# Photographic Assessment Of Maxillary Central Incisor Position As Perceived By Orthodontists And Its Relationship To The Forehead In Adult Subjects.

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## Abstract:

**Background**: The positioning of the maxillary central incisors, in particular, plays a crucial role in determining facial harmony. Traditional diagnostic approaches often rely on repose profile views, which may not fully capture the impact of maxillary incisor positioning on facial esthetics. To evaluate, compare and differentiate the anteroposterior position of the permanent maxillary central incisor to the inclination and prominence of the forehead between subjects having acceptable and unacceptable incisor positioning as perceived by orthodontists from facial profile photographs. To evaluate if a significant difference exists in the anteroposterior maxillary incisor position between the two groups.

*Materials and Methods:* Smile profile photographs of 60 subjects (30 males, 30 females) were analyzed and divided into acceptable (n=30) and unacceptable (n=30) incisor position groups, as judged by 11 orthodontists. Maxillary central incisor position was measured relative to Glabella Vertical (GV) and forehead inclination (FI). Pearson correlation was used to analyze GV-Incisor distance and FI relationships, while the unpaired t-test was used to assess the inter-group differences.

**Results**: The study shows a very low correlation between forehead inclination and maxillary incisor–GV distance in samples with acceptable incisor positioning (r=0.319). In males, incisors are significantly more anterior in the acceptable group (p=0.044). When only female subjects are considered, there is a weak positive correlation between the forehead inclination angle and the I-GV distance in both the groups.

**Conclusion:** The study concludes that orthodontists agree on acceptable maxillary incisor positioning. A significant difference in maxillary incisor to GV distance exists in males, with incisors in front of the Glabella Vertical line being more acceptable. Weak correlations with forehead inclination were observed.

Key Word: Anteroposterior maxillary incisor position, Glabella, smiling profile photograph

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## I. Introduction

One of the primary objectives of orthodontic treatment is to enhance facial esthetics, which is a significant motivating factor for individuals seeking orthodontic care. People are often driven to orthodontics not only to improve oral health and function but also to enhance their physical appearance, particularly their facial harmony. Research highlights the strong social and psychological benefits associated with physical attractiveness. **Dion et al**<sup>1</sup>. found that attractive individuals are more likely to secure better jobs, experience happier relationships, and enjoy more fulfilling lives. **Berschield et al**<sup>2</sup>. further demonstrated that this preferential treatment occurs consistently across various social contexts, regardless of an individual's gender, age, race, or socioeconomic status. These findings underscore the role of orthodontic treatment in improving facial esthetics and, consequently, social success.

A comprehensive orthodontic examination goes beyond the assessment of dental alignment and occlusion to evaluate the face in the sagittal, vertical, and transverse planes. This thorough examination allows orthodontists to accurately diagnose issues and plan treatment. Traditionally, cephalometric analysis has been used to assess skeletal and dental relationships, particularly in the anteroposterior (AP) and vertical planes. Variability in landmark identification and inconsistencies between underlying hard tissues and overlying soft tissues can make this analysis unreliable at times. This highlights the importance of soft tissue evaluation in diagnosing and planning orthodontic treatments, as noted by **Proffit et al**<sup>4</sup>.

The positioning of the maxillary central incisors, in particular, plays a crucial role in determining facial harmony. Traditional diagnostic approaches often rely on repose profile views, which may not fully capture the impact of maxillary incisor positioning on facial esthetics.

Andrews introduced the concept of the Facial Axis point (FFA), which is the midpoint of the clinical crown, and the **Goal Anterior Limit Line** (**GALL**)<sup>4</sup>, which represents the optimal AP position of the incisors. He argued that the maxillary incisors are ideally positioned when the FFA coincides with the GALL, and this relationship holds true across different genders, ages, and ethnicities. Subsequent studies, such as **Tomblyn et al<sup>5</sup>**., have supported Andrews' ideas, with findings suggesting that the Glabella Vertical (GV) line can reliably serve as a reference for assessing maxillary incisor positioning.

This study aims to explore the relationship between the AP position of the maxillary central incisors and forehead inclination. It will compare two groups of young adults—one with an acceptable AP maxillary incisor position and the other with an unacceptable position—based on orthodontists' evaluations. By examining these relationships, the study seeks togive an important insight regarding evaluation of AP position of maxillary central incisor and improve orthodontic treatment outcomes.

## II. Material And Methods

This study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, College of Dental Sciences and Research Center, Bopal, Ahmedabad, with 60 subjects (30 males and 30 females), aged between 18 and 30 years. Subjects met the inclusion criteria of no prior orthodontic treatment, no history of dental trauma, no significant dentofacial deformities in profile view, well-aligned anterior teeth, and visible maxillary incisors in a smiling profile photograph.

## Study design: Photographic study

**Study location:** This study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, College of Dental Sciences and Research Center, Bopal, Ahmedabad

Study Duration: November 2021 to November 2023

## Sample size: 60 patients

**Subjects and selection method:** This study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, College of Dental Sciences and Research Center, Bopal, Ahmedabad, with 60 subjects (30 males and 30 females), aged between 18 and 30 years. Based on the views of orthodontists 30 samples had acceptable incisor positioning (females=15, males=15) and 30 samples had unacceptable incisor positioning (females=15, males=15).

The study utilized a Canon 1500D camera with an 100 mm lens, micropore tape (24 mm x 24 mm), printed photographs (15 cm x 20 cm), a 15 cm metal ruler, and a ballpen. Key anatomical landmarks included the glabella and trichion. The Glabella Vertical (GV) line and forehead inclination were marked on each printed photograph.

### Inclusion criteria:

- 1. Young adult individuals (age 18-30 years).
- 2. No history of previous orthodontic treatment.
- 3. No history of trauma to the dentition.
- 4. No major dentofacial deformities as seen from a profile view clinically.
- 5. Well aligned anterior teeth.
- 6. Incisor teeth visible on smiling profile photograph.

### **Exclusion criteria:**

- 1. Pregnant women;
- 2. Patients with genetic disorders
- 3. Patients with craniofacial abnormality

## **Procedure methodology**

- The armamentarium used in this study were- ➤ Micropore tape
- ➤ Canon 1500D camera with 18-55 mm lens
- > Printed smiling profile photograph of 15 cm height\*20 cm length
- > Metal ruler of 15 cm length

## ≻ Ball Pen

A square micropore tape measuring 24 mm\*24 mm with the sample number mentioned on it was placed on the cheek of each sample. Samples 1-30 consisted of female subjects while 31-60 consisted of male subjects. Subjects were photographed in a Natural Head Position (NHP) while smiling, with a fixed 1-meter distance between the camera and the subject. The images were then printed for evaluation. A panel of 11 orthodontists assessed the maxillary incisor positions, categorizing subjects into Acceptable Incisor Position (AIP) or Unacceptable Incisor Position (UIP) groups based on:

Acceptable Incisor Position (AIP)– If 9 or more orthodontists out of 11 orthodontists judged the incisor position to be acceptable.

Unacceptable Incisor Position (UIP)- If 9 or more orthodontists out of 11 orthodontists judged the incisor position to be unacceptable.

The horizontal distance from the upper central incisor to the GV line was measured and assigned a positive or negative value depending on its position relative to the GV line. Measurements were adjusted for magnification using the size of the micropore tape, and the forehead inclination angle was also measured and recorded. Mean and Standard deviation of the maxillary incisor to GV (I-GV) distance were calculated for both the groups. The unpaired t test was used to check the level of difference in the GV Incisor distance between the two groups and the level of difference in forehead inclination between the two groups.

### Statistical analysis

Based on the views of orthodontists 30 samples had acceptable incisor positioning (females=15, males=15) and 30 samples had unacceptable incisor positioning (females=15, males=15). Mean and Standard deviation of the GV-Maxillary Incisor distance and the forehead inclination were calculated for both the groups. The unpaired t- test was used to check the level of difference in the GV-Incisor distance and the level of difference in forehead inclination between the two groups. The Chi Square test was used to check if there was a significant difference between the views of 11 orthodontists for the 60 samples. The Pearson co-relation test was used to check the correlation between the GV-Incisor distance and the forehead inclination. Intra observer errors were calculated by repeating measurements of (I-GV and forehead inclination angle) of 10 subjects after 2 weeks by same orthodontist. 2 orthodontist traces same photograph of 10 subjects and measurements were calculated by both. Intra and inter observer errors were statistically non-significant for both I-GV and forehead inclination angle.

<b>TABLE-1</b> Acceptance of maxillary incisor position in female subjects by eleven orthodontists.											
JUDGE	M-1	M-2	M-3	M-4	M-5	M-6	M-7	F-1	F-2	F-3	F-4
Acceptable	13	20	15	15	15	13	12	16	18	16	12
Unacceptable	17	10	15	15	15	17	18	14	12	14	18
Chi sq distribution value $= 8.26$			df =	= 10				p = 0.602	2		

III. Result

Chart – 1





TABLE - 1 along with CHART-1 shows the number of female subjects judged to have acceptable or unacceptable incisor position by each orthodontist. The Chi Square value of this distribution is 8.26 which

showed that the orthodontists share a common opinion regarding the acceptable position of maxillary central incisors in female subjects.

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JUDGE	M-1	M-2	M-3	M-4	M-5	M-6	M-7	F-1	F-2	F-3	F-4
Acceptable	14	16	9	16	12	10	10	12	18	16	12
Unacceptable	16	14	21	14	18	20	20	18	12	14	18
Chi sq d	istributio	n value =	= 12.12		df =	= 10				p = 0.276	5

**TABLE-2** Acceptance of maxillary incisor position in male subjects by eleven orthodontists.

CHART – 2 Number of male subjects judged to have acceptable or unacceptable incisor position by the panel of eleven orthodontists.



Yes= Acceptable, No= Unacceptable

TABLE -2 along with CHART-2 shows the number of male subjects judged to have acceptable or unacceptable incisor position by each orthodontist. The Chi Square value of this distribution is 12.12 which showed that the orthodontists share a common opinion regarding the acceptable position of maxillary central incisors in male subjects.

 TABLE – 3 Correlation between forehead inclination and maxillary central incisor to glabella vertical (gv)

 distance (mm) in acceptable and unacceptable groups

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	ACCEPTABLE	C GROUP (30)	UNACCEPTABLE GROUP (30)		
	Forehead Inclination Perpendicular Angle Distance (mm)		Forehead Inclination Angle	Perpendicular Distance (mm)	
	Trichion-Glabella to GV	Incisor to Glabella Vertical (GV)	Trichion-Glabella to GV	Incisor to Glabella Vertical (GV)	
MEAN	23.17	-1.36	22.87	-2.45	
SD	3.86	4.24	5.64	5.48	
	r=0.087		r=0.319		
	WEAK POSITIVE CORELATION		LOW POSITIVE CORELATION		

An intragroup comparison is done in **TABLE- 3** showing the corelation between the I-GV distance and the forehead inclination when male and female subjects were pooled together in both the groups: - Acceptable Incisor Position and Unacceptable Incisor Position. In the Acceptable

Incisor Position group there is a weak positive corelation between the IGV distance and forehead inclination (r=0.087). In the Unacceptable Incisor Position group there is a low positive corelation between the I-GV distance and forehead inclination(p=0.319). This means that although both variables tend to increase/decrease in response to one another, the relationship between them is not very strong.

CHART 3- Scatter plot of forehead inclination and maxillary central incisor to glabella vertical (gv) distance (mm) in acceptable and unacceptable groups



**CHART- 3** shows a scatter plot of the relationship between the forehead inclination and I-GV distance in acceptable and unacceptable groups. The points are not clustered close to each other which indicates that the relationship between the forehead inclination angle and the I-GV distance is weak.

un	distance (mm) in acceptable and unacceptable groups – male subjects					
	ACCEPTABLE	GROUP (15)	UNACCEPTABLE GROUP (15)			
	Forehead Inclination Angle	Perpendicular Distance (mm)	Forehead Inclination Angle	Perpendicular Distance (mm)		
	Trichion-Glabella to GV	Incisor to Glabella Vertical (GV)	Trichion-Glabella to GV	Incisor to Glabella Vertical (GV)		
MEAN	23.20	0.27	22.20	-3.38		
SD	3.34	3.91	4.46	5.43		
	r= 0.170		r=0.339			
	WEAK POSITIVE	CORELATION	LOW POSITIVE CORELATION			

**TABLE 4** Correlation between forehead inclination and maxillary cental incisor to glabella vertical (gv) distance (mm) in acceptable and unacceptable groups – male subjects

An intragroup comparison is done in **TABLE- 4** showing the corelation between the I-GV distance and the forehead inclination in male subjects only belonging to both groups. In males for the acceptable incisor position group a weak positive corelation exists between the I-GV distance and the forehead inclination (r=0.170). In the Unacceptable Incisor Position group there is a low positive corelation between the I-GV distance and forehead inclination (r=0.339) **4** 





**CHART- 4** shows a scatter plot of the relationship between the forehead inclination and I-GV distance in males subjects of acceptable and unacceptable groups. The points are not clustered close to each other which indicates that the relationship between the forehead inclination angle and the I-GV distance is weak.

TABLE 5 Correlation between	n forehead inclination	and maxillary cen	tral incisor to	glabella v	vertical (	(gv)
distance (mm	) in acceptable and un	acceptable groups	- female sub	jects		

distance (initi) in deceptable and undeceptable groups Tennale subjects					
	ACCEPTABI	LE GROUP (15)	UNACCEPTABLE GROUP (15)		
	Forehead	Perpendicular	Forehead	Perpendicular	
	Inclination	Distance (mm)	Inclination	Distance (mm)	
	Trichion-Glabella	Incisor to Glabella	Trichion-Glabella	Incisor to Glabella	
	to GV	Vertical (GV)	to GV	Vertical (GV)	
MEAN	23.13	-2.96	23.53	-1.27	
SD	4.44	3.97	6.72	5.18	
	r= 0.027		r=0.286		
	LOW POSITIV	E CORELATION	LOW POSITIVE CORELATION		

An intragroup comparison is done in **TABLE- 5** showing the corelation between the I-GV distance and the forehead inclination in female subjects only belonging to both groups. In females for the acceptable incisor position group a low positive corelation exists between the I-GV distance and the forehead inclination. (r=0.027). In females for the unacceptable incisor position group a low positive corelation exists between the I-GV distance and the forehead inclination. (r=0.286)

### CHART-5

Scatter plot of forehead inclination and Maxillary central incisor to glabella vertical (gv) distance (mm) in acceptable and unacceptable groups – female subjects



**CHART- 5** shows a scatter plot of the relationship between the forehead inclination and I-GV distance in female subjects of acceptable and unacceptable groups. The points are not clustered close to each other which indicates that the relationship between the forehead inclination angle and the I-GV distance is weak.

TABLE-6 Level of difference in forehead inclination Angle between acceptable and unacceptable group-

(males and females)					
	FOREHEAD INCLINATION ANGLE (Degree)				
	ACCEPTABLE GROUP (30)	UNACCEPTABLE GROUP (30)			
MEAN	23.17	22.87			
SD	3.86	5.64			
p =	0.811				
INFERENCE	STATISTICALLY INSIGNIFICANT				

**TABLE- 6** shows an intergroup comparison of the level of difference in forehead inclination angle between acceptable and unacceptable group when all subjects are pooled together. The mean forehead inclination angle in acceptable incisor position group is  $23.17^{\circ}$  +/-  $3.86^{\circ}$ . The mean forehead inclination angle in unacceptable incisor position group is  $22.87^{\circ}$  +/-  $5.64^{\circ}$ . There is no statistically significant difference in the means of forehead inclination angle between the groups(p=0.81)

**CHART 6-**Level of difference in forehead inclination angle between acceptable and unacceptable group-(males and females)



**CHART-6** shows the mean forehead inclination when both male and female subjects were pooled in each group - acceptable and unacceptable incisor position.

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	FOREHEAD INCLINATION ANGLE (Degree)				
	ACCEPTABLE GROUP	UNACCEPTABLE GROUP			
	(15)	(15)			
MEAN	23.20	22.20			
SD	3.34	4.46			
p =	0.493				
INFERENCE	STATISTICALLY INSIGNIFICANT				

**TABLE 7-**Level of difference in forehead inclination angle between acceptable and unacceptable group- males only

**TABLE- 7** shows an intergroup comparison of the level of difference in forehead inclination angle between male subjects only of acceptable and unacceptable group. The mean forehead inclination angle in acceptable incisor position group is  $23.20^{\circ}$  +/-  $3.34^{\circ}$ . The mean forehead inclination angle in unacceptable incisor position group is  $22.20^{\circ}$  +/-  $4.46^{\circ}$ . The difference in the mean of forehead inclination angle between the two groups is not statistically significant(p=0.493).

CHART-7Level of difference in forehead inclination angle between acceptable and unacceptable group- males



**CHART-7** shows the mean forehead inclination of male subjects only in each group - acceptable and unacceptable incisor position.

CHART-8 Level of difference in forehead inclination angle between acceptable and unacceptable group-

	FOREHEAD INCLINATION (Degree)				
	ACCEPTABLE GROUP (15)	UNACCEPTABLE GROUP (15)			
MEAN	23.13	23.53			
SD	4.44	6.72			
p =	0.845				
INFERENCE	STATISTICALLY INSIGNIFICANT				

**TABLE-8** shows an intergroup comparison of the level of difference in forehead inclination angle between female subjects only of acceptable and unacceptable group. The mean forehead inclination angle in acceptable incisor position group is  $23.13^{\circ}$  +/-  $4.4^{\circ}$ . The mean forehead inclination angle in unacceptable incisor position group is  $23.53^{\circ}$  +/-  $6.72^{\circ}$ . The difference in the mean of forehead inclination angle between the two groups is not statistically significant(p=0.845)

CHART-8 Level of difference in forehead inclination angle between acceptable and unacceptable groupfemales only



**CHART-8** shows the mean forehead inclination of female subjects only in each group - acceptable and unacceptable incisor position.

**TABLE-9** Level of difference in maxillary incisor to glabella vertical distance between acceptable and unacceptable group-males and females

	I-GV PERPENDICULAR DISTANCE (mm)				
	ACCEPTABLE GROUP (30)	UNACCEPTABLE GROUP (30)			
MEAN	-1.36	-2.45			
SD	4.24	5.48			
p =	0.390				
INFERENCE	STATISTICALLY INSIGNIFICANT				

**TABLE- 9** shows an intergroup comparison of the level of difference in Maxillary Incisor to GV distance (I-GV) between acceptable and unacceptable group when all subjects are pooled together. The mean IGV distance in the acceptable incisor position group is -1.36 +/-4.24mm. The mean I-GV distance in the unacceptable incisor position group is -2.45 +/-5.48mm. This difference is not statistically significant (p=0.390).

**CHART-9** Level of difference in maxillary incisor to glabella vertical distance between acceptable and unacceptable group-males and females



**CHART-9** shows the mean I-GV distance between the acceptable and unacceptable incisor position group when both male and female subjects are included.

<b>FABLE-10</b> Level of difference in maxillary i	incisor to g	glabella vertical	distance betwee	n acceptable and
unaccont	abla group	malas only		

	I-GV PERPENDICULAR DISTANCE (mm)			
	ACCEPTABLE CROUD (15)	UNACCEPTABLE		
	ACCEPTABLE OROUP (13)	GROUP (15)		
MEAN	0.27	-3.38		
SD	3.91	5.43		
p =	0.044			
INFERENCE	STATISTICALLY SIGNIFICANT			

**TABLE-10** shows an intergroup comparison of the level of difference in Maxillary Incisor to GV distance (I-GV) of male subjects only between acceptable and unacceptable group. The mean I-GV distance in the acceptable incisor position group is 0.27 +/- 3.91mm. The mean I-GV distance in the unacceptable incisor position group is -3.38 +/- 5.43mm. This difference is statistically significant (p=0.044). Hence the incisors were placed significantly forward in males judged to have acceptable incisor positioning compared to those judged to have unacceptable incisor positioning.





**CHART-10** shows the mean I-GV distance between the acceptable and unacceptable incisor position group when only male subjects are included.

**TABLE-11** Level of difference in maxillary incisor to glabella vertical distance between acceptable and unacceptable group-females only

	Incisor to Glabella Vertical (GV)	
	PERPENDICULAR DISTANCE (mm)	
	ACCEPTABLE GROUP (15)	UNACCEPTABLE GROUP (15)
MEAN	-2.96	-1.27
SD	3.97	5.18
p =	0.325	
INFERENCE	STATISTICALLY INSIGNIFICANT	

**TABLE-11** shows an intergroup comparison of the level of difference in Maxillary Incisor to GV distance (I-GV) of female subjects only between acceptable and unacceptable group. The mean I-GV distance in the acceptable incisor position group is -2.96 + -3.97 mm. The mean IGV distance in the unacceptable incisor position group is -1.27 + -5.18 mm. This difference is not statistically significant (p=0.325).





**CHART-11** shows the mean I-GV distance between the acceptable and unacceptable incisor position group when only female subjects are included.

## IV. Discussion

This study evaluated the relationship between the anteroposterior positioning of the maxillary central incisors and forehead inclination in subjects judged to have acceptable and unacceptable incisor positioning.

The findings showed a non-significant relation between the I-GV distance and forehead inclination in both the Acceptable and Unacceptable Incisor Position groups. This suggests that although there is a tendency for these variables to change together, the relationship is not strong. These results contrast with Sowmithradevi et al.6, who reported a moderate correlation in the South Indian population, which may be attributed to ethnic differences.

For male subjects, both the AIP and UIP groups showed a non-significant relation between the I-GV distance and forehead inclination. This aligns with the findings of Adams7, who also reported minimal correlation, potentially due to anatomical differences like frontal bossing and the more anterior placement of the glabella in males. In contrast, Jead et al.8 found a strong correlation in Iraqi males, highlighting potential racial or regional variations. For females, a low positive correlation was observed in both groups, consistent with the study by Ajmera et al.9 in adult Indian females and Abrol et al.10 in North Indian females, who also reported weak correlations. Similarly, Cho et al.11 found no significant correlation in Korean females with a pleasing profile, while Gidaly et al.12 observed a significant correlation in African-American females, underscoring the impact of ethnicity on facial esthetic parameters.

The intergroup comparison of forehead inclination angles between the AIP and UIP groups did not show a statistically significant difference in all subjects, aligning with the study by Basamtabar et al.13, who also found no significant difference between subjects with optimal incisor positioning and those seeking orthodontic treatment. However, in males, the results contrast with Adams, who reported significant differences in forehead inclination among Caucasian males, likely due to racial differences. Similarly, no significant difference in forehead inclination was noted in female subjects, in agreement with Andrews, who found no significant variation in adult Caucasian females with acceptable and unacceptable incisor positioning.

An intergroup comparison of the I-GV distance showed no statistically significant difference when considering all subjects together, contrary to Basamtabar et al., who reported a significant difference in subjects with optimal facial harmony. However, in males, a statistically significant difference was found, with the maxillary incisors placed more anteriorly in the AIP group, supporting Adams' findings. In females, no significant difference in the I-GV distance was observed, consistent with Abrol et al.10, who found no variation in the position of the maxillary central incisors in North Indian females with good facial balance. In contrast, Andrews and Gidaly et al.12 reported significant differences in the maxillary central incisor position in Caucasian and African-American females, respectively, highlighting the influence of ethnicity on these findings.

### V. Conclusion

This study highlights the importance of the anteroposterior positioning of the maxillary central incisors and its relationship with forehead inclination in determining facial esthetics. The orthodontists in the study shared a consistent opinion regarding the acceptability of incisor positioning in both males and females, with a statistically significant difference in the I-GV distance observed in males.

Maxillary incisors positioned anterior to the Glabella Vertical line were deemed more acceptable.

The study also found no significant correlation between forehead inclination and I-GV distance in the acceptable incisor group also no significant correlation existed in the unacceptable group.

Forehead inclination may have a limited influence on the perception of incisor positioning.

Including a smiling profile photograph in routine orthodontic practice could improve the evaluation of maxillary incisor positioning.

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