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

[1]Dr Kanupriya, Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopaedics, Swami Devi Dyal Dental Hospital And College, Barwala, Panchkula

[2]Dr Shruti Mittal, MDS Orthodontics And Dentofacial Orthopaedics, Professor and Head Of The Department, Department Of Orthodontics And Dentofacial Orthopaedics, Swami Devi Dyal Dental Hospital And College, Barwala, Panchkula

[3]Dr Prerna Hoogan Teja, MDS Orthodontics And Dentofacial Orthopaedics, Reader, Department Of Orthodontics And Dentofacial Orthopaedics, Swami Devi Dyal Dental Hospital And College, Barwala, Panchkula

Corresponding Author: Dr Kanupriya, Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopaedics, Swami Devi Dyal Dental Hospital And College, Barwala, Panchkula

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Abstract

Objective: To evaluate and correlate the effect of various skeletal and dentoalveolar parameters on smile esthetics in different malocclusion groups. **Materials and Method:** 60 subjects in age range of 17 -25 years were selected and skeletally divided into group I and II on the basis of Beta angle, ANB angle and Wits appraisal. Group II was further subdivided into 2 groups on the basis of Angle's classification of 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. Similar tendency was shown by 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: skeletal and dentoalveolar parameters, smile esthetics, Angle's classification of malocclusion.

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 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.

Material And Methods

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 OPD 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 cross bite, 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 viz. Beta angle, ANB angle, and Wits appraisal. The division of subjects into Group I and Group II were done on the basis of satisfying at least any two of the three previously mentioned parameters. There were total number of 20 subjects in Group I and 40 subjects in Group II (**Table 1**).

Group II (40 subjects) were 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 malocclusion) (**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 natural unstrained social smile position, each subject was requested to present their full smile a few times and image was captured when subject successfully repeated the full smile pattern. The photographic setup customized for the present study was a tripod stand.

The closeup 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, Figure 2 - 4)**. All measurements were recorded to the nearest of 0.5mm.

The lateral cephalograms in occlusion for the study subjects were obtained in natural head position and were traced manually on acetate tracing sheet with sharp 3H pencil on a view box. The various hard and soft tissues cephalometric landmarks were identified and marked. The hard tissue landmarks, 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, Figure 5 – 8**).

The data obtained was analysed with conventional, descriptive statistics. All the analyses were performed with commercial statistical software SPSS (Statistical Package For The Social Sciences) version 17.0. Data were summarized as mean (standard deviation). Groups were compared by one-way analysis of variance, and the significance of mean difference between (inter) groups was done by Tukey's *post hoc* test. Categorical groups were compared by chi-square test. Correlations between various smile parameters and various skeletal and dentoalveolar parameters was done by Pearson correlation and further analyzed by Multiple regression analysis. *P* value less than .05 ($P < .05$) 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 non- parametric smile characteristics i.e. facial index, lip sscompetency, smile arc, smile style and smile pattern in different malocclusion, only lip competency showed statistically significant differences. (**Graph 3)**

Correlation of smile parameters with various 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. (**Table 5 and 6)**

Correlation of smile parameters with various skeletal and dentoalveolar parameters in Group IIa subjects showed significant correlation with upper lip length, maxillary incisal display at rest, maxillary incisal display at smile. (**Table 7 and 8)**

Correlation of smile parameters with various skeletal and dentoalveolar parameters in Group IIb subjects showed significant correlation with upper lip length, maxillary incisal display at rest, gingival display at smile, modified smile index. **(Table 9and 10)**

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.

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 – 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 line, and controversial data exist in the literature regarding this. Although Peck et al[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 Alkahalaf[12] who showed that upper lip length at rest in Class I was higher compared with other groups and Rakosi[13] who showed that Class II have 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 incisal display during smile is affected by hard tissue factors, such as vertical maxillary height, dental height, and soft tissue factors, such as lip length and lip elevation.[11] In a study by Siddiqui et al[7], they showed 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 findings of Sarver and Ackermann[6] who reported that incisor proclination dramatically affects incisor display. Flared maxillary incisors tend to reduce incisor display, while upright maxillary incisor 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 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 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 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 assessment and comparison of change in upper lip length on smiling in different malocclusion groups was maximum in Class II div 2 and minimum in Class II div 1malocclusion but revealed no statistically significant differences may be because the protrusion of the upper incisors in Class II cases causes decreasing of the lips elasticity and the muscles' ability to raise the upper lip. Islam et al[16] found that the upward movement of the upper lip in Class II div 1 subjects was smaller in comparison with the Class I subjects. Change in upper lip length is primarily a function of 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 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 were statistically significant. This can be attributed to the fact that the incisors are retroclined in Class II div 2 patients, so tendency for competent lips is more. Moreover, these group patients have maximum upper lip length. The flaring of maxillary incisors decreases the ability of lips to close. Also shorter upper lip contributes to lip incompetency.

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 Kakadia et al.[17]

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

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

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. Because the patients did not have a well

aligned occlusion before orthodontic treatment. 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.[18] In future different views of smiling photographs have to be assessed to ensure a comprehensive smile analysis. Also error is associated with election of the appropriate still frame representing the posed smile.

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Legends Tables and Figures

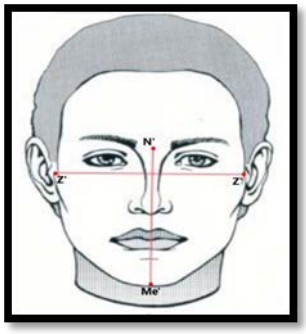
Table 1: Distribution of study group

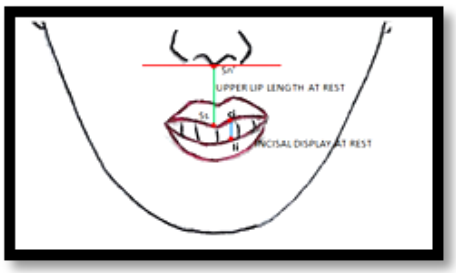
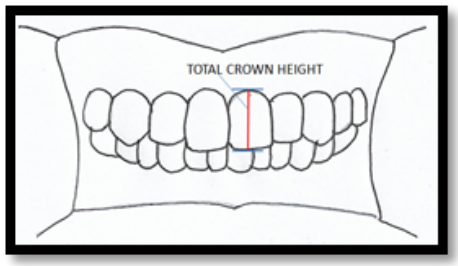
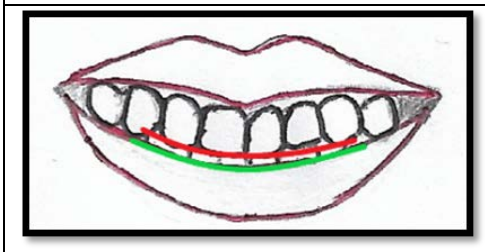
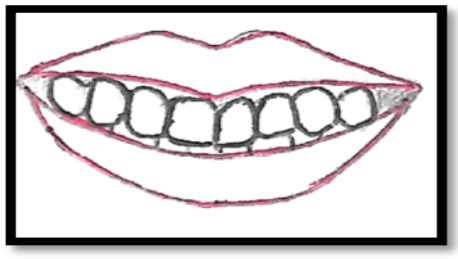
Group	Malocclusion	BETA angle°	ANB angle (°)	WITS appraisal (mm)	No. of subjects
Group I	Skeletal Class I	27-35°	0-4°	-2.65 ± 3.43	20
Group II	Skeletal Class II	< 25°	≥ 4°	>0.78	40

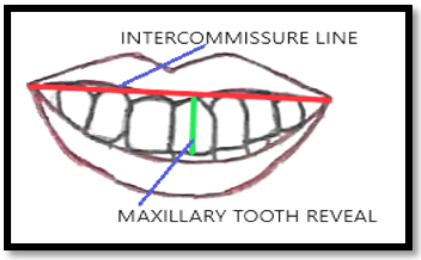
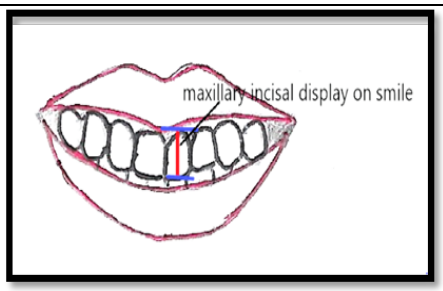
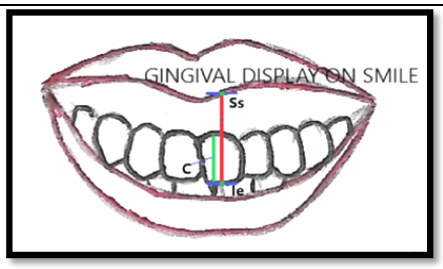
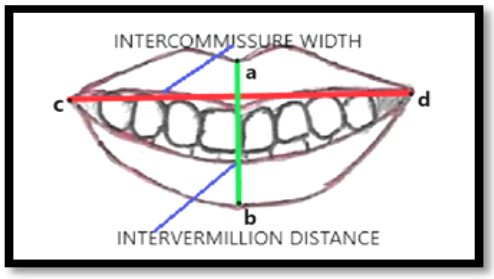
Table 2: Distribution of study group II

Group	Malocclusion	No. of subjects
Group IIa	Angle's Class II div 1 malocclusion	20
Group IIb	Angle's Class II div2 malocclusion	20

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 length of face to its maximal width between the zygomatic prominences.
B.	Measurements on Close-up Photograph of lower third of 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 (stomium superioris - 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, 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 crown of left central incisor.
D.	Measurements on Closeup Frontal smiling photographs of lower third of 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 non consonant smile arc.
	Smile Style	According to Rubin's classification; smile style is classified into: cuspid smile style, commissure smile style, 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, low smile line.
	Morley Ratio	It is the height of maxillary anterior tooth revealed below the inter-commissure line (ICL) in %.
	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 upper lip (Ss) to the incisal edge of incisor (Ie) subtracted by the visible crown height (C) in mm.
	Modified Smile Index	The ratio of the intervermilion distance at midline to the inter-commissural distance in%.

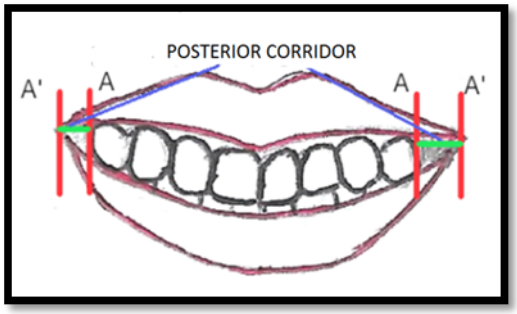
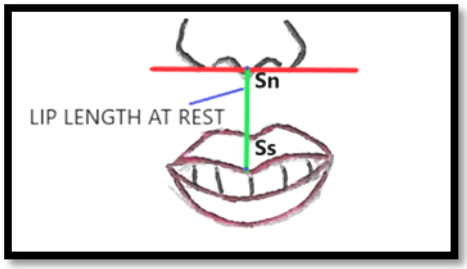
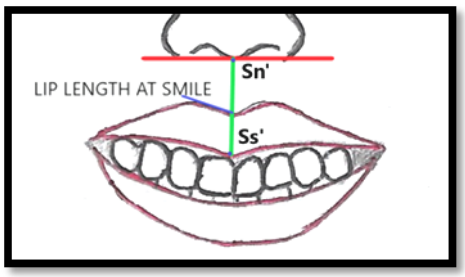
	Posterior corridor	It is the horizontal distance from the distal aspect of the most posterior tooth visible on smile to the outer commissure on the same side (right and left). The width of posterior corridor of left and right side is added and then divided by 2 to get the mean.
 	Change in lip length on smiling (% curtain raise)	It is the change in upper lip length upon rest and smile divided by the upper lip length upon rest (in %).

Table 4: Cephalometric parameters

A.	Hard-tissue cephalometric landmarks	
	Sella (S)	The centre of the pituitary fossa
	Nasion (N)	The most anterior point of the frontonasal suture in the mid-sagittal plane.
	Articulare (Ar)	The intersection of basi-sphenoid and the posterior border of the condyle mandibularis
	Pterygomaxillary fissure (Ptm)	The most posterior point on the anterior contour of the maxillary tuberosity.
	Subspinale (point A)	The deepest point in the mid-sagittal plane between the anterior nasal spine and prosthion usually around the level of and anterior to the apex of the maxillary central incisors.
	Pogonion (Pog)	The most anterior point in the midsagittal plane of the contour of the chin
	Supramentale (point B)	The deepest point in the midsagittal plane between infradentale and Pog, usually anterior to and slightly below the apices of the mandibular incisors.
	Anterior nasal spine (ANS)	The most anterior point of the nasal floor; the tip of the premaxilla in the

		midsagittal plane.
	Menton (Me)	The lowest point of the contour of the mandibular symphysis.
	Gnathion (Gn)	The midpoint between Pog and Me, located by bisecting the facial line N-Pog and the mandibular plane (lower border).
	Gonion (Go)	The midpoint between Pog and Me, located by bisecting the facial line N-Pog and the mandibular plane (lower border).
	Posterior nasal spine (PNS)	The most posterior point on the contour of the palate.
	Center of condyle (C)	Found by tracing the condyle and approximating its center.
B.	Cephalometric Planes	
	Sella Nasion Plane (S-N Plane)	The line connecting S and N
	Frankfurt Horizontal Plane (FH Plane)	The line connecting Po and Or.
	C-B Line	Line connecting the center of condyle (C) with Point B
	A-B Line	Line connecting Point A with Point B.
	Mandibular plane (MP)	A plane constructed from gnathion (Gn) to the angle of the mandible (Go).
	Tweed's Mandibular plane	A plane tangent to the lower border of the mandible through menton (Me).
	Palatal Plane	A plane constructed from posterior nasal spine (PNS) to anterior nasal spine (ANS).
	Occlusal plane	Line passing through the region of overlapping cusps of first premolar and first molar.
C.	Skeletal Parameters	
	SNA Angle	It is the measurement of relative anteroposterior position of maxilla to anterior cranial base.
	SNB Angle	It is the measurement of relative anteroposterior position of mandible to anterior cranial base.
	ANB Angle	Measure of the maxilla mandibular relationship.
	WITS appraisal	Relative position of maxilla wrt mandible.
	Beta angle	The angle formed between A-B line and the perpendicular line dropped from point A on C-B line
	Mandibular Plane Angle (SN-GoGn)	Angle formed between sella-nasion (SN) plane and mandibular plane (Go-Gn).
	Jarabak Ratio (J-ratio=S-Go/N-Me)	Ratio between posterior facial height (S-Go) to anterior facial height (N-Me).

	Basal plane angle	Angle formed between palatal plane and mandibular plane (Go-Gn)
D.	Dentoalveolar Parameters	
	Upper Incisor to SN Plane (1-SN)	Angle between the long axis of the upper incisor and the SN plane posteriorly.
	Incisor Mandibular Plane Angle (IMPA)	Angle formed between long axis of the mandibular central incisor and the mandibular plane.
	Interincisal Angle	Angle between the upper and lower central incisor axis posteriorly.

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

S. No.	Parameters	SN-MP		J-ratio		Basal plane angle	
		r	p value	r	p value	r	p value
1.	Upper lip length	-0.57	0.009*	0.19	0.41	-0.69	0.001*
2.	Maxillary incisal display at rest	0.46	0.04*	-0.17	0.46	0.48	0.03*
3.	Maxillary incisal display at smile	0.29	0.22	0.07	0.78	0.41	0.07
4.	Morley ratio	0.22	0.35	0.03	0.90	0.41	0.03*
5.	Gingival display at smile	-0.04	0.86	0.10	0.68	0.19	0.42
6.	Modified smile index	0.47	0.04*	0.11	0.66	0.68	0.001*
7.	Posterior corridor	-0.28	0.23	0.01	0.98	-0.08	0.74
8.	Change in upper lip length on smiling	-0.49	0.03*	0.53	0.02*	-0.23	0.33

* Statistically significant

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

S.No.	Parameters	1-pal plane		IMPA		Inter-incisal angle	
		r	p value	r	p value	r	p value
1.	Upper lip length	0.76	<0.01*	-0.50	0.03*	0.18	0.45
2.	Maxillary incisal display at rest	-0.38	0.09	0.40	0.08	-0.17	0.48
3.	Maxillary incisal display at smile	-0.38	0.09	0.07	0.76	-0.44	0.06
4.	Morley ratio	-0.43	0.06	0.38	0.10	-0.41	0.07
5.	Gingival display at smile	0.17	0.49	-0.06	0.79	-0.12	0.61
6.	Modified smile index	-0.46	0.04*	0.16	0.49	-0.26	0.27
7.	Posterior corridor	-0.04	0.85	-0.08	0.74	0.07	0.76
8.	Change in upper lip length on smiling	0.15	0.53	0.07	0.78	0.29	0.20

*: Statistically significant

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

S.No.	Parameters	SN-MP		J-ratio		Basal plane angle	
		R	p value	r	p value	R	p value
1.	Upper lip length	-0.01	0.98	0.11	0.64	-0.05	0.83
2.	Maxillary incisal display at rest	0.38	0.09	-0.46	0.04*	0.39	0.08
3.	Maxillary incisal display at smile	0.46	0.04*	-0.49	0.03*	0.49	0.03*
4.	Morley ratio	0.28	0.23	-0.29	0.22	0.37	0.11
5.	Gingival display at smile	0.29	0.21	-0.03	0.90	0.31	0.19
6.	Modified smile index	0.08	0.73	-0.04	0.88	0.03	0.91
7.	Posterior corridor	0.16	0.50	-0.025	0.92	0.28	0.23
8.	Change in upper lip length on smiling	0.15	0.54	-0.06	0.82	0.12	0.61

*: Statistically significant

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

S.No.	Parameters	1-pal plane		IMPA		Inter-incisal angle	
		r	p value	r	p value	r	p value
1.	Upper lip length	0.73	<0.01*	-0.15	0.54	0.25	0.29
2.	Maxillary incisal display at rest	-0.34	0.14	-0.01	0.98	-0.23	0.32
3.	Maxillary incisal display at smile	-0.03	0.91	-0.39	0.08	0.04	0.86
4.	Morley ratio	-0.16	0.51	-0.38	0.10	-0.31	0.18
5.	Gingival display at smile	0.24	0.30	0.02	0.95	-0.05	0.85
6.	Modified smile index	0.25	0.29	0.13	0.59	-0.25	0.29
7.	Posterior corridor	-0.03	0.90	-0.08	0.75	-0.33	0.16
8.	Change in upper lip length on smiling	0.23	0.34	0.01	0.97	0.35	0.13

*:statistically significant

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

S.No.	Parameters	SN-MP		J-ratio		Basal plane angle	
		r	p value	r	p value	R	p value
1.	Upper lip length	-0.16	0.50	0.14	0.55	-0.26	0.28
2.	Maxillary incisal display at rest	0.64	0.003*	-0.53	0.02*	0.49	0.03*
3.	Maxillary incisal display at smile	0.29	0.22	-0.30	0.19	0.21	0.37
4.	Morley ratio	0.25	0.28	-0.18	0.46	0.29	0.21
5.	Gingival display at smile	0.49	0.03*	-0.39	0.09	0.32	0.17

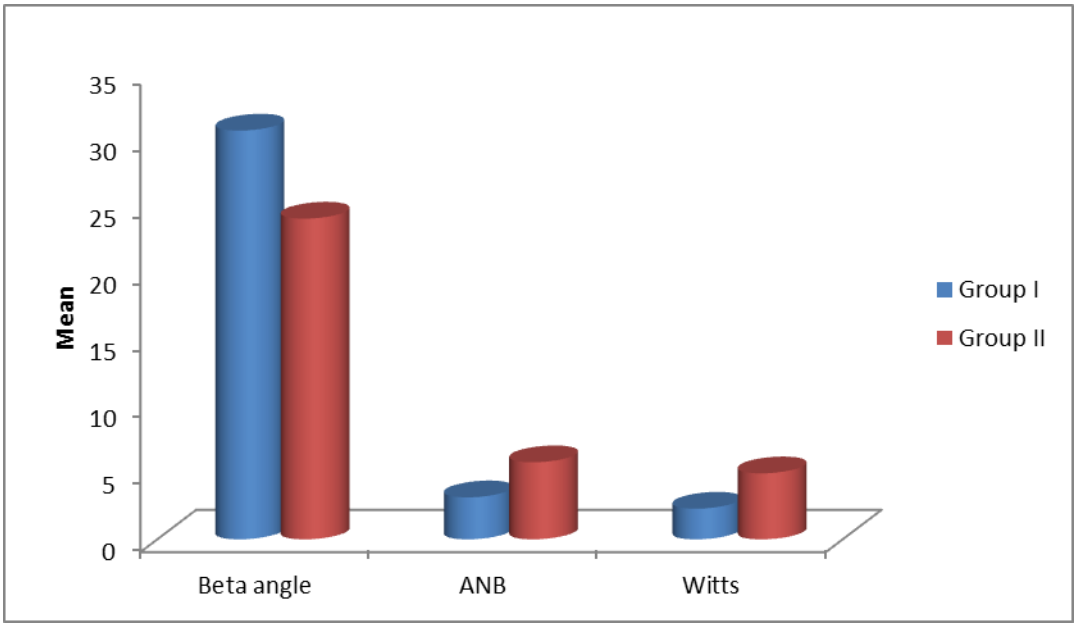
6.	Modified smile index	0.51	0.02*	-0.38	0.09	0.58	0.01*
7.	Posterior corridor	0.11	0.63	-0.25	0.29	0.01	0.96
8.	Change in upper lip length on smiling	-0.07	0.77	0.01	0.98	0.27	0.26

*: Statistically significant

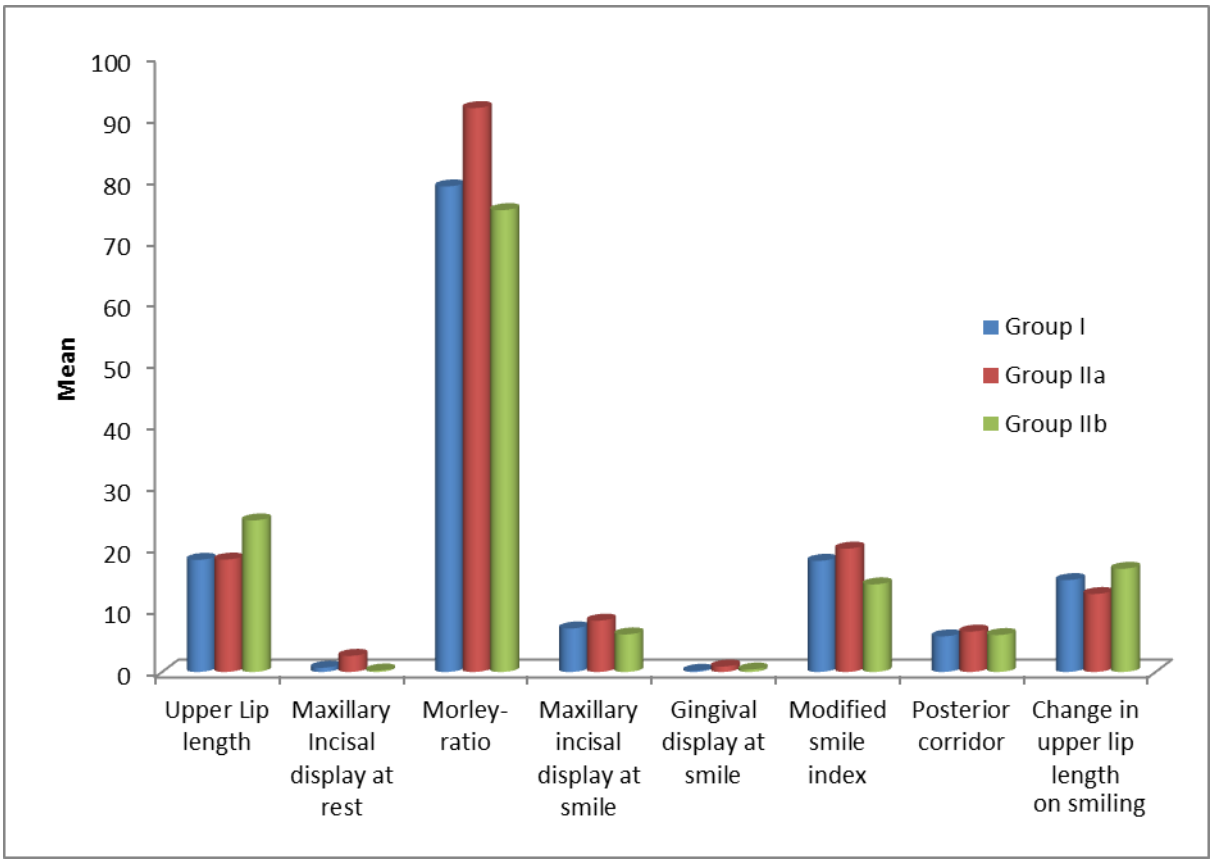
Table 10: Pearson correlation between smile parameters and various dentoalveolar parameters Group II b subjects

S. No.	Parameters	1-pal plane		IMPA		Inter-incisal angle	
		R	p value	r	p value	r	p value
1.	Upper lip length	0.30	0.19	-0.56	0.01*	0.09	0.71
2.	Maxillary incisal display at rest	-0.02	0.93	0.25	0.29	-0.08	0.75
3.	Maxillary incisal display at smile	0.15	0.54	-0.12	0.62	0.03	0.90
4.	Morley ratio	0.08	0.74	0.13	0.58	-0.17	0.47
5.	Gingival display at smile	0.17	0.49	0.11	0.66	-0.09	0.68
6.	Modified smile index	0.16	0.50	0.22	0.46	-0.29	0.21
7.	Posterior corridor	0.06	0.79	-0.17	0.48	0.01	0.97
8.	Change in upper lip length on smiling	0.15	0.53	-0.26	0.28	-0.36	0.12

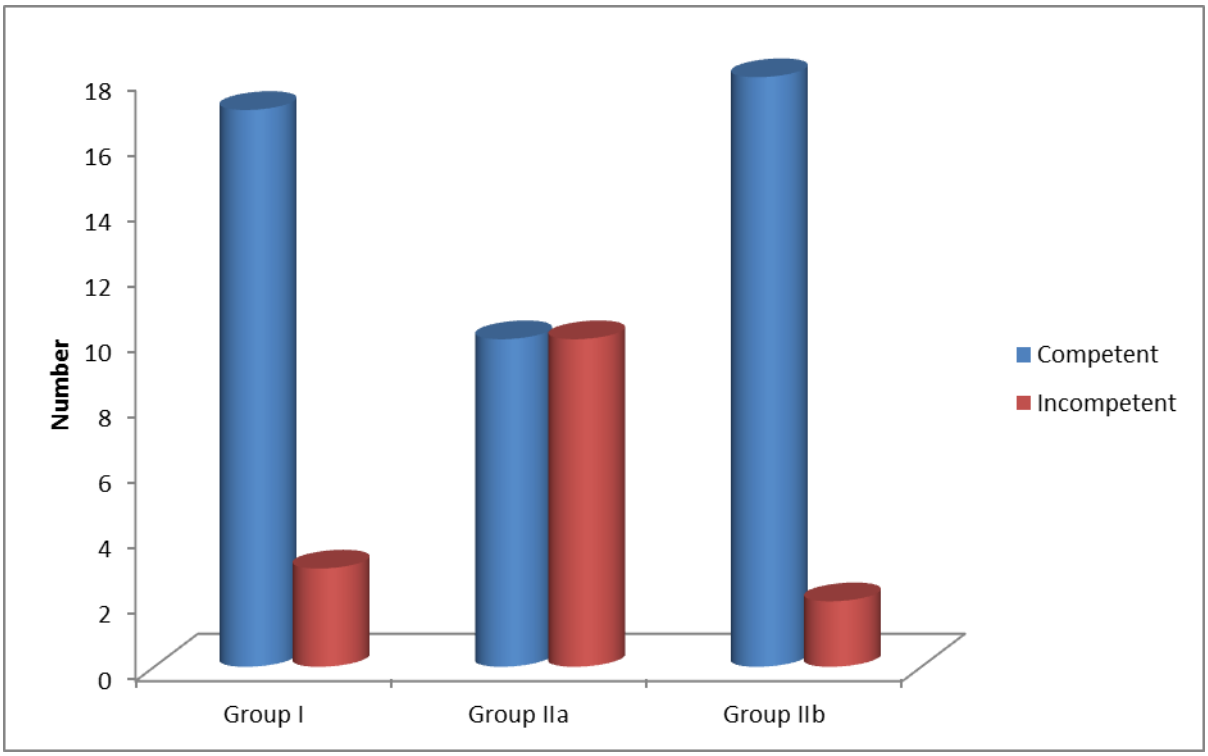
*: Statistically significant



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



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



Graph 3: Comparison of Lip Competency among the study groups

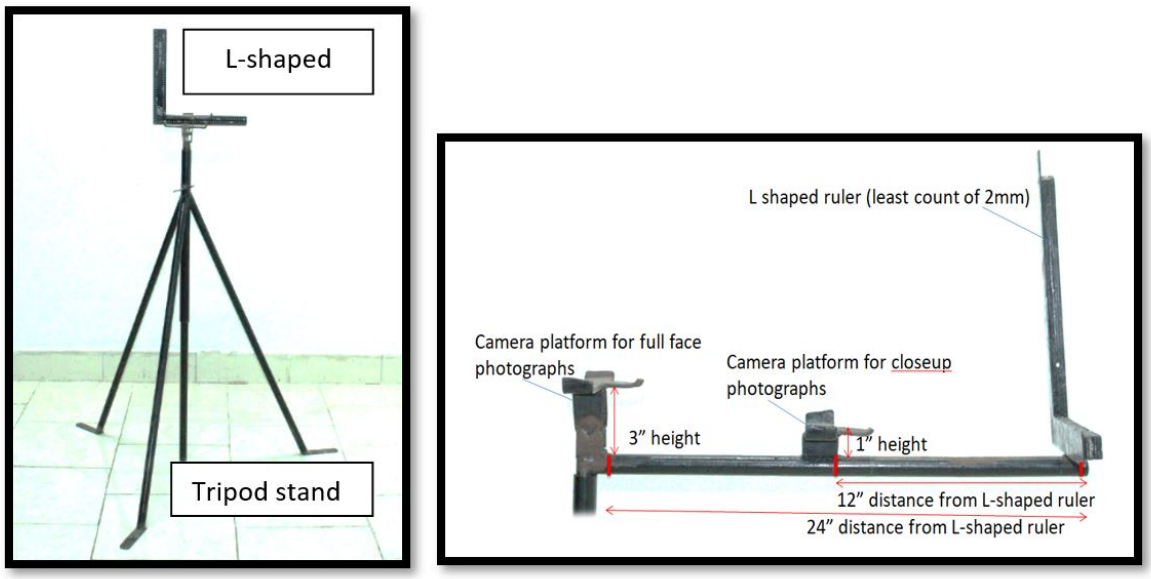


Fig.1: Photographic setup

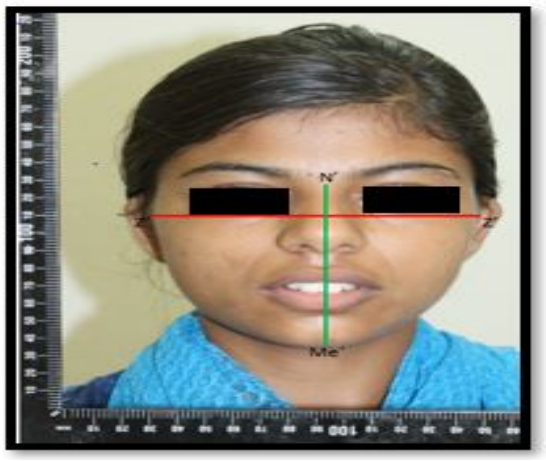


Fig.2: Facial index

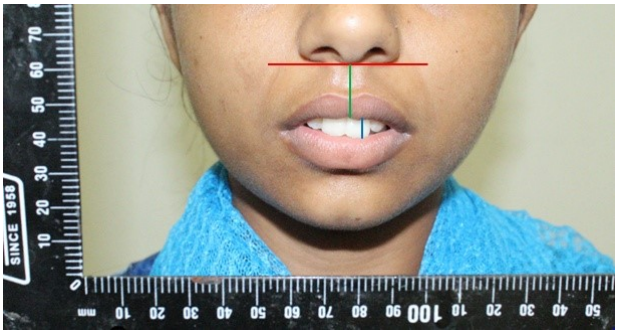


Fig.3: Upper lip length and maxillary incisal display at rest

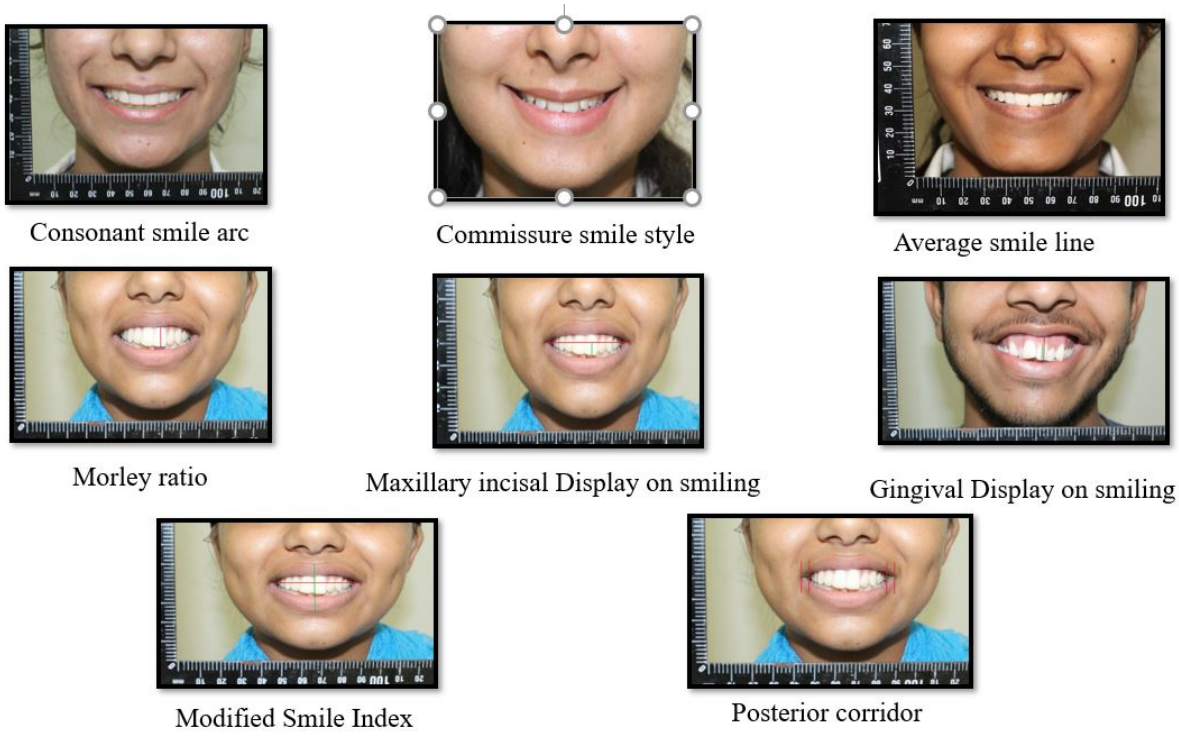


Fig. 4: Smile parameters

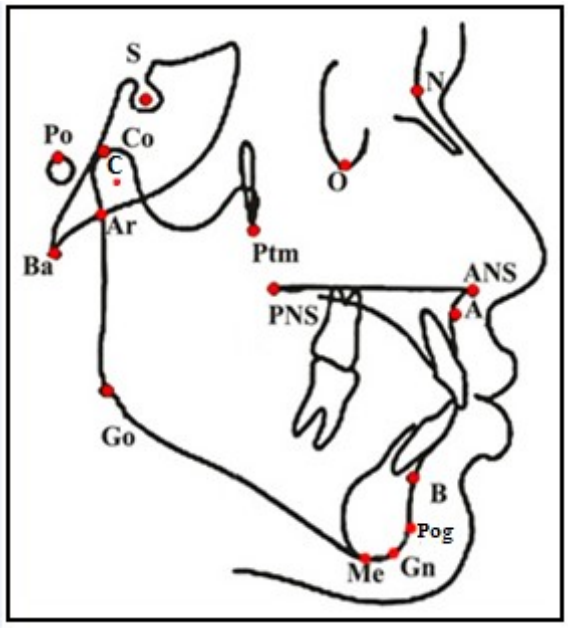


Fig. 5: Hard tissue cephalometric landmarks

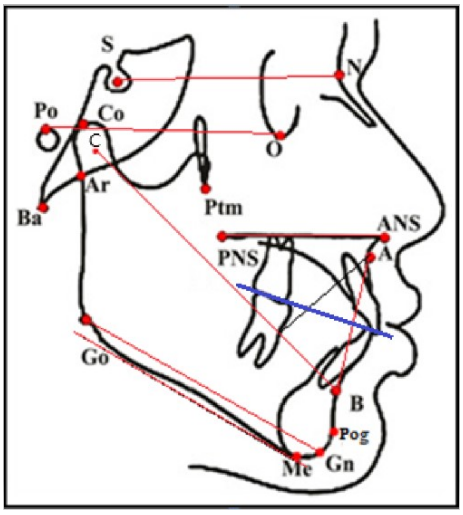


Fig. 6 : Cephalometric planes

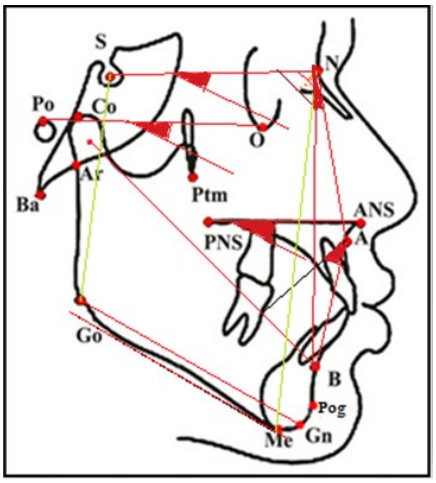


Fig. 7: Skeletal Parameters

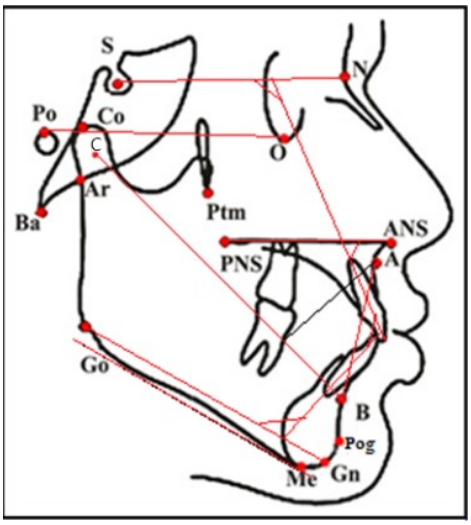


Fig. 8: Dentoalveolar Parameters