Original Article

A correlative study to evaluate the effect of various skeletal and dentoalveolar parameters on smile esthetics in different malocclusion groups

ABSTRACT

Introduction: The smile is one of the most effective means by which people convey their emotions and from a social standpoint, it is viewed frontally more often than in profile. Smiles can be either posed or spontaneous. Peck and Peck classified smiles as Stages I and II, and Ackerman *et al.* classified smiles into two basic types: the social smile and the enjoyment smile. Each type involves a different anatomic presentation of the elements of the display zone. Smile characteristics are determined by the interplay of static and dynamic relationships between the dentoskeletal and soft-tissue components of the face. Hence, a study was planned to understand the influence of various skeletal and dentoalveolar parameters on smile esthetics in different malocclusion groups.

Materials and Methods: Sixty subjects in the age range of 17–25 years were selected and skeletally divided into Groups I and II on the basis of beta angle, ANB angle, and Wits appraisal. Group II was further subdivided into two groups on the basis of Angle's classification of the malocclusion. Various skeletal and dental parameters were measured on cephalogram and smile measurements were made on facial photographs in Adobe Photoshop. Various statistical tests were applied for assessment and comparison of various skeletal and dentoalveolar parameters and their correlation with smile esthetics were in different malocclusion groups.

Results: Upper lip length was maximum in Class II div 2 malocclusion patients and least in Class I malocclusion patients. It was maximum in horizontal growth pattern patients. It decreased with the increase in proclination of upper incisors. Maxillary incisal display at rest and smile was maximum in Class II div 1 malocclusion patients and least in Class II div 2 malocclusion patients. It was maximum in vertical growth pattern individuals. It increased with the increase in proclination of upper incisors. A similar tendency was shown by the Morley ratio and modified smile. Lip competency was maximum in Class II div 2 patients and minimum in Class II div 1 patients. It was maximum in horizontal growth pattern patients. Proclination of the incisors decreased the lip competency.

Conclusions: Different skeletal patterns exhibit their characteristic smile features. Orthodontic treatment should be planned considering the correlation of skeletal and dental effects on smile esthetics.

Keywords: Angle's classification of malocclusion, skeletal and dentoalveolar parameters, smile esthetics

INTRODUCTION

Smile is an expression, used to convey a sense of compassion and understanding. It is the cornerstone of social interaction.[1] The "art of smile" lies in the clinician's ability to recognize and enhance the positive elements of beauty in each patient. Smiles can be either posed or spontaneous.[2] Peck and Peck[3] classified smiles as stages I and II. Ackerman *et al*.[4] classified smiles into two basic types: the social smile

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and the enjoyment smile. Each type involves a different anatomic presentation of the elements of the display zone. In the anatomy of smile, the upper and lower lips frame the display zone of the smile. Both skeletal and dental relationships contribute to smile components. Smile style is another soft-tissue determinant of the dynamic display zone. There are three smile styles: the cuspid smile, the complex smile, and the commissural smile.[5] An individual's smile depends on the direction of elevation and depression of the lips and the predominant muscle groups involved.[6] Smile characteristics are determined by the interplay of static and dynamic relationships between the dentoskeletal and soft-tissue components of the face. Hence, the present study was planned to evaluate the influence of various skeletal and dentoalveolar parameters on smile esthetics in different malocclusion groups.

MATERIALS AND METHODS

Study type and study site

The present retrospective, cross-sectional, analytic study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Swami Devi Dyal Hospital and Dental College, Barwala, District Panchkula, Haryana. The sample for the present study consisted of 60 young adults within the age range of 17–25 years. The sample was scrutinized from patients coming to the outpatient department of the department of orthodontics. Selected individuals ranged in 17–25 years with no previous history of orthodontic treatment, significant skeletal asymmetry, anterior or posterior crossbite, missing or malformed teeth, any maxillofacial surgery, or anterior maxillary prosthodontic rehabilitation. The study was approved by the institutional ethical committee, and informed consent was obtained from all participants.

The subjects were skeletally divided into two groups on the basis of sagittal cephalometric parameters, namely Beta angle, ANB angle, and Wits appraisal. The division of subjects into Group I and Group II was done on the basis of satisfying at least any two of the three previously mentioned parameters. There were a total number of 20 subjects in Group I and 40 subjects in Group II [Table 1].

Group II (40 subjects) was further subdivided dentally into two groups on the basis of Angle's classification of malocclusion into Group IIa (Angle's Class II div 1 malocclusion) and Group IIb (Angle's Class II div 2 malocclusions) [Table 2].

Four facial photographs were recorded, compared, and analyzed including full-face photograph at rest, close-up photograph at rest, close-up smiling photograph, and frontal occlusal photograph. The photographic setup customized for the present study was a tripod stand [Figure 1]. All photographs were captured with DSLR (CANON 1300D [W]) camera from a standard distance of 24" for full face and 12" for close-up photographs to obtain quantitative and qualitative data. To get a natural unstrained social smile position, each subject was requested to present their full smile a few times and the image was captured when the subject successfully repeated the full smile pattern. The photographic setup customized for the present study was a tripod stand.

The close-up photographs were cropped to eliminate most of the nose and cheeks in order to minimize the influence of background attractiveness. For calibration, the digital photographs were imported into a commercially available photo editing program (Adobe Photoshop, version 7.0) and were accurately calibrated before recording any measurement. Horizontal and vertical grid lines were used for all measurements. The grid lines were placed on defined hard- and soft-tissue landmarks. The following parameters of smile esthetics were evaluated [Table 3 and Figures 2-4]. All measurements were recorded to the nearest of 0.5 mm.

The lateral cephalograms in occlusion for the study subjects were obtained in a natural head position and were traced manually on acetate tracing sheet with a sharp 3H pencil on a view box. The various hard and soft tissues cephalometric landmarks were identified and marked. The hard-tissue

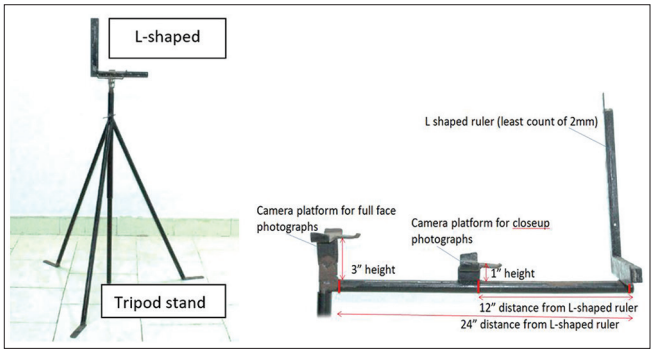


Figure 1: Photographic setup

Table 1: Distribution of the study group

Group	Malocclusion	β angle (°)	ANB angle (°)	Wits appraisal (mm)	Number of subjects
Group I	Skeletal class I	27-35	0-4	−2.65±3.43	20
Group II	Skeletal class II	<25	≥4	>0.78	40

Table 2: Distribution of study Group II

Group	Malocclusion	Number of subjects
Group IIa	Angle's Class II div 1 malocclusion	20
Group IIb	Angle's Class II div 2 malocclusion	20

landmarks and linear and angular measurements were marked on the cephalograms. For the measurements of linear distances, scale to the nearest of 0.5 mm and angles to the nearest of 0.5° were used. Following landmarks and measurements were used: [Table 4 and Figures 5-8].

The data obtained were analyzed with conventional, descriptive statistics. All the analyses were performed with commercial statistical software Statistical Package for the Social Sciences version 17.0 (IBM (International Business Machines) Armonk, New York, America). Data were summarized as mean (standard deviation). Groups were compared by one-way analysis of variance, and the significance of the mean difference between (inter) groups was done by Tukey's *post hoc* test. Categorical groups were compared by the Chi-square test. Correlations between various smile parameters and various skeletal and dentoalveolar parameters were done by Pearson correlation and further analyzed by multiple regression analysis. $P < 0.05$ was considered statistically significant.

RESULTS

Assessment and comparison of various skeletal and dentoalveolar parameters in different malocclusion groups showed statistically significant differences in basal plane angle (Pal-MP),1-Palatal plane angle (1-Pal plane), and Interincisal angle (∟ii) [Graph 1].

Assessment and comparison of parametric smile characteristics in different malocclusion groups showed statistically significant differences in upper lip length, maxillary incisal display at rest, Morley ratio, maxillary incisal display at smile, and modified smile index [Graph 2].

Assessment and comparison of Nonparametric (subjective) characterstics, i.e., facial index, lip competency, smile arc, smile style and smile pattern in different malocclusion, only lip competency showed statistically significant differences [Graph 3].

Smile parameters are compared with skeletal and dentoalveolar parameters in Group I subjects, statistically significant positive correlation of upper lip length, maxillary incisal display at rest, Morley ratio, modified smile index was found [Tables 5 and 6].

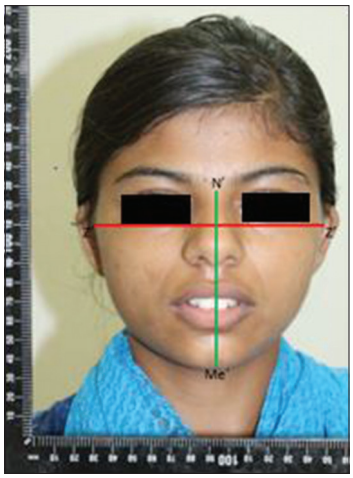


Figure 2: Facial index

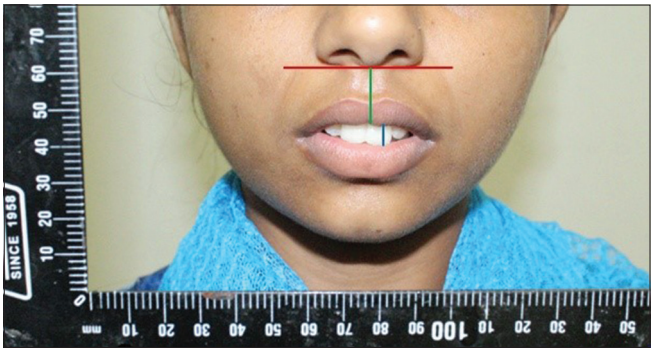
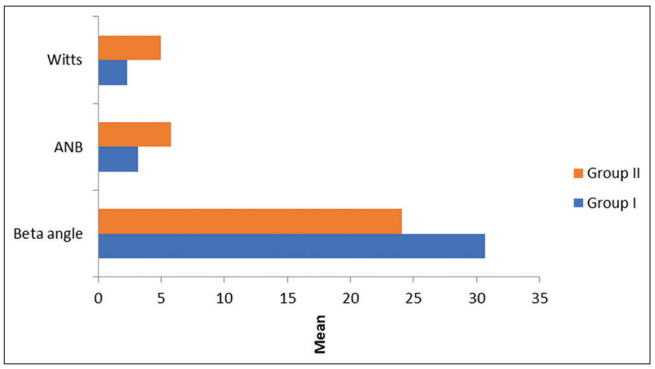


Figure 3: Upper lip length and maxillary incisal display at rest

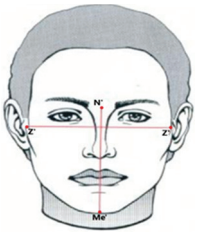
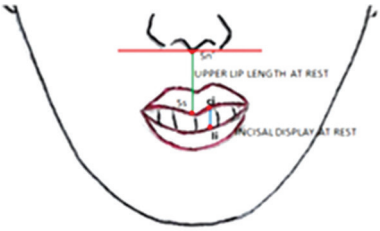
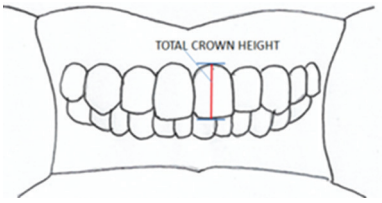
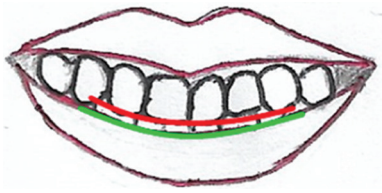
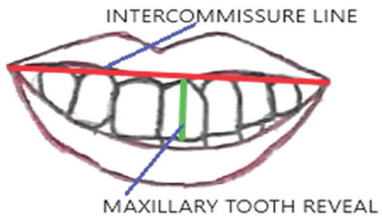


Graph 1: Comparison of beta angle, ANB angle, and Wits appraisal between the study groups

Comparison of smile parameters with skeletal and dentoalveolar parameters in Group IIa subjects showed statistically significant positive correlation of upper lip length, maxillary incisal display at rest and maxillary incisal display at smile [Tables 7 and 8].

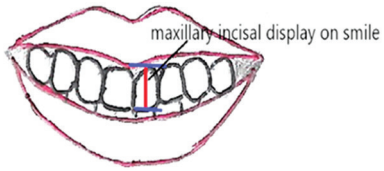
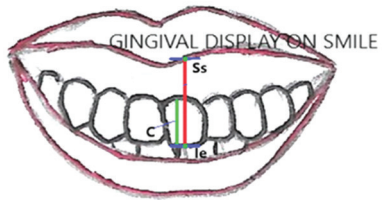
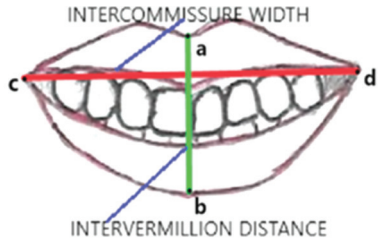
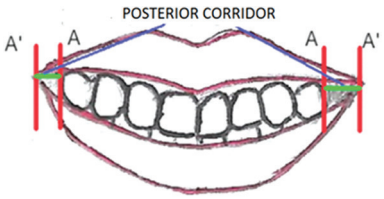
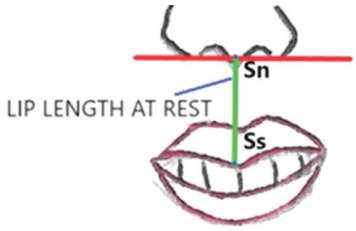
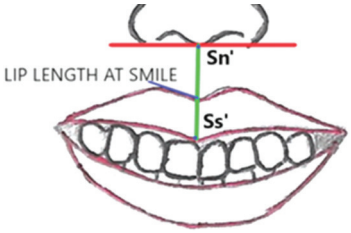
Comparison of smile parameters with skeletal and dentoalveolar parameters in Group IIb subjects showed statistically significant positive correlation of upper lip length, maxillary incisal display at rest, gingival display at smile and modified smile index [Tables 9 and 10].

Table 3: Smile parameters

(a) Measurement on full-face frontal facial photograph with lips at rest		
	Facial index (N'-Me'/ Zy'-Zy')	It is defined as the ratio of the length of face to its maximal width between the zygomatic prominences
(b) Measurements on close-up photograph of the lower third of the face with lips at rest		
	Upper lip length	It is measured in millimeters from subspinale (Sn') to the most inferior portion of the upper lip (stomiumsuperioris - Ss)
	Maxillary incisor display at rest	The vertical measurement from the most cervical (Ci) to the most incisal portion of left central incisor visible at rest (Ii)
	Lip competency	Lip competency is classified as competent lips, incompetent lips, and potentially competent lips
(c) Measurements on close-up frontal facial photograph with teeth in maximum occlusion		
	Total crown height	It is measured from the most gingival to the most incisal portion of the crown of the left central incisor
(d) Measurements on close-up frontal smiling photographs of the lower third of the face		
	Smile arc	Relationship of the curvature of the incisal edges of the maxillary incisors and canines to the curvature of the lower lip in the posed social smile. Qualitatively smile arc is classified as consonant and nonconsonant smile arc
	Smile style	According to Rubin's classification; smile style is classified into cuspid smile style, commissure smile style, and complex smile style
	Smile pattern	It is the maxillary anterior tooth crown exposure at maximum smile, i.e., classified as average smile line, high smile line, and low smile line
	Morley ratio	It is the height of maxillary anterior tooth revealed below the ICL in percentage

Contd...

Table 3: Contd...

(d) Measurements on close-up frontal smiling photographs of the lower third of the face		
	Maxillary incisal display on smiling	It is the vertical measurement of the left central incisor which is visible on smiling. It is measured from the most cervical portion of the tooth crown to the incisal edge of the same tooth visible on smiling
	Gingival display on smiling	It is the vertical measurement in mm from the most inferior point of the upper lip (Ss) to the incisal edge of the incisor (Ie) subtracted by the visible crown height (C) in mm
	Modified smile index	The ratio of the intervermilion distance at the midline to the intercommissural distance in percentage
	Posterior corridor	It is the horizontal distance from the distal aspect of the most posterior tooth visible on the smile to the outer commissure on the same side (right and left). The width of the posterior corridor of the left and right side is added and then divided by 2 to get the mean
	Change in lip length on smiling (percentage curtain raise)	It is the change in upper lip length upon rest and smile divided by the upper lip length upon rest (in percentage)
		

ICL: Intercommissure line

DISCUSSION

Smile is a representation of the dynamic relationship of perioral soft tissue with underlying skeletal and dental components.[7] Different skeletal patterns have characteristic dentoskeletal features that affect smile.

The present study was undertaken to assess the relationship between different skeletal, dental, and soft-tissue structures and configuration of the smile in patients with various degrees and types of malocclusions in the anteroposterior and vertical dimensions. These results apply to the subjects before orthodontic treatment when possible problems of alignment were part of the overall evaluation of the smile characteristics. Knowledge of the correlation between the hard- and soft-tissue anatomy and smile esthetics can add important clinical meaning to orthodontic diagnosis and treatment planning.

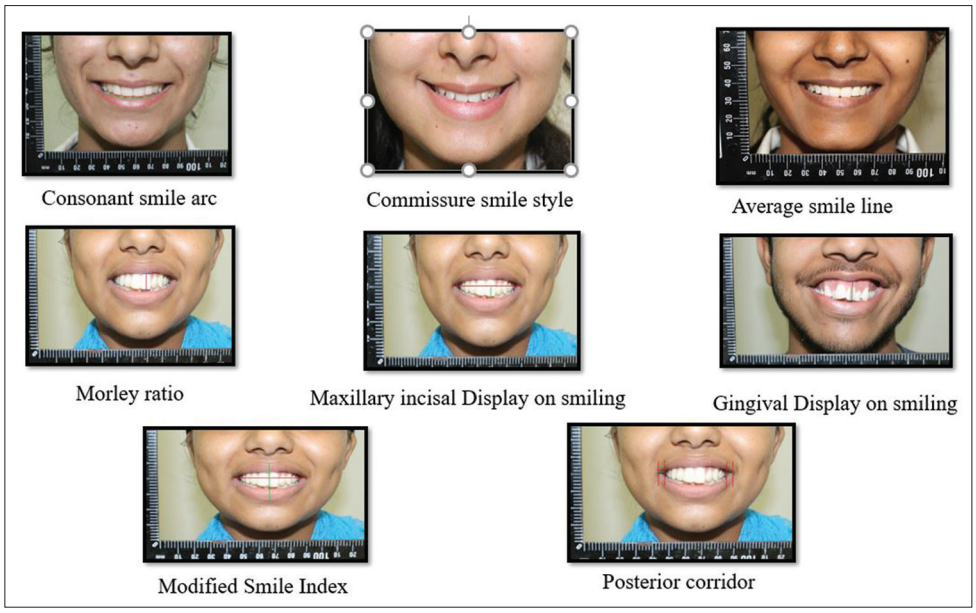


Figure 4: Smile parameters

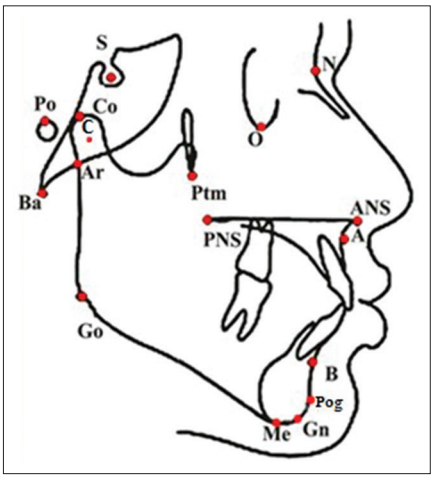


Figure 5: Hard-tissue cephalometric landmarks

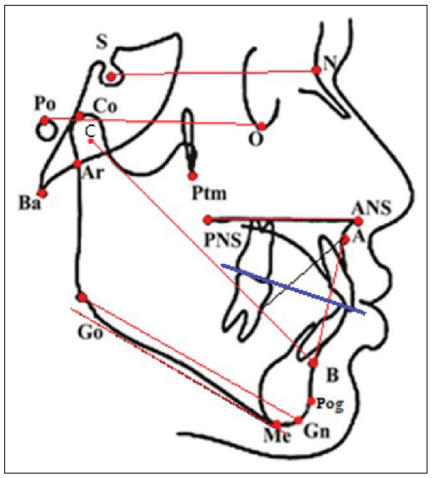


Figure 6: Cephalometric planes

Many studies have reported age-related variations[8] in smile characteristics. To eliminate the effect of these factors, we evaluated the smile dynamics of individuals aged between 17 and 25 years. We were not able to study sexual dimorphism in smile variables as the study sample size was small and unequal when divided further into gender basis.

The comparison of upper lip length between different malocclusion groups showed statistically significant differences. The maximum value of upper lip length was recorded in class II div 2 malocclusion subjects and least in class I malocclusion subjects. ULL is one of the important factors that determine the amount of maxillary incisal and gingival exposure during smiling and speech.[9,10] Short upper lip length has been considered a suspect in producing gingival smile lines, and controversial data exist in the literature regarding this. Although Peck and Peck[3] found no difference in upper lip length between the gingival smile group and reference groups, Miron *et al*.[11] observed short ULL in participants with high smile line. Our results were against the study by Al-Sabbagh[12] who showed that upper lip length at rest in Class I was higher compared with other groups and Graber *et al*.[13] who showed that Class II has a shorter upper lip than Class I subjects.

In the present study, the maxillary incisal display at rest and smile was found maximum in class II div 1 malocclusion subjects and least in class II div 2 malocclusion subjects. The comparison between different malocclusion groups showed high statistically significant differences. Maxillary

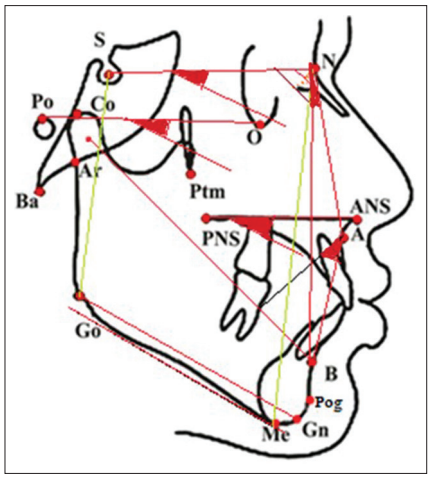


Figure 7: Skeletal parameters

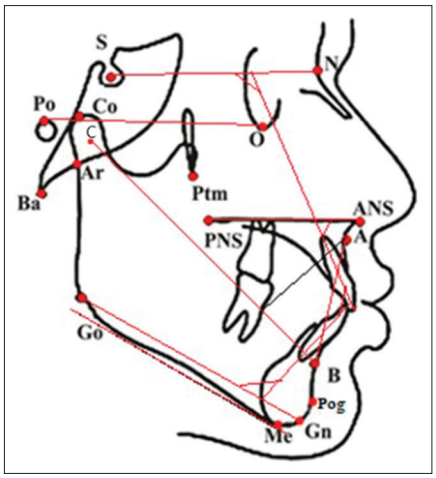
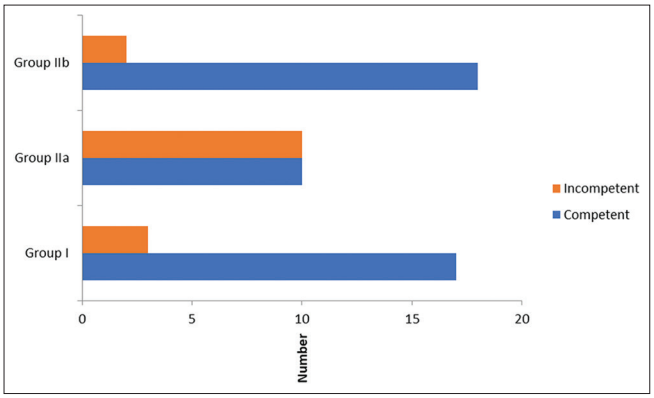
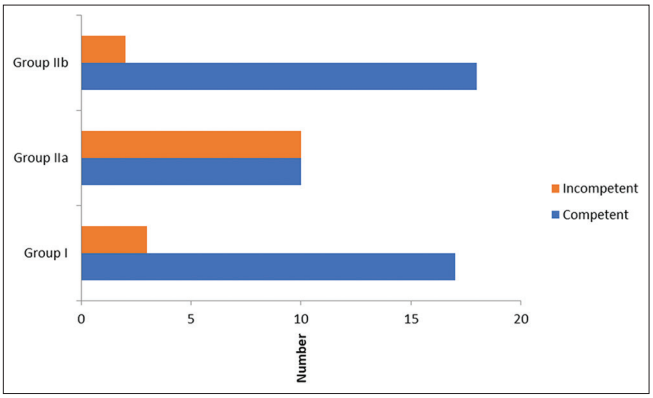


Figure 8: Dentoalveolar parameters



Graph 2: Comparison of parametric values of smile characteristics among the study groups



Graph 3: Comparison of lip competency among the study groups

incisal display during smile is affected by hard-tissue factors, such as vertical maxillary height and dental height, and soft-tissue factors, such as lip length and lip elevation.[11] In a study by Siddiqui *et al.*,[7] they showed a positive correlation of maxillary incisal display at smile with facial height and upper incisor to palatal plane angle. Therefore, it can be implied that increased incisal display during smile is a result of a combination of increased skeletal as well as increased maxillary dental height but more closely associated with the increased elevation of the upper lip in individuals with a horizontal skeletal pattern. Our findings are in contrary with the findings of Ackerman and Ackerman[6] who reported that incisor proclination dramatically affects incisor display. Flared maxillary incisors tend to reduce incisor display, whereas upright maxillary incisors tend to increase it.

Morley ratio was found maximum in Class II div 1 malocclusion subjects and least in class II div 2 malocclusion subjects. The comparison of the Morley ratio between different malocclusion groups showed high statistically significant differences. This finding can be correlated to the maximum incisal display in Class II div 1 and least in Class II div 2 malocclusion group subjects.

Modified smile index was recorded maximum in class II div 1 malocclusion subjects and least in class II div 2 malocclusion subjects. The comparison of the modified smile index between different malocclusion groups showed high statistically significant differences. This can be related to increased maxillary incisal exposure at smile in Class II div 1 patients as compared to Class II div 2 patients.

Assessment and comparison of the posterior corridor in different malocclusion groups revealed no statistically significant differences, but it was maximum in Class II div 1 and least in Class I malocclusion subjects. This can be attributed to narrow v-shaped arches in Class II div 1 malocclusion subjects. According to Sarver and Ackerman,[14] a patient with a retrusive maxilla can have large buccal corridors. Although the maxilla may be of normal width, the buccal corridors might be more prominent because the wider portion of the arch is placed more posteriorly. Transverse smile dimension, therefore, is a function of both arch width and anteroposterior position of the maxillary and mandibular arches.

In the present study, the assessment and comparison of change in the upper lip length on smiling in different malocclusion groups was maximum in Class II div 2 and minimum in Class II div 1 malocclusion. Islam *et al*.[15] found that the upward movement of the upper lip in Class II div 1 subjects was smaller in comparison with the Class I subjects.

Table 4: Cephalometric parameters

Sella (S)
Nasion (N)
Articulare (Ar)
Pterygomaxillary fissure (Ptm)
Subspinale (point A)
Pogonion (Pog)
Supramentale (point B)
ANS
Menton (Me)
Gnathion (Gn)
Gonion (Go)
PNS
Center of condyle (C)
S-N plane
FH plane
C-B Line
A-B Line
MP
Tweed's mandibular plane
Palatal plane
Occlusal plane
SNA angle
SNB angle
ANB ANGLE
WITS appraisal
Beta angle
Mandibular plane angle (SN-GoGn)
Jarabak ratio (J-ratio=S-Go/N-Me)
Basal plane angle
Upper Incisor to SN Plane (1-SN)
IMPA
Interincisal angle

ANS: Anterior nasal spine, IMPA: Incisor mandibular plane angle, S-N plane: Sella-Nasion plane, PNS: Posterior nasal spine, MP: Mandibular plane, FH plane: Frankfurt horizontal plane

Change in the upper lip length is primarily a function of the activity of upper lip musculature. A positive correlation was found between the upper lip length and the change in upper lip length on smiling, which implies that the longer the upper lip the more it elevates during smile. The same observation was also made by Miron *et al*.[12] who found the positive correlation between the lip length and lip elevation.

The maximum subjects with competent lips were recorded in class II div 2 subjects and least in class II div 1 subjects. The difference between the different malocclusion groups was statistically significant. This can be attributed to the fact that the incisors are retroclined in Class II div 2 patients, so the tendency for competent lips is more. Moreover, these group patients have a maximum upper lip length. The flaring of maxillary incisors decreases the ability of the lips to close. Furthermore, a shorter upper lip contributes to lip incompetency.

A maximum number of subjects with consonant smile arc were in Class II div 1 and minimum in Class I malocclusion which can be attributed to increasing the cant of the maxillary occlusal plane. The differences in smile arc between different malocclusion groups were not statistically significant, which is consistent with the findings by Kakadiya *et al*.[16]

Although there are millions of different smiles, three basic smile styles can be identified, i.e., commissural, cuspid, and complex smile styles. The commissural smile style is the most acceptable socially. Assessment and comparison of smile styles in different malocclusion groups revealed no statistically significant differences. The maximum value of commissural smile style was found in Class II div 2 subjects, the maximum value of complex smile style was found in Class I malocclusion subjects, and the maximum value of cuspid smile style was found in Class II div 1 subjects. This can be attributed to the respective activation of the different muscle groups in different smiles.

Table 5: Pearson correlation between smile parameters and various skeletal parameters (Group I subjects)

Parameters	SN-MP		J-ratio		Basal plane angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	−0.57	0.009*	0.19	0.41	−0.69	0.001*
Maxillary incisal display at rest	0.46	0.04*	−0.17	0.46	0.48	0.03*
Maxillary incisal display at smile	0.29	0.22	0.07	0.78	0.41	0.07
Morley ratio	0.22	0.35	0.03	0.90	0.41	0.03*
Gingival display at smile	−0.04	0.86	0.10	0.68	0.19	0.42
Modified smile index	0.47	0.04*	0.11	0.66	0.68	0.001*
Posterior corridor	−0.28	0.23	0.01	0.98	−0.08	0.74
Change in upper lip length on smiling	−0.49	0.03*	0.53	0.02*	−0.23	0.33

*Statistically significant. SN: Sella Nasion, MP: Mandibular plane

Table 6: Pearson correlation between smile parameters and various dentoalveolar parameters (Group I subjects)

Parameters	1-pal plane		IMPA		Interincisal angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	0.76	<0.01*	−0.50	0.03*	0.18	0.45
Maxillary incisal display at rest	−0.38	0.09	0.40	0.08	−0.17	0.48
Maxillary incisal display at smile	−0.38	0.09	0.07	0.76	−0.44	0.06
Morley ratio	−0.43	0.06	0.38	0.10	−0.41	0.07
Gingival display at smile	0.17	0.49	−0.06	0.79	−0.12	0.61
Modified smile index	−0.46	0.04*	0.16	0.49	−0.26	0.27
Posterior corridor	−0.04	0.85	−0.08	0.74	0.07	0.76
Change in upper lip length on smiling	0.15	0.53	0.07	0.78	0.29	0.20

*Statistically significant. IMPA: Incisor mandibular plane angle

Table 7: Pearson correlation between smile parameters and various skeletal parameters in Group IIa subjects

Parameters	SN-MP		J-ratio		Basal plane angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	−0.01	0.98	0.11	0.64	−0.05	0.83
Maxillary incisal display at rest	0.38	0.09	−0.46	0.04*	0.39	0.08
Maxillary incisal display at smile	0.46	0.04*	−0.49	0.03*	0.49	0.03*
Morley ratio	0.28	0.23	−0.29	0.22	0.37	0.11
Gingival display at smile	0.29	0.21	−0.03	0.90	0.31	0.19
Modified smile index	0.08	0.73	−0.04	0.88	0.03	0.91
Posterior corridor	0.16	0.50	−0.025	0.92	0.28	0.23
Change in upper lip length on smiling	0.15	0.54	−0.06	0.82	0.12	0.61

*Statistically significant. SN: Sella Nasion, MP: Mandibular plane

Table 8: Pearson correlation between smile parameters and various dentoalveolar parameters in Group IIa subjects

Parameters	1-pal plane		IMPA		Interincisal angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	0.73	<0.01*	−0.15	0.54	0.25	0.29
Maxillary incisal display at rest	−0.34	0.14	−0.01	0.98	−0.23	0.32
Maxillary incisal display at smile	−0.03	0.91	−0.39	0.08	0.04	0.86
Morley ratio	−0.16	0.51	−0.38	0.10	−0.31	0.18
Gingival display at smile	0.24	0.30	0.02	0.95	−0.05	0.85
Modified smile index	0.25	0.29	0.13	0.59	−0.25	0.29
Posterior corridor	−0.03	0.90	−0.08	0.75	−0.33	0.16
Change in upper lip length on smiling	0.23	0.34	0.01	0.97	0.35	0.13

*Statistically significant. IMPA: Incisor mandibular plane angle

Table 9: Pearson correlation in smile parameters and various skeletal parameters Group IIb subjects

Parameters	SN-MP		J-ratio		Basal plane angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	−0.16	0.50	0.14	0.55	−0.26	0.28
Maxillary incisal display at rest	0.64	0.003*	−0.53	0.02*	0.49	0.03*
Maxillary incisal display at smile	0.29	0.22	−0.30	0.19	0.21	0.37
Morley ratio	0.25	0.28	−0.18	0.46	0.29	0.21
Gingival display at smile	0.49	0.03*	−0.39	0.09	0.32	0.17
Modified smile index	0.51	0.02*	−0.38	0.09	0.58	0.01*
Posterior corridor	0.11	0.63	−0.25	0.29	0.01	0.96
Change in upper lip length on smiling	−0.07	0.77	0.01	0.98	0.27	0.26

*Statistically significant. SN: Sella Nasion, MP: Mandibular plane

Smile pattern (lip line) is the height or position of the upper lip relative to the maxillary central incisors on smiling. It was bound to be a statistically insignificant difference between smile patterns in different malocclusion groups. A maximum number of patients presented with average smile line in all the malocclusion groups.

Table 10: Pearson correlation between smile parameters and various dentoalveolar parameters Group IIb subjects

Parameters	1-pal plane		IMPA		Interincisal angle	
	r	*P*	*r*	*P*	*r*	*P*
Upper lip length	0.30	0.19	−0.56	0.01*	0.09	0.71
Maxillary incisal display at rest	−0.02	0.93	0.25	0.29	−0.08	0.75
Maxillary incisal display at smile	0.15	0.54	−0.12	0.62	0.03	0.90
Morley ratio	0.08	0.74	0.13	0.58	−0.17	0.47
Gingival display at smile	0.17	0.49	0.11	0.66	−0.09	0.68
Modified smile index	0.16	0.50	0.22	0.46	−0.29	0.21
Posterior corridor	0.06	0.79	−0.17	0.48	0.01	0.97
Change in upper lip length on smiling	0.15	0.53	−0.26	0.28	−0.36	0.12

*Statistically significant. IMPA: Incisor mandibular plane angle

Smile analysis is a complex and difficult procedure. Dynamic alteration of smile is influenced by several factors. The advantage of using a frontal facial photograph for analysis in this study was simple and cost-effective. There was a difficulty in obtaining a natural smiling photograph. As patients with malocclusion hesitate in smiling. Several factors may not be visible in frontal smiling photographs. The problem of excessive positive or negative overjet is not as apparent in frontal smiling photographs.[17] In future, different views of smiling photographs have to be assessed to ensure a comprehensive smile analysis. Furthermore, the error is associated with the election of the appropriate still frame representing the posed smile.

Limitations of the study

Smile analysis is a complex and difficult procedure. Because a smile is not affixed feature, dynamic alteration may be influenced by several factors:

- The advantage of using a frontal facial photograph for analysis in this study was simple and cost-effective. This photographic record is usually available in orthodontic clinical practice. Evaluation of smile esthetics during facial animation using this method poses a major difficulty in precise capture of the repeatable and reliable image at one or multiple time points
- There was a difficulty in obtaining a natural smiling photograph. Because the patients did not have a well-aligned occlusion before orthodontic treatment, they might have felt shy in smiling.

SUMMARY AND CONCLUSIONS

1. Upper lip length was maximum in Class II div 2 malocclusion patients and least in Class I malocclusion patients. Upper lip length was maximum in horizontal growth pattern patients. It decreased with the increase in proclination of upper incisors
2. Maxillary incisal display at rest and smile was maximum in Class II div 1 malocclusion patients and least in Class II div 2 malocclusion patients. Maxillary incisal display at rest and smile was maximum in vertical growth pattern individuals. It increased with the increase in proclination of upper incisors
3. Morley ratio was maximum in Class II div 1 malocclusion subjects and least in Class II div 2 malocclusion patients. Morley ratio increased with the increase in vertical skeletal parameters. It increased with the increase in flaring of upper incisors
4. Modified Smile Index was maximum in Class II div 1 malocclusion patients and least in Class II div 2 malocclusion patients. Modified smile index increased with increase in vertical skeletal parameters. It increased with the increase in inclination of upper incisors
5. The posterior corridor was maximum in horizontal growth pattern patients and patients with posteriorly located maxilla in the sagittal plane
6. The change in upper lip length on smiling was maximum in subjects with the horizontal growth pattern
7. Lip competency was maximum in Class II div 2 patients and minimum in Class II div 1 patients. It was maximum in horizontal growth pattern patients. Proclination of the incisors decreased the lip competency
8. Flat smile arc was more common in horizontal growth pattern patients. Proclination of the incisors decreased the frequency of consonant smile arc
9. Commissural smile style is the most pleasant and was found maximum in Class II div 2 subjects
10. Average smile line is most acceptable and was present in maximum subjects.

Future scope of study

Further studies can demonstrate the effect of male and female differences in various skeletal and dentoalveolar parameters in smile esthetics which was not evaluated in our study because of less sample size.

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Conflicts of interest

There are no conflicts of interest.

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