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Original Research Article

Evaluation of smile esthetics in adults with different overjets

Priyanka Choudhary[1,*], Payal Sharma[1], Piush Kumar[1], Shubhangi Jain[1]

[1]*Dept. of Orthodontics & Dentofacial Orthopedics, I.T.S Centre for Dental Studies and Research, Muradnagar, Ghaziabad, Uttar Pradesh, India*

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ABSTRACT

Aim: Our aim was to quantitatively assess the relationship of smile esthetics variables with various types of anterior overjet (OJ) malocclusion, and identify the cephalometric factors affecting smile measurements in different types of anterior overjet malocclusion.
Materials and Methods: 90 patients undergoing orthodontic treatment in the Department of Orthodontics were selected for this retrospective study based upon the inclusion criteria. The patients were divided into the following groups according to their OJ: Group 1 (0-4mm), Group 2 (>4mm), Group 3 (<0mm).
Results: The upper lip height, and inter-labial gap differed significantly among the groups, whereas arc ratio, tooth number, upper midline, buccal corridor, smile index, arch form index and lower tooth exposure did not significantly among the groups.
Conclusion: Some smile variables (upper lip height, inter-labial gap) differed significantly among different types of anterior overjet malocclusion. This study confirmed that the smile pattern varies between different types of malocclusion.

1. Introduction

One of the most essential expressions that contributes to facial attractiveness is the smile. And one of the most common reasons individuals seek orthodontic treatment is to improve the appearance of their smile. Understanding the elements of an aesthetically pleasing smile is critical for patient happiness and good treatment outcomes.[1]

The quantity of gingiva shown in the smile arc, as well as the color of the teeth, influence the aesthetics of a smile. A smile with little gingival display is thought to be more attractive than one with considerable gingival display. A smile with a curvature of the maxillary incisal edges (smile arc) that mirrors the curvature of the lower lip is thought to be more attractive than one with a flat maxillary incisal edge connection. A light shade of teeth, as well as the coincidence of the maxillary midlines with the face midlines, has been determined to be crucial. The presence or absence of buccal corridors is another potentially relevant smiling feature.[2–5]

Several studies on the aesthetics of smiles have been carried out. However, only a few clinical investigations have looked at the impact of various types of malocclusion on smile esthetics. As a result, the goal of this study was to quantify the association between smile esthetic features and various forms of anterior overjet (OJ) malocclusions, as well as to determine the cephalometric elements that influence smile measurements in various types of anterior overjet malocclusions.[6–8]

2. Materials and Methods

The study was conducted after the ethical approval of the institutional committee. 90 patients undergoing orthodontic treatment in the Department of Orthodontics were selected for this retrospective study based upon the following inclusion criteria (1) The patient's age at the time of treatment initiation was > 16 years. (2) An intact set of diagnostic pre-treatment records available, including study

* *Corresponding author*.
E-mail address: cpriyanka864@gmail.com (P. Choudhary).

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models, panoramic radiographs, lateral cephalograms and intra- and extra-oral photograph series. The patients were divided into the following groups according to their OJ: Group J1 (OJ, 0-4mm), Group J2 (OJ, >4mm), Group J3 (OJ, <0mm).

2.1. Cephalometric analysis

All lateral cephalograms were traced using Dolphin imaging software.[9,10]

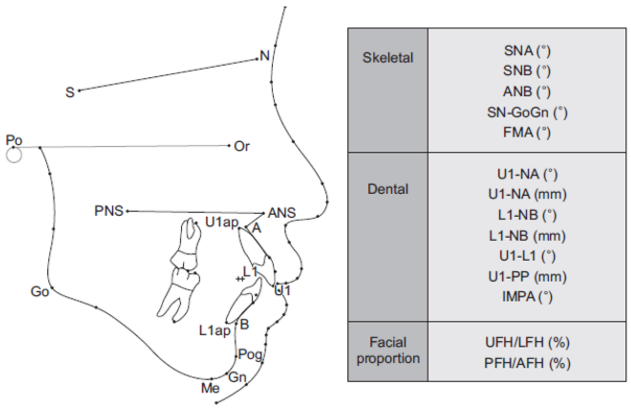

Fig. 1: Cephalometric landmarks and skeletal, dental, and soft tissue variables used in this study.

2.2. Smile analysis

On frontal smiling photographs, nine smile variables (Figure 2) were measured by one investigator using the linear measuring distizer method in Adobe Photoshop at nearest 0.1mm. All smile variables were evaluated as a ratio except for tooth number and the upper midline (Table 1).

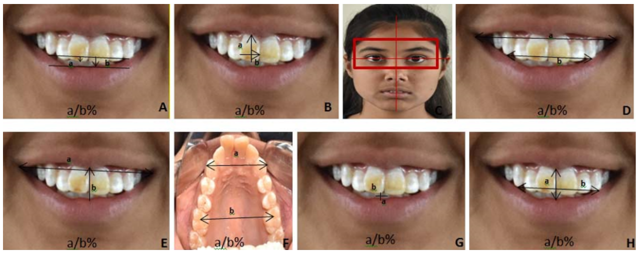

Fig. 2: Smile measurements. A, Arc ratio; B, upper lip height; C, upper midline; D, buccal corridor ratio; E, smile index; F,archform index; G, lower teeth exposure; and H, interlabial gap.

2.3. Statistical analysis

Statistical analyses were performed using SPSS software (version 16.0; IBM Corp., Armonk, NY, USA). The normality of data was tested by Shapiro Wilk's test and data was found to be skewed. Hence, to test the significance non-parametric tests were used. The significance of difference between the three study groups was tested by Krushkal Wallis tests followed by Mann- Whitney test for inter group comparisons. The level of significance and confidence intervals were 5% and 95% respectively.

Multiple linear regression analysis was performed to identify the cephalometric factors affecting smile measurements in different types of malocclusion.

Table 1: Definitions of smile esthetic variables used in this study.

Arc ratio	Perpendicular distance of the incisal edge of tooth 11 (FDI) to a line connecting the cusp tips of the maxillary canine / distance between a tangent line of upper border of the lower lip and the maxillary intercanine line.
Tooth number	Number of the exposed teeth in the maxilla.
Upper lip height	The shortest distance from the incised edge of tooth 11 to the lower border of the upper lip / mesio-distal width of tooth 11.
Upper midline	Amount of deviation of the maxillary dental midline to the facial midline.
Buccal corridor ratio	Intercommissure width / intercanine gap
Smile index	Intercommissure width / interlabial gap
Archform index	Intercanine width / intermolar width
Lower tooth exposure	Distance from the incisal edge of tooth 11 to upper border of the lower lip / mesio–distal width of 41
Interlabial gap	Interlabial gap / intercanine width

3. Results

hows the comparison of the cephalometric variables in the study groups using kruskal- wallis test. The test revealed that SNA(^{0}), SNB(^{0}), ANB(^{0}), SN-GoGn(^{0}), FMA(^{0}), L1-NB(mm), L1-NB(^{0}), U1LI(^{0}), U1PP(mm), IMPA(^{0}), OJ, OB differed significantly among the groups whereas U1-NA(mm), U1-NA(^{0}), UFH/LFH and PFH/AFH did not differ significantly among the groups. Table 3 shows the comparison of the smile variables in the study groups using Kruskal-Wallis test. The test revealed that the upper lip height, and inter-labial gap differed significantly among the groups, whereas arc ratio, tooth number, upper midline, buccal corridor, smile index, arch form index and lower tooth exposure did not significantly among the groups.

4. Discussion

Our goal in this work was to quantify the association between aesthetic smile characteristics and various forms of anterior overjet (OJ) malocclusions, as well as to discover the cephalometric parameters affecting smile measurements in various types of anterior OJ malocclusions. The

Table 2: Comparison ofcephalometric variables between different types of anterior overjet malocclusion using Kruskal Wallis test.

Variable	Group	N	Mean Rank	p-value
SNA(^{0})	1	30	50.07	
	2	30	57.62	
	3	30	28.82	
	Total	90		.000***
SNB(^{0})	1	30	40.07	
	2	30	24.52	
	3	30	71.22	
	Total	90		.000***
ANB(^{0})	1	30	30.58	
	2	30	75.40	
	3	30	30.52	
	Total	90		.000***
SN-GoGn(^{0})	1	30	49.33	
	2	30	57.35	
	3	30	29.82	
	Total	90		.000***
FMA(^{0})	1	30	51.73	
	2	30	52.15	
	3	30	32.62	
	Total	90		.000***
U1-NA(mm)	1	30	41.33	
	2	30	54.23	
	3	30	40.93	
	Total	90		.076^{NS}
UI-NA(^{0})	1	30	39.03	
	2	30	51.70	
	3	30	45.77	
	Total	90		.170^{NS}
LI-NB(mm)	1	30	50.13	
	2	30	50.72	
	3	30	35.65	
	Total	90		.038*
LI-NB(^{0})	1	30	54.48	
	2	30	50.12	
	3	30	31.90	
	Total	90		.002**
U1-L1(^{0})	1	30	39.58	
	2	30	32.50	
	3	30	64.42	
	Total	90		.000***
UI-PP(mm)	1	30	19.32	
	2	30	43.85	
	3	30	73.33	
	Total	90		.000***
IMPA(^{0})	1	30	57.33	
	2	30	54.78	
	3	30	24.38	
	Total	90		.000***
OJ	1	30	42.42	
	2	30	75.10	
	3	30	18.98	
	Total	90		.000***
	1	30	47.48	
	2	30	63.65	
	3	30	25.37	
	Total	90		.000***

Table 3: Comparison ofsmile variables in the study groups using Kruskal Wallis test.

Variable	Group	N	Mean Rank	p-value
Arch Ratio	1	30	49.37	.178^{NS}
	2	30	38.28	
	3	30	48.85	
	Total	90		
Tooth Number	1	30	40.42	.291^{NS}
	2	30	45.68	
	3	30	50.40	
	Total	90		
Upper Lip Height	1	30	54.37	.000***
	2	30	54.03	
	3	30	28.10	
	Total	90		
Upper Midline	1	30	46.97	.100^{NS}
	2	30	49.98	
	3	30	39.55	
	Total	90		
Buccal Corridor Ratio	1	30	47.93	.819^{NS}
	2	30	44.57	
	3	30	44.00	
	Total	90		
Smile Index	1	30	39.97	.183^{NS}
	2	30	52.22	
	3	30	44.32	
	Total	90		
Archform Index	1	30	47.52	0.79^{NS}
	2	30	51.87	
	3	30	37.12	
	Total	90		
Loweer Tooth Exposure	1	30	46.47	.832^{NS}
	2	30	46.78	
	3	30	43.25	
	Total	90		
Interlabial Gap	1	30	54.53	.001**
	2	30	51.12	
	3	30	30.85	
	Total	90		

relationship between the maxillary and mandibular skeletons, the height and length of the upper lip, age, race, and gender are all factors that influence smile.[11] Smiles may be influenced by skeletal pattern, dental procumbency, or face form, according to Cheng and Cheng.[12]

Because the posed smile is reproducible and can be generated on demand, it is frequently employed when analyzing face esthetics and smiling characteristics.[13–15] As a result, smile characteristics were measured using frontal pictures of a posed smile. The use of a frontal facial image for analysis in this study had the benefit of being easy and inexpensive.

Subjective and objective evaluations of smile esthetics have always been used. Subjective assessment is a way of evaluating smiles that involves evaluators. Ordinal and interval scales are commonly used to examine esthetic preferences since they represent an ordered order of judgment from least to most desired.[16,17]

Subjective evaluation has the disadvantage that aesthetic perception differs from person to person and is impacted by personal experiences and social settings. Many esthetic concepts about the face and smile are based on the opinions of authors rather than scientific evidence. Each smiling variable was defined as a ratio (a/b percent) that was utilized to reduce errors and boost reliability.[12]

The cephalometric variables (Table 2) revealed that the sagittal skeletal relationship was significantly different in the study groups. The position of the maxilla was significantly different between Groups 1 and 3 and Groups 2 and 3. The maxilla was retrognathic in Group 3 (mean±SD= 79.9±2.0). The mandibular position differed significantly between Groups 1, 2, and 3 with Group 3 showing the maximum value of SNB(^{0}). ANB(^{0}) differed significantly between Groups 1 and 2 and also between Groups 2

Table 4: Comparison ofcephalometric variables using Mann- Whitney for inter- group comparison

Variable	p-value 1 vs 2	p-value 1 vs 3	p-value 2 Vs 3
SNA(^{0})	.335^{NS}	.003**	.000***
SNB(^{0})	.002**	.000***	.000***
ANB(^{0})	.000***	.961^{NS}	.000***
SN-GoGn(^{0})	.137^{NS}	.001***	.000***
FMA(^{0})	.744^{NS}	.002**	.008**
U1-NA(mm)	.092^{NS}	.858^{NS}	.024*
UI-NA(^{0})	.070^{NS}	.289^{NS}	.347^{NS}
L1-NB(mm)	.887^{NS}	.027*	.028*
L1-NB(^{0})	.564^{NS}	.001***	.009**
U1-L1(^{0})	.321^{NS}	.000***	.000***
U1-PP(mm)	.000***	.000***	.000***
IMPA(^{0})	.594^{NS}	.000***	.000***
OJ	.000***	.000***	.000***
OB	.007**	.000***	.000***
UFH/LFH	.433^{NS}	.173^{NS}	.018***
PFH/AFH	.988^{NS}	.296^{NS}	.181^{NS}

(b): Comparison of smile variables using Mann- Whitney for inter- group comparison

Variable	p-value 1 vs 2	p-value 1 vs 3	p-value 2 vs 3
Arc ratio	.111^{NS}	.900^{NS}	.107^{NS}
Tooth number	.435^{NS}	.105^{NS}	.492^{NS}
Upper lip height	.912^{NS}	.000***	.000***
Upper midline	.590^{NS}	.107^{NS}	.031*
Buccal corridor ratio	.673^{NS}	.509^{NS}	.994^{NS}
Smile index	.042*	.673^{NS}	.344^{NS}
Archform index	.453^{NS}	.100^{NS}	.037*
Lower tooth exposure	.981^{NS}	.671^{NS}	.535^{NS}
Inter-labial gap	.401^{NS}	.001***	. .001***

Table 5: Cephalometric measurements correlated with Upper lip height in Group 1

Upper lip height	B	Standard error	p-value
SNA(^{0})	-0.82	0.22	.003**
SNB(^{0})	0.81	0.22	.003**
ANB(^{0})	0.83	0.24	.004**
FMA(^{0})	0.03	0.01	.043*
L1-NB(mm)	0.07	0.03	.016*

(b): Cephalometric measurements correlated with buccal corridor ratio in Group 1

Buccal corridor ratio	B	Standard error	p-value
PFH/AFH	-0.01	0.01	.040*

(c): Cephalometric measurements correlated with Archform index in Group 1

Archform index	B	Standard error	p-value
U1-L1(^{0})	0.01	0.00	.015*

(d): Cephalometric measurements correlated with Inter-labial gap in Group 1

Inter-labial gap	B	Standard error	p-value
SNA(^{0})	-0.17	0.08	.049*
ANB(^{0})	0.22	0.08	.021*
L1-NB(^{0})	-0.01	0.03	.012*

Table 6: Cephalometric measurements correlated with upper lip height in Group 2

Upper lip Height	B	Standard error	p-value
SNA(^{0})	0.36	0.12	.012*
SNB(^{0})	0.35	0.13	.017*
ANB(^{0})	-0.21	0.09	.039*
U1-L1(^{0})	-0.05	0.02	.015*
PFH/AFH	-0.03	0.01	.021*
(b): Cephalometric measurements correlated with upper midline in Group 2			
Upper midline	**B**	**Standard error**	**p-value**
SNA(^{0})	0.01	0.03	.006**
SNB(^{0})	-0.10	0.03	.006**
PFH/AFH	-0.01	0.00	.023*
(c): Cephalometric measurements correlated with lower tooth exposure in Group 2			
Lower tooth exposure	**B**	**Standard error**	**p-value**
SN-GoGn(^{0})	0.05	0.02	.013*
U1-NA(^{0})	0.08	0.03	.008**
U1-L1(^{0})	0.07	0.02	.005**
IMPA(^{0})	0.05	0.02	.014*
OB	-0.29	0.11	.018*
PFH/AFH	0.04	0.01	.011*

Table 7: Cephalometric measurements correlated with Arc ratio in Group 3

Arc ratio	B	Standard ratio	p-value
U1-PP (mm)	0.38	0.10	.002**
OJ	-0.15	0.07	.046*
(b): Cephalometric measurements correlated with upper midline in Group 3			
Upper midline	**B**	**Standard ratio**	**p-value**
OB	0.11	0.04	.017*
(c): Cephalometric measurements correlated with buccal corridor ratio in group 3			
Buccal corridor ratio	**B**	**Standard ratio**	**p-value**
U1-PP(mm)	-0.18	0.06	.012*
(d): Cephalometric measurements correlated with Archform index in Group 3			
Archform index	**B**	**Standard ratio**	**p-value**
U1-L1(^{0})	0.01	0.01	.023*
(e). Cephalometric measurements correlated with Inter-labial gap in Group 3			
Inter-labial gap	**B**	**Standard ratio**	**p-value**
U1-PP(mm)	-0.05	0.02	.034*
IMPA(^{0})	-0.01	0.00	.027*

and 3. The cephalometric measurements indicated that the patients in Group 2 had a skeletal Class II relationship and mandibular retrognathism as well as a high mandibular plane angle. The upper incisor measurements indicated that they were proclined but their position did not differ significantly among the groups. The lower incisors were also proclined and their position was significantly different between Groups 1 and 3 and Groups 2 and 3. The vertical position of the upper incisors differed significantly in all the groups. Group 3 showed the least overjet and overbite compared to the other groups.

The results of smile analysis (Table 3) results showed that different types of malocclusion prohibited different types of smiles. Regarding the malocclusion in Group 1, according to multiple linear regression analysis (Table 5 a-d), the upper lip height was significantly influenced by five of the cephalometric factors: SNA(^{0}), SNB(^{0}), ANB(^{0}), FMA(^{0}) and distance of the lower incisors from NB. The buccal corridor ratio was significantly influenced by the ratio of posterior face height to anterior face height while the archform index was significantly influenced by the inter-incisal angle. Inter-labial gap was significantly influenced by SNA(^{0}), ANB(^{0}) and L1-NB(^{0}).

In Group 2 (Table 6 a-d), the upper lip height was positively correlated by SNA(^{0}), SNB(^{0}), ANB(^{0}), inter-incisal angle and the ratio of posterior to anterior face height. Upper midline was significantly influenced by SNA(^{0}), SNB(^{0}) and the posterior to anterior face height ratio. The exposure of lower tooth was positively correlated by the mandibular plane angle, upper incisor position, inter-incisal angle, lower incisor angulation, overbite and ratio of posterior to anterior face height.

In Group 3, (Table 7 a-e), arc ratio was positively correlated with U1-PP (mm) and negatively correlated with overjet. The upper midline was positively correlated with overbite; Archform index was positively correlated with UI-L1(^{0}). The inter-labial gap was negatively correlated with UI-PP(mm) and IMPA(^{0}).

Smile analysis is a challenging and time-consuming task. However, photos cannot capture the dynamic quality of a smile. Furthermore, numerous aspects may be difficult to see in frontal smile images. On frontal smile images, the problem of an overly positive or negative OJ is less noticeable than in oblique and lateral smile photographs. Different views of smiling images may need to be examined in the future to ensure a complete smile.

Our findings revealed no direct link between overjet and smile characteristics. Cheng and Cheng 17, on the other hand, conducted a similar study in the Korean population and discovered that the horizontal disparity of anterior teeth (OJ) may be the most important factor determining smile style in various types of malocclusion. The disparities in results could be attributed to the two populations being researched, as well as differences in skeletal, dental, and smile variances between the two groups.

This study confirmed that the smile pattern varies between different types of malocclusion. Orthodontists must take into account the smile esthetics during diagnosis, treatment planning, and treatment mechanisms before orthodontic treatment. Further research is required to investigate smile features and advance the knowledge in this field.

5. Conclusions

The following conclusions were drawn from the study.

1. In this study, some smile variables (upper lip height, inter-labial gap) differed significantly among different types of anterior overjet malocclusion.
2. This study confirmed that the smile pattern varies between different types of malocclusion.
3. In this study, we could not find a direct association between overjet and smile variables.
4. Some of the smile characteristics were related to cephalometric measurements in different types of anterior OJ malocclusion.

6. Source of Funding

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7. Conflicts of Interest

There are no conflicts of interest.

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Author biography

Priyanka Choudhary, Post Graduate Student

Payal Sharma, HOD

Piush Kumar, Professor

Shubhangi Jain, Senior Lecturer

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