in stipulated time gave us a better insight of age related changes on the perioral tissues, long term longitudinal study would give more authentic picture. However; it could also help to rule out any error if sample size is large.

CONCLUSIONS:

From present study we may conclude that:

- Upper lip length at rest increased non significantly as the person ages, in both males and females.
- The upper lip thickness at rest decreased as the person ages significantly in both males and females.
- Smile index significantly increased indicating as the person ages, the smile gets narrower vertically and wider transversely.

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Date of Submission: 28 January 2013
Date of Provisional acceptance: 10 February 2013
Date of Final acceptance: 27 February 2013
Date of Publication: 05 March 2013
Source of Support: Nil ; Conflict of Interest: Nil