

Relationship of the maxillary teeth display with the smile zone shape and upper lip mobility during smile- A cross sectional study

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Abstract

Introduction: Number and amount of maxillary teeth display during smile play a very important role in developing esthetic values in a patient. Display of teeth depends on smile zone shape and lip mobility in superior and lateral direction. Arrangement of artificial teeth in natural position increases the esthetic values of any restoration. Aim of this study is to determine the relationship of smile zone shape and lip mobility with the display of maxillary anterior teeth.

Materials and Methods: Based on the population sample size for this study at 95% confidence and 5% margin of error was proposed to be of 384 male & female subjects ranging in age from 18 to 40 years. Frontal image of each subject's face was captured under standardized condition

by a digital camera (Nikon, D5300, 70-300 mm lens). Images were downloaded on computer. Relationship of smile zone shape and lip mobility with the teeth display was analysed gender-wise. For statistical analysis Unpaired- Student t-test, one-way ANOVA, Post-hoc pairwise comparison LSD test, Pearson correlation tests were used.

Results: In males bow and straight smile zone shapes were more common (62.3%, 28.3%) while in females curve and ellipse smile zone shapes were more common (18.7% ,12.4%). Females were having more lip mobility and exposure of maxillary teeth in comparison to males in all types of smile zone shapes.

Conclusions: Exposure of the teeth depends upon the upper lip mobility in the superior and lateral direction as

well as on the shape of the smile zone, which is different for different subjects due to the direction and strength of the facial muscles.

Keywords: Lip Mobility, Muscle activity, Teeth visibility, Smile Zone shape

Introduction-

Replacement of missing teeth and restoration of the anatomy of anterior teeth in the esthetic zone have a great impact on the patient's personality. Esthetics can be described in two ways:- subjective esthetics and objective esthetics. In Subjective esthetics, the beautiful is that which gratifies us on being seen. An object is beautiful to a person to the point it brings inclination by looking on or anticipating it. Objective esthetics is one in which an object may be beautiful, it is the contemplation of the object itself and not the object in association to a person. We call the object beautiful as it has things that make it splendid.^[1] Concepts and ideas of beauty may vary from person to person, and one must decide whether there is a difference between being normal and being beautiful and what we are trying to create in our patients.^[2] Various factors decide the esthetics in dentistry, these are the inclination of maxillary and mandibular anterior teeth, length of maxillary and mandibular anterior teeth, the contour of the incisal edges, midlines and smile lines, the symmetry of crown shapes and sizes both on right and left side.^[3,4,5,6] Among the various esthetic factors, exposure of maxillary anterior teeth and number of maxillary teeth display during a smile play a very important role in developing esthetic values in a patient.^[7] Maxillary anterior teeth exposure depends upon upper lip coverage and the shape of the smile zone. Upper lip coverage depends upon upper lip mobility in the superior direction. For maxillary anterior teeth, upper lip coverage increases with age and that's why exposure of maxillary teeth was found to be greater in younger people^[8,9] and lesser in

older ones.^[10] The smile zone shape is a display area that is comprised of the inferior border of the upper lip and the superior border of the lower lip during the smile.^[11] The smile zone mainly encompasses the teeth and gingival tissues during the smile.^[12] There are six types of smile zone shapes these are straight, curve, ellipse, bow, rectangular, & inverted.^[13]

The number of teeth displays during a smile depends upon lip mobility in the lateral direction. The degree of lateral lip movement varies from person to person or depends on the deepness of communication and expression of individuals.^[14] Every patient wants a pleasant and attractive smile. In Prosthodontics number of teeth exposed and the amount of maxillary anterior teeth exposed plays a very significant role in the rehabilitation of esthetics in dentate, partially dentate, and completely edentulous patients. It has been established that the arrangement of artificial teeth in natural position increases the esthetic values of any restoration. Many orofacial landmarks play an important role in the replacement and rehabilitation of artificial and natural teeth in the esthetic region.

The purpose of conducting this study is to determine the types and frequency of smile zone shape, lip mobility, and their relationship with the number of total maxillary teeth exposed and amount of maxillary anterior teeth exposed during smile in males and females ranging in age from 18-40 years.

Materials and Methods

Based on the population sample size for this study at 95% confidence and 5% margin of error were proposed to be of 384 subjects ranging in age from 18 to 40 years. The subject's inclusion criteria were, Subjects should be of Indian origin & should have natural dentition in maxillary & mandibular arch. The subject's exclusion criteria were, Subjects who have undergone surgical treatments like

extraction of anterior teeth followed by replacement of missing teeth in the esthetic region, periodontal surgeries, orthodontic treatment, incompetent lips were excluded from this study.

This study was approved by the Institutional Ethics Committee of Government Dental College & Hospital IEC GDCH), Ahmedabad

The selected subjects were informed about the study and written consent was taken.

An unvarying frontal image of each subject's face was captured in resting and in the spontaneous smiling state by using a digital camera (Nikon, D5300 with 70-300 mm lens). The camera was stabilized with the help of a tripod at a fixed working distance of 60 inches or 5 feet from the subject. The subject's head was positioned, so that the Frankfort horizontal plane should be parallel to the floor. The camera was adjusted so that glabella of the subject should be in center of the camera lens. Images were downloaded on a personal computer. Smile zone shape, Lip mobility superiorly, Lip mobility laterally, the number of maxillary teeth visibility, amount of maxillary anterior teeth visibility, and the relationship of all these parameters in intergroup and intragroup of smile zone shape were analysed gender-wise.

Smile zone shape

The display area during the smile framed by upper and lower lips is the smile zone. Six types of smile zone shapes are present: straight, curve, ellipse, bow, rectangular, & inverted. The shape of the smile zone was determined by evaluating the outline of upper and lower lips during the smile (Figure 1).



Figure 1: Smile zone shape in patient during smile

Upper lip length at rest and smile

Upper lip length was determined by measuring the distance between the base of the nose and the lower border of the upper lip at rest and smiling state (Figure 2 & 3).



Figure 2: Lip length at rest



Figure 3: Lip length during smile

Mouth width at rest and smile

Mouth width was determined by measuring the distance between corner of the mouth at rest and smiling state (Figure 4 & 5).



Figure 4: Mouth width at rest



Figure 5: Mouth width during smile

Upper lip mobility

Upper lip mobility is the amount of lip movement in superior and lateral direction during a smile. Superior lip mobility was determined by subtracting the upper lip length in a maximum smile from upper lip length at rest. Lateral lip mobility was determined by subtracting the mouth width at rest from the mouth width or smile width in a maximum smile.

Superior lip movement depicts the amount of teeth exposed during a smile and Lateral lip movement depicts the number of teeth exposed during a smile.

Length of maxillary anterior teeth intraorally

Total length was calculated intraorally by measuring the cervicoincisal length of maxillary anterior teeth (Figure 6).



Figure 6: Length of maxillary anterior teeth intraorally

Length of maxillary anterior teeth during smile

Cervicoincisal length of maxillary anterior teeth was measured during smile (Figure 7).



Figure 7 Length of maxillary anterior teeth during smile

Amount of exposure was expressed in percentage.

$$\frac{\text{Length of maxillary anterior tooth during smile}}{\text{Length of maxillary anterior tooth intraorally}} \times 100$$

Data analysis

The above measurements were performed by utilizing Adobe Photoshop version 8. There was a single investigator for all the measurements.

Available data were statistically analysed by using SPSS version 21 software. Following tests were used for the analysis of data:

- Unpaired- Student t-test,
- one-way ANOVA
- Post-hoc pairwise comparison LSD test
- Pearson correlation

Results

Data were collected from 384 subjects (193 females and 191 males) and the mean age of all subjects was 26.98

years while minimum and maximum age were 18 years and 40 years respectively .The most common smile zone shape was a bow (52.9%) which was followed by straight (26.8%), curve (14.1%), & ellipse (6.3%). The frequency of bow and straight smile zone shape was more common in males (62.3% and 28.3%) in comparison to females (43.5% and 25.4%) while the frequency of curve and ellipse smile zone shape was more common in females (18.7% and 12.4%) in comparison to males (9.4% and 0%) (Table 1).

Table 1: Overall and gender wise distribution of smile zone shape

Smile zone shape	Overall		Female		Male	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bow smile zone	203	52.9	84	43.5	119	62.3
Straight smile zone	103	26.8	49	25.4	54	28.3
Curved smile zone	54	14.1	36	18.7	18	9.4
Ellipse smile zone	24	6.3	24	12.4	0	0
Total	384	100.00	193	100	191	100

A significant difference was found in the Upper lip mobility in the superior direction in males and females ($p < 0.05$), in females, mean lip mobility superiorly (5.36 mm) was more than the males (4.78 mm) (Table 2).

Table 2: Comparison of superior lip mobility in male and female subjects

Lip Mobility Superiorly	Gender	N	Mean	Std. Deviation	t value	p value	
	F	193	5.36	1.95	3.119	0.002	$p < 0.05(S)$
	M	191	4.78	1.71			

Superior lip mobility was categorized into 3 groups:

1-5 mm, 6-10 mm, 11-15 mm

In bow smile zone shape out of 203 subjects, 90 subjects had 1-5 mm, 109 subjects had 6-10 mm, and 4 subjects had 11-15 mm superior lip mobility. In straight smile zone shape out of 103 subjects, 57 subjects had 1-5 mm and 46 subjects had 6-10 mm superior lip mobility. In the curve smile zone shape out of 54 subjects, 50 subjects had 1-5 mm and 4 subjects had 6-10 mm superior lip mobility. In

the ellipse smile zone shape out of 24 subjects, 4 subjects had 1-5 mm and 20 subjects had 6-10 mm superior lip mobility. In straight, curve, & ellipse smile zone shape no one subject was having 11-15 mm superior lip mobility (Table 3).

The mean percentage exposure of total length of individual maxillary anterior teeth in different shapes of smile zone at different categories of superior lip mobility is shown in Table 3.

Table 3: Relationship of mean percentage exposure of maxillary anterior teeth, smile zone shapes, and superior lip mobility

Smile zone shape	Superior lip mobility	Amount of maxillary anterior teeth exposure (%)																	
		Right central incisor			Left central incisor			Right lateral incisor			Left lateral incisor			Right canine			Left canine		
		1-5mm	6-10mm	11-15mm	1-5mm	6-10mm	11-15mm	1-5mm	6-10mm	11-15mm	1-5mm	6-10mm	11-15mm	1-5mm	6-10mm	11-15mm	1-5mm	6-10mm	11-15mm
Bow smile zone (N=203)	N	90	109	4	90	109	4	90	109	4	90	109	4	90	109	4	90	109	4
	Mean Exposure	75.86	80.74	100.00	77.42	81.05	100.00	85.98	91.63	100.00	89.87	86.97	100.00	76.91	85.20	100.00	86.99	86.07	100.00
	Std. Deviation	21.75	18.57	0.00	19.67	17.97	0.00	14.69	15.09	0.00	10.47	20.22	0.00	28.71	18.93	0.00	14.00	18.95	0.00
Straight smile zone (N=103)	N	57	46	0	57	46	0	57	46	0	57	46	0	57	46	0	57	46	0
	Mean Exposure	68.19	82.55	0.00	65.84	82.25	0.00	74.79	86.91	0.00	68.93	85.45	0.00	54.66	72.54	0.00	61.26	79.04	0.00
	Std. Deviation	15.18	11.83	0.00	15.73	11.66	0.00	19.27	14.50	0.00	19.66	12.45	0.00	32.45	12.39	0.00	23.98	15.33	0.00
Curved smile zone (N=54)	N	50	4	0	50	4	0	50	4	0	50	4	0	50	4	0	50	4	0
	Mean Exposure	65.11	90.50	0.00	65.51	90.50	0.00	72.88	100.00	0.00	72.85	100.00	0.00	65.90	100.00	0.00	65.71	100.00	0.00
	Std. Deviation	18.09	0.58	0.00	17.73	0.58	0.00	20.83	0.00	0.00	21.05	0.00	0.00	25.53	0.00	0.00	25.28	0.00	0.00
Ellipse smile zone (N=24)	N	4	20	0	4	20	0	4	20	0	4	20	0	4	20	0	4	20	0.00
	Mean Exposure	80.00	100.00	0.00	80.00	100.00	0.00	75.00	100.00	0.00	93.75	100.00	0.00	42.86	92.89	0.00	62.50	95.00	0.00
	Std. Deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.95	0.00	0.00	7.95	0.00
	p-value	NA			NA			NA			NA			0.01			0.01		

In one-way ANOVA test significant ($p < 0.05$) difference was found in exposure of maxillary anterior teeth at 1-5 mm and 6-10 mm superior lip mobility in all four types of smile zone shapes (Table 4).

Table 4: Comparison of maxillary anterior teeth exposure (%) at various superior lip mobility in all shapes of the smile zone (One way Anova test)

Superior lip mobility	Smile zone shape	N		Maxillary anterior teeth Exposure (%)					
				Right central incisor	Left central incisor	Right lateral incisor	Left lateral incisor	Right canine	Left canine
1-5 mm	Bow Smile zone	90	Mean	75.86	77.42	85.98	89.87	76.91	86.99
			Std. Deviation	21.75	19.67	14.69	10.47	28.71	14.00
	Straight Smile zone	57	Mean	68.19	65.84	74.79	68.93	54.66	61.26
			Std. Deviation	15.18	15.73	19.27	19.66	32.45	23.98
	Curved smile zone	50	Mean	65.11	65.51	72.88	72.85	65.90	65.71
			Std. Deviation	18.09	17.73	20.83	21.05	25.53	25.28
	Ellipse smile	4	Mean	80.00	80.00	75.00	93.75	42.86	62.50

	zone								
			Std. Deviation	0	0	0	0	0	0
	One Way ANOVA		F value	4.189	7.159	7.772	23.195	7.679	22.818
			p value	0.01	0.01	0.01	0.01	0.01	0.01
				p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)
6-10 mm	Bow Smile zone	109	Mean	80.74	81.05	91.63	86.97	85.20	86.07
			Std. Deviation	18.57	17.97	15.09	20.22	18.93	18.95
	Straight Smile zone	46	Mean	82.55	82.25	86.91	85.45	72.54	79.04
			Std. Deviation	11.83	11.66	14.50	12.45	12.39	15.33
	Curved smile zone	4	Mean	90.50	90.50	100.00	100.00	100.00	100.00
			Std. Deviation	0.58	0.58	0.00	0.00	0.00	0.00
	Ellipse smile zone	20	Mean	100.00	100.00	100.00	100.00	92.89	95.00
			Std. Deviation	0.00	0.00	0.00	0.00	11.95	7.95
	One Way ANOVA		F value	8.721	9.054	4.633	4.395	10.462	5.305
			p value	0.001	0.001	0.004	0.005	0.001	0.002
				p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	p<0.05 (S)

Comparison of mean percentage exposure of maxillary anterior teeth at 1-5 mm and 6-10 mm superior lip mobility in various smile zone shapes is shown by post hoc pairwise comparison test (Table 5).

Table 5: Pairwise comparison of smile zone shapes for percentage exposure maxillary anterior teeth at various superior lip mobility (Post Hoc pairwise comparison LSD test)

Superior lip mobility	Comparison of smile zone shapes			Maxillary anterior teeth					
				RCI	LCI	RLI	LLI	RC	LC
				p value	p value	p value	p value	p value	p value
1-5 mm	Bow smile	Vs	Straight smile	0.018	0.01	0.01	0.01	0.01	0.01
	Bow smile	Vs	Curved smile	0.002	0.01	0.01	0.01	0.032	0.01
	Bow smile	Vs	Ellipse smile	0.711	0.808	0.291	0.688	0.046	0.041
	Straight smile	Vs	Curved smile	0.405	0.925	0.578	0.221	0.047	0.26
	Straight smile	Vs	Ellipse smile	0.296	0.186	0.984	0.012	0.492	0.918
	Curved smile	Vs	Ellipse smile	0.19	0.178	0.84	0.034	0.182	0.791
6-10 mm	Bow smile	Vs	Straight smile	0.516	0.655	0.056	0.613	0.001	0.02
	Bow smile	Vs	Curved smile	0.226	0.227	0.24	0.136	0.082	0.109
	Bow smile	Vs	Ellipse smile	0.001	0.001	0.015	0.002	0.059	0.032
	Straight smile	Vs	Curved smile	0.335	0.303	0.074	0.104	0.002	0.019
	Straight smile	Vs	Ellipse smile	0.001	0.001	0.001	0.002	0.001	0.001
	Curved smile	Vs	Ellipse smile	0.273	0.259	1.000	1.000	0.436	0.592

Significant difference ($p < 0.05$) was seen in the exposure of maxillary anterior teeth in male and female subjects in a bow, straight, curve, & ellipse smile zone shapes. Females were having more exposure of maxillary anterior teeth in comparison to males in all types of smile zone shapes (Table 6).

Table 6: Relationship between smile zone shape and maxillary anterior teeth exposure in male and female subjects

Smile zone shape	Maxillary Anterior Teeth	Gender	N	Mean	Std. Deviation	p-value	
Bow smile zone (N=203)	Right central incisor	F	84	93.05	10.29	0.01	$p < 0.05$ (S)
		M	119	69.01	19.54		
	Left central incisor	F	84	93.26	9.84	0.01	$p < 0.05$ (S)
		M	119	70.32	17.86		
	Right lateral incisor	F	84	96.37	7.78	0.01	$p < 0.05$ (S)
		M	119	84.29	16.88		
	Left lateral incisor	F	84	97.22	7.80	0.01	$p < 0.05$ (S)
		M	119	82.36	18.17		
	Right canine	F	84	93.33	12.95	0.01	$p < 0.05$ (S)
		M	119	73.69	26.66		
	Left canine	F	84	95.06	8.46	0.01	$p < 0.05$ (S)
		M	119	80.89	18.68		
Straight smile zone (N=103)	Right central incisor	F	49	78.58	14.17	0.01	$p < 0.05$ (S)
		M	54	70.99	15.87		
	Left central incisor	F	49	79.31	12.90	0.02	$p < 0.05$ (S)
		M	54	67.60	17.00		
	Right lateral incisor	F	49	84.55	19.84	0.002	$p < 0.05$ (S)
		M	54	76.26	15.85		
	Left lateral incisor	F	49	82.12	18.15	0.01	$p < 0.05$ (S)
		M	54	71.03	17.69		
	Right canine	F	49	78.32	17.64	0.01	$p < 0.05$ (S)
		M	54	48.43	26.11		
	Left canine	F	49	81.29	14.95	0.01	$p < 0.05$ (S)
		M	54	58.23	22.34		
Curved smile zone (N=54)	Right central incisor	F	36	75.13	16.36	0.01	$p < 0.05$ (S)
		M	18	50.72	10.58		
	Left central incisor	F	36	75.24	16.33	0.02	$p < 0.05$ (S)
		M	18	51.61	9.95		
	Right lateral incisor	F	36	81.53	15.84	0.01	$p < 0.05$ (S)
		M	18	61.62	24.79		
	Left lateral incisor	F	36	84.16	15.82	0.01	$p < 0.05$ (S)
		M	18	56.25	19.29		
	Right canine	F	36	74.95	22.31	0.008	$p < 0.05$ (S)
		M	18	55.37	28.92		
	Left canine	F	36	80.09	20.42	0.01	$p < 0.05$ (S)
		M	18	44.56	18.68		
Ellipse smile zone (N=24)	Right central incisor	F	24	96.67	7.61	NA	
		M	0	.	.		
	Left central incisor	F	24	96.67	7.61	NA	
		M	0	.	.		
	Right lateral incisor	F	24	95.83	9.52	NA	

		M	0	.	.		
	Left lateral incisor	F	24	98.96	2.38	NA	
		M	0	.	.		
	Right canine	F	24	84.55	21.92	NA	
		M	0	.	.		
	Left canine	F	24	89.58	14.33	NA	
		M	0	.	.		

A positive correlation was found between lip mobility superiorly and amount of maxillary anterior teeth exposed in males and females (Table 7).

Table 7: Correlation between superior lip mobility and amount of teeth exposure (Pearson correlation test)

Lip mobility Superior					
		Female	Male	Overall	
	N	193	191	384	
Right central incisor	Pearson Correlation	0.388	0.514	0.462	
	Sig. (2-tailed)	0.001	0.001	0.001	p<0.05 (S)
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	
Left central incisor	Pearson Correlation	0.374	0.512	0.453	
	Sig. (2-tailed)	0.001	0.001	0.001	
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	
Right lateral incisor	Pearson Correlation	0.266	0.494	0.404	
	Sig. (2-tailed)	0.001	0.001	0.001	
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	
Left lateral incisor	Pearson Correlation	0.297	0.295	0.324	
	Sig. (2-tailed)	0.001	0.001	0.001	
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	
Right canine	Pearson Correlation	0.355	0.394	0.391	
	Sig. (2-tailed)	0.001	0.001	0.001	
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	
Left canine	Pearson Correlation	0.285	0.39	0.363	
	Sig. (2-tailed)	0.001	0.001	0.001	
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)	

Lip mobility in lateral direction was categorized into 4 groups:

1-5 mm

6-10 mm

11-15 mm

Above 15 mm

Although females were having more mean value of lateral lip mobility in comparison to males but no significant ($p>0.05$) difference was seen in lateral lip mobility of males and females (Table 8).

Table 8: Comparison of lateral lip mobility in male and female subjects

Lip Mobility	Gender	N	Mean	Std. Deviation	t value	p value	
Laterally	F	193	13.95	4.99	0.916	0.361	p>0.05(NS)
	M	191	13.50	4.58			

Out of 384 subjects, 13, 81, 175, & 115 subjects were having 1-5 mm, 6-10 mm, 11-15mm, & above 15 mm lateral lip mobility respectively. Mean number and range of maxillary teeth exposed in 1-5 mm, 6-10 mm, 11-15mm, & above 15 mm lateral lip mobility is shown in Table 9.

Significant ($p<0.05$) difference was seen in display of maxillary teeth in males and females at all lateral lip mobility except at 11-15 mm (Table 9).

Table 9: Overall and gender-wise mean exposure of maxillary teeth at various lateral lip mobility

Lip Mobility Laterally	1-5mm		6-10mm		11-15mm		Above 15mm	
N	13		81		175		115	
Number of maxillary teeth exposed								
Mean No. of Maxillary Teeth EXPOSED	8.46		9.32		10.19		10.49	
Median No. of Maxillary Teeth EXPOSED	8		9		10		10	
Std. Deviation	0.88		1.35		1.39		1.33	
Minimum No. of Maxillary Teeth EXPOSED	8		8		6		8	
Maximum No. of Maxillary Teeth EXPOSED	10		12		12		12	
Gender	F	M	F	M	F	M	F	M
N	4	9	36	45	97	78	56	59
Mean	9.50	8.00	9.92	8.84	10.07	10.33	10.79	10.20
Std. Deviation	1.00	0.00	1.49	1.00	1.53	1.18	1.22	1.39
t – value	4.78		3.88		-1.24		2.388	
p – value	0.001		0.001		0.217		0.019	
	p<0.05 (S)		p<0.05 (S)		p>0.05 (NS)		p<0.05 (S)	

In a bow, straight, curve and ellipse smile zone shapes the mean number and range of maxillary teeth exposed on lateral lip mobility is shown in Table 10. In straight and curve smile zone shape, on lateral lip mobility significant ($p<0.05$) difference was seen in display of maxillary teeth in males and females while no significant difference was seen in bow smile zone shape. Ellipse smile zone shape was present in females only (Table 10).

Table 10: Overall and gender wise mean exposure of maxillary teeth at various smile zone shapes

Smile zone shape	Bow Smile		Straight Smile		Curved Smile		Ellipse smile	
N	203		103		54		24	
Number of maxillary teeth exposed								
Mean No. of Maxillary Teeth EXPOSED	10.06		10.21		9.63		10.00	
Median No. of Maxillary Teeth EXPOSED	10		10		10		10	
Std. Deviation	1.51		1.41		1.13		1.44	
Minimum No. of Maxillary Teeth EXPOSED	6		8		8		8	
Maximum No. of Maxillary Teeth EXPOSED	12		12		12		12	
Gender	F	M	F	M	F	M	F	M

N	84	119	49	54	36	18	24	0
Mean	10.05	10.07	10.90	9.59	9.95	9.00	10.00	0
Std. Deviation	1.66	1.41	1.19	1.31	1.06	1.03	1.44	0
p – value	0.928		0.001		0.03		NA	
	p>0.05(NS)		p<0.05 (S)		p<0.05 (S)			

Significant ($p<0.05$) difference was seen in display of maxillary teeth in males and female at 1-5 mm, 6-10 mm, 11-15 mm, and above 15 mm lateral lip mobility in all shapes of the smile zone. 1- 5 mm lateral lip mobility was seen in straight smile zone shape only (Table 11).

Table 11: Relationship of number of teeth exposure, lateral lip mobility, and smile zone shape in male and female subjects (Unpaired t test)

Lip Mobility		Number of maxillary teeth exposed						
		GENDER	N	Mean	Std. Deviation	t value	p value	
Laterally (1-5mm)	Straight smile zone	F	4	9.50	1.00	4.78	0.001	p<0.05 (S)
		M	9	8.00	0.00			
Laterally (6-10 mm)	Bow smile zone	F	8	9.00	1.07	4.947	0.001	p<0.05 (S)
		M	26	8.00	0.00			
	Straight smile zone	F	13	11.08	1.44	3.283	0.003	p<0.05 (S)
		M	19	10.00	0.00			
	Curve SMILE ZONE	F	11	9.56	1.27			
		M	0	0	0			
	Ellipse SMILE ZONE	F	4	9.00	0.00			
		M	0	0	0			
Laterally (11-15 mm)	Bow smile zone	F	60	10.20	1.73	-2.494	0.014	p<0.05 (S)
		M	50	10.88	0.92			
	Straight smile zone	F	8	11.00	1.07	2.981	0.009	p<0.05 (S)
		M	10	10.00	0.00			
	Curve SMILE ZONE	F	17	9.71	0.47	2.584	0.014	p<0.05 (S)
		M	18	9.00	1.03			
	Ellipse SMILE ZONE	F	12	9.33	1.30			
		M	0	0.00	0.00			
Laterally (Above 15 mm)	Bow smile zone	F	16	10.00	1.46	-1.1	0.276	p<0.05 (S)
		M	43	10.37	1.02			
	Straight smile zone	F	24	11.00	1.02	2.56	0.015	p<0.05 (S)
		M	16	9.75	2.05			
	Curve SMILE ZONE	F	8	11.00	1.07			
		M	0	0.00	0.00			
	Ellipse SMILE ZONE	F	8	11.50	0.53			
		M	0	0.00	0.00			

In one-way ANOVA test significant ($p<0.05$) difference was seen in display of maxillary teeth at 6-10 mm, 11-15 mm, and above 15 mm lateral lip mobility in all four types of smile zone shapes (Table 12).

Table 12: Comparison of number of teeth exposure at various lateral lip mobility in all shapes of the smile zone (One way Anova test)

	Number of maxillary teeth exposed						
		N	Mean	Std. Deviation	f value	p value	
Lip Mobility Laterally (6-10 mm)	Bow smile zone	34	8.24	0.65	32.435	0.001	p<0.05 (S)
	Straight smile zone	32	10.44	1.05			
	Curved smile zone	11	9.56	1.27			
	Ellipse smile zone	4	9.00	0.00			
Lip Mobility Laterally (11-15 mm)	Bow smile zone	110	10.51	1.46	9.146	0.001	p<0.05 (S)
	Straight smile zone	18	10.44	0.86			
	Curved smile zone	35	9.34	0.87			
	Ellipse smile zone	12	9.33	1.30			
Lip Mobility Laterally (Above 15 mm)	Bow smile zone	59	10.27	1.16	2.55	0.05	p<0.05 (S)
	Straight smile zone	40	10.50	1.62			
	Curved smile zone	8	11.00	1.07			
	Ellipse smile zone	8	11.50	0.53			

Comparison of mean display of maxillary teeth at 6-10 mm, 11-15 mm, and above 15 mm lateral lip mobility in various smile zone shapes is shown by post hoc pairwise comparison test (Table 13).

Table 13: Pairwise comparison of smile zone shapes for number of teeth exposure at various lateral lip mobility (Post Hoc pairwise comparison LSD test)

	Smile Zone Shape			p value	
		Vs			
Lip Mobility Laterally (6-10 mm)	Bow smile	Vs	Straight smile	0.001	p<0.05 (S)
	Bow smile	Vs	Curved smile	0.001	p<0.05 (S)
	Bow smile	Vs	Ellipse smile	0.117	p>0.05 (NS)
	Straight smile	Vs	Curved smile	0.008	p>0.05 (NS)
	Straight smile	Vs	Ellipse smile	0.004	p<0.05 (S)
	Curved smile	Vs	Ellipse smile	0.293	p>0.05 (NS)
Lip Mobility Laterally (11-15 mm)	Bow smile	Vs	Straight smile	0.845	p>0.05 (NS)
	Bow smile	Vs	Curved smile	0.001	p<0.05 (S)
	Bow smile	Vs	Ellipse smile	0.003	p<0.05 (S)
	Straight smile	Vs	Curved smile	0.004	p<0.05 (S)
	Straight smile	Vs	Ellipse smile	0.023	p<0.05 (S)
	Curved smile	Vs	Ellipse smile	0.983	p>0.05 (NS)
Lip Mobility Laterally (Above 15 mm)	Bow smile	Vs	Straight smile	0.395	p>0.05 (NS)
	Bow smile	Vs	Curved smile	0.142	p>0.05 (NS)
	Bow smile	Vs	Ellipse smile	0.014	p<0.05 (S)
	Straight smile	Vs	Curved smile	0.325	p>0.05 (NS)
	Straight smile	Vs	Ellipse smile	0.05	p<0.05 (S)
	Curved smile	Vs	Ellipse smile	0.446	p>0.05 (NS)

A positive correlation was seen between lip mobility laterally and the mean number of teeth exposed in male and female subjects (Table 14).

Table 14: Correlation between lateral lip mobility and number of teeth exposure (Pearson correlation test)

	Lateral lip mobility			
		Female	Male	Overall
No. of Teeth Exposed	Pearson Correlation	0.418	0.43	0.425
	Sig. (2-tailed)	0.001	0.001	0.001
		p<0.05 (S)	p<0.05 (S)	p<0.05 (S)

Discussion

Esthetic rehabilitation of the patient requires a comprehensive evaluation of the oral and perioral structures. Regardless of age, ^[10,15-18] gender, ^[10,15-16,19-21] muscular capability, ^[9,22] facial configuration, ^[10,19,22-24] culture, ^[10,20] and phonetics ^[25-28] replacement of missing teeth in the maxillary anterior region depends upon the shape of the smile zone and upper lip mobility in the superior and lateral direction. In Indian population the most common smile zone shape is bow which is followed by straight, curve, & ellipse. The frequency of bow and straight smile zone shape is more common in males, while the frequency of curve and ellipse smile zone shape is more common in females. Various factors are responsible for different shapes of the smile zone, these are: direction and development of muscles, genetic variations in length and width of lips, variations in bony anatomical and tooth structures, and pathological conditions. Muscle groups, responsible for different shapes of smile zone are: elevators of the upper lip and elevators and depressors of the corner of the mouth. Stronger muscles group decides the shape of the smile zone.

Any smile is attractive if 75-100% maxillary anterior teeth are visible. ^[19] Smile is also esthetically acceptable if the exposure of the maxillary centrals is up to 2 mm apical to the height of the gingiva. ^[29] Upper Lip mobility in the superior direction decides the amount of maxillary anterior teeth exposed. Upper lip mobility is influenced by the muscular activity of zygomaticus, quadratus labii

superioris, & caninus. ^[14] As per the previous study, upper

lip mobility varies from person to person during smile. ^[30]

Zachrisson mentioned in his article that upper lip mobility ranges from 2-12 mm, with an average of 7-8 mm. ^[3]

Peck and Peck ^[31] mentioned in their study an average lip mobility of 5.2 mm that is 23% lessening from an original lip length of 22.3 mm in the course of posed smiles. Tarantili et al ^[32] mentioned that the original lip length decreases up to 28% in a spontaneous smile. As per the previous studies literature on superior lip mobility, in the present study upper Lip mobility is categorized into 3 groups; 1-5 mm, 6-10 mm, & 11-15 mm. Maximum subjects were having 1-5 mm superior lip mobility followed by 6-10 mm and 11-15 mm. Most common superior lip mobility recorded in bow and ellipse smile zone shape was 6-10 mm while in straight and curve smile zone shape it was 1-5 mm. Females have 3.5% more superior lip mobility than males. ^[33] The present study is showing the same results, in females mean lip mobility superiorly (5.36 ± 1.95 mm) was more than the males (4.78 ± 1.71 mm).

As the superior lip mobility increases the amount of maxillary anterior teeth exposure increased. A significant difference was found in the exposure of maxillary anterior teeth at 1-5 mm and 6-10 mm superior lip mobility in all four types of smile zone shapes. Females were having more exposure of maxillary anterior teeth in comparison to males in all types of smile zone shapes at all range of superior lip mobility

Amount of upper lip elevation depends on strength of the muscles of the upper lip. Stronger the muscles more will be the upper lip elevation none the less more will be the exposure of maxillary anterior teeth. In a previous study, it was found that during a smile upper lip elevated by 80% from its original length, showing 10 mm length of maxillary incisors.^[33]

In present study maximum exposure of the right and left central incisors at 1-5 mm and 6-10 mm of superior lip mobility was seen in ellipse smile zone shape (80% and 100% respectively). Maximum exposure of the right and left lateral incisors at 1-5 mm of superior lip mobility was seen in bow smile zone shape (RLI 85.98%, LLI 89.87%) while at 6-10 mm of superior lip mobility maximum exposure of the right and left lateral incisors were seen in curve and ellipse smile zone shapes (RLI 100%, LLI 100% Respectively). Maximum exposure of the right and left canines at 1-5 mm of superior lip mobility was seen in bow smile zone shape (RC 76.91%, LC 86.99%) while at 6-10 mm of superior lip mobility maximum exposure of the right and left canines were seen in curve smile zone shape (RC & LC 100%). 11-15 mm superior lip mobility was seen in bow smile zone shape only.

Apart from superior lip mobility categories, maximum mean exposure of anterior teeth was seen in ellipse smile zone shape

The number of maxillary teeth displays during a smile depends upon the smile width, as the smile width increases the number of maxillary teeth display increases. During smile mouth width increases by 30%.^[33,34,35] The width of the smile depends on lip mobility in the lateral direction or retraction of the lips during the smile which is dependent on the combined action of zygomaticus, risorius, platysma, triangularis, and buccinator facial muscles in the lateral direction.

In the present study lateral lip mobility was categorized into 4 groups; 1-5 mm, 6-10 mm, & 11-15 mm, & above 15 mm.

Maximum subjects were having 11-15 mm lateral lip mobility, and at this mobility, the mean number of maxillary teeth displayed was 10.19, and the range of the number of teeth displayed was 6-10. Means, maximum subjects were displaying either canine to canine, first premolar to first premolar, or second premolar to second premolar teeth.

Previous studies stated that, if any young subject with normal occlusion is having the first molar to first molar smile is considered as a more esthetically pleasing smile.^[36,37] In a sample of previous studies, it was found that only 3.7% of subjects were displaying the first molars while 57% of subjects were displaying the second premolars.^[19,36] Results of the present study following the results of previous studies by mean exposure of 10.19 teeth on lateral lip mobility during a smile.

The maximum mean number of teeth was displayed in straight (10.21teeth) followed by the bow (10.06 teeth), ellipse (10 teeth), and curve (9.63 teeth) smile zone shape. Clinical significance of the present study is that if the clinician is having through knowledge of the percentage exposure of maxillary anterior teeth and total number of maxillary teeth visibility in specific shape of smile zone within a given categories of superior and lateral lip mobility then anticipation and rehabilitation of the maxillary teeth in similar position can be done in a patient having the similar shape of the smile zone and lip mobility as predetermined.

Conclusion

The conclusions of this study are as follows:

1. The most common smile zone shape is bow followed by straight, curve, & ellipse. Bow and straight smile zone shape are more common in males while curve

and ellipse smile zone shape are more common in females.

2. Maximum subjects were having 1-5 mm superior lip mobility and 11-15 mm lateral lip mobility.
3. In females, mean lip mobility is more than the males both in superior and lateral direction.
4. maximum mean exposure of anterior teeth was seen in ellipse smile zone shape
5. significant difference was found in exposure of maxillary anterior teeth at 1-5 mm and 6-10 mm superior lip mobility in all four types of smile zone shapes
6. The maximum mean number of teeth displays in straight followed by the bow, ellipse, and curve smile zone shape.
7. Significant difference was seen in display of maxillary teeth in males and female at 1-5 mm, 6-10 mm, 11-15 mm, and above 15 mm lateral lip mobility in all shapes of the smile zone.

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