

Age and Gender Specific Effect of Lip Form on Maxillary and Mandibular Incisal Display with Lips at Rest in Elderly Indian Population: A Cross-sectional Study

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ABSTRACT

Introduction: Maxillary and mandibular incisal display at rest and smile is an integral part of dentofacial aesthetics. Its correlation with lip form and the effect of age and gender has not been studied in elderly Indian population. Dental photography has been given a great importance in prosthodontics and the study of various aesthetic parameters on digitalised photographs can act as additional diagnostic tool.

Aim: To determine correlation between lip form and incisal display in elderly subjects and to determine age and gender related changes.

Materials and Methods: A cross-sectional study was conducted in the Department of Prosthodontics, Karnavati School of Dentistry, Gandhinagar, Gujarat, India, from November 2020 to September 2021. The study sample comprised of digital photographs taken in natural head position of 324 elderly Indian subjects (180 males and 144 females) and they were divided into 4 age groups: Group I consisting of 157 subjects aged (31-45 years), Group II consisting of 107 subjects aged (46-55 years), Group III consisting of 47 subjects aged (56-65 years) and Group IV consisting of 13 subjects aged >65 years. The various parameters (lip form, maxillary and mandibular incisal display) were then analysed using Image J (Fiji app) image analysis software. The statistical analysis was done using Pearson's correlation (significant when $p < 0.05$), scatter plot, and Independent t-test (significant when $p < 0.05$) and one-way

Analysis Of Variance (ANOVA) post-hoc Tukey-Kramer test to compare the parameters of different groups.

Results: The results of the present study showed that there is a significant correlation between lip form and maxillary and mandibular incisal display at rest ($r=0.388$, $p=0.001$). Females have more incisal display for a particular type of lip form as compared to male subjects. A statistically significant difference was found in maxillary incisal display and lip form between male and female groups ($T=-5.934$, $p\text{-value}=0.001$ and $T=-2.367$, $p\text{-value}=0.019$, respectively) but no statistically significant difference was found in mandibular incisor display between male and female groups ($T=1.832$, $p\text{-value}=0.068$). Hence, females above 30 years of age had more maxillary incisal display as compared to males but almost same mandibular incisal display. Also, straight lip form was more common among elderly male subjects (63.6% as compared to females 36.4%) but females had moderate lip form most commonly (52.1% as compared to males 47.9%). High lip form was reported equally in both male and female subjects with 50% in each group.

Conclusion: It has been concluded from the study that for a particular type of lip form (either straight, moderate or high), females have more average incisal displays as compared to males. A strong correlation exists between lip form and incisal display in elderly Indian population. Hence, lip form can be used as a definitive parameter to determine incisal displays in prosthetic rehabilitation to get optimum aesthetic outcomes.

Keywords: Aesthetics, Digital photography, Repose, Smile

INTRODUCTION

The pleasant dental aesthetics-smile is an important factor for psychosocial well-being of a person which favours his or her social acceptance [1]. It is considered as one of the most attractive facial expressions which represent the gesture of a person. Lips and maxillary and mandibular incisal display form the frame of smile and defines the aesthetic zones [2,3]. In modern dentistry, smile aesthetics, is of major importance. In smile aesthetics, factors such as exposure of maxillary and mandibular anterior teeth, outline of vermilion border of lips and type of lip form, gingival display, incisal curvature, ratio and symmetry of maxillary incisors, the presence of gingival and dental asymmetries, and the presence of midline diastema are of great importance [4-9]. All these factors are quite important in fixed dental prostheses for anterior or full mouth rehabilitation, dentures (complete or partial) and implant supported prostheses.

Tooth placement is very critical and likely the greatest contributor to the denture/prostheses look which is "that typical facial appearance common to the most denture wearers" [10-12]. Pound advised to

place the teeth back in their original position from which they arose and many others have accepted the authors philosophy, which is widely advocated in the modern prosthodontic literature [11]. In a few studies, it was instructed to position the upper central incisor vertically, so that 0-2 mm of the incisal edge is visible below the upper lip [11,13].

But in earlier studies, no consideration was given to the type of lip form and their correlation to maxillary and mandibular incisal display in elderly population. Kim J et al., has given a classification of lip form based on the distance from the highest portion of lower vermilion border of upper lip from a line passing through the commissures of the mouth as straight lip form (0-3 mm), moderate (between 3 mm to 6 mm) and high lip form (more than 6 mm) [14]. The present study was done in American white population. In a previous study, the correlation between lip form and incisal display in young Indian population has been studied [9], but no study has been done in elderly Indian population. As lip position, type of lip form and the amount of tooth display during smile and speech are very important in prosthodontics [15]; therefore, the present study

was designed to evaluate the age and gender related changes of maxillary and mandibular incisor display related to lip form at rest in elderly Indian population. Primary objective of the study was to determine correlation between lip form and incisal display in male and female elderly subjects and secondarily to determine age related changes. It was hypothesised that, there is no difference in maxillary and mandibular incisal display of male and female subjects for a particular type of lip form; also age has no effect on lip form and incisal display.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Prosthodontic and Crown and Bridge of Karnavati School of Dentistry, Gandhinagar, Gujarat, India from November 2020 to September 2021. The study protocol was approved by the Institutional Ethics Committee of KSD, Gandhinagar (No.KSDEC/17-18/Apr/40). Written informed consent was obtained from all the participants prior to evaluation.

Sample size calculation: was calculated by using the formula:

$$n = Z^2 P(1-P)/d^2$$

Where 'n' is the sample size, Z=95%, P=13.43% according to Jeelani W et al., and d=0.05. Considering the dropout rate of 10% estimated sample size was 324 [15]. Subjects were randomly selected between age group 30 years above and then categorised into 4 groups to see the age related effects.

Inclusion criteria: Subjects with more than 30 years of age, no previous history of orthodontic treatment or maxillofacial surgery, all anterior teeth present, no severe malocclusion and willing to participate in the study were included in the study.

Exclusion criteria: Patients with any missing anterior teeth, prosthodontic work on teeth visible in smile, inability to determine natural head position/neuromuscular in coordination and excessive dental attrition/worn dentition were excluded from the study.

Study Tools

Photographic room and DSLR camera with tripod

A photographic room was used with green background to provide contrast. A DSLR camera (Nikon D3500) with lens AF-P DX NIKKOR 18-55 mm f/3.5-5.6G VR lens and AF-P DX NIKKOR 70-300 mm f/4.5-6.3G ED was used for taking digital photographs. The camera was mounted on a tripod stand and positioned at 5 feet distance from the subject and adjusted to subject's eye level in natural head position.

Image analysis software (Image J; Fiji app) [16]

The images were then transferred to ImageJ image analysis software which is a Java-based image processing program developed at the National Institutes of Health and the Laboratory for Optical and Computational Instrumentation (LOCI, University of Wisconsin). Image J software can display, process, edit and save and analyse, print 8-bit color and grayscale images and can read many image file formats e.g., Joint Photographic Experts Group (JPEG), Portable Network Graphics (PNG), Graphics Interchange Format (GIF), Tagged Image File (TIFF), BitMaP (BMP), etc.,

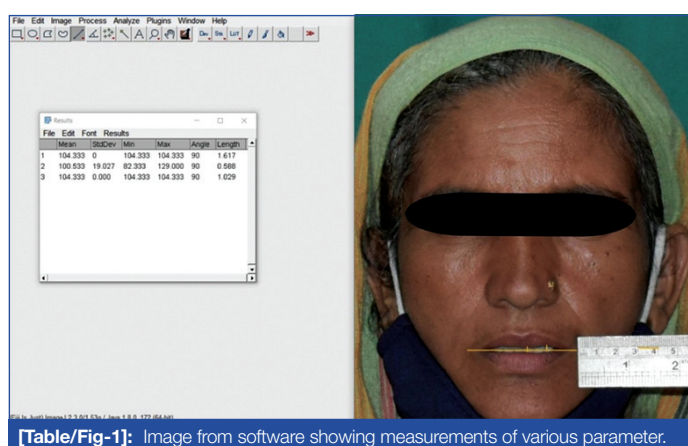
Study Procedure

The subjects were photographed with lips at rest in natural head position by following described method of standardisation:

1. A single DSLR camera Nikon D-3500 was used to take all the facial photographs.
2. Distance between the camera and the subject was taken as 5 feet.
3. The camera was mounted on a tripod stand with the lens positioned at patient's eye level.

4. The subjects were made to sit in natural head position which is the position of the head in a standing up or an erect sitting individual, with his/her visual axis oriented horizontally [17].
5. The subjects' lips were relaxed and captured in repose/rest, which is achieved by asking them to lick their lips and facial surfaces of their upper teeth and then instructing them to part their lips [18].
6. The same illumination was used for photography of each subject.

The facial photographs of the subjects taken were then opened in Image J software (version 1.53 C; Fiji app), and measurements of maxillary and mandibular incisal display and lip form were made digitally for collecting the data. The procedure followed to make measurements was as below: a straight line was drawn passing through the commissures of the lips horizontally and then a perpendicular line to this line was drawn from the highest part of lower vermilion border of the upper lip [Table/Fig-1]. A metal scale was placed horizontally on the side of the face of each individual before taking their photographs and a known distance of 10 mm on this scale was used to calibrate the images in the software before making measurements. Maxillary and mandibular incisal display was measured by drawing a straight line from the centre of incisal edge of left upper central incisor to highest portion of lower vermilion border of upper lip and from the centre of incisal edge of left lower central incisor to highest portion of upper vermilion border of lower lip, respectively [Table/Fig-1].



[Table/Fig-1]: Image from software showing measurements of various parameter.

Depending upon the vertical distance measured; type of lip form for each subject was determined according to the lip form classification given by Kim J et al., as:

- Straight (Type 1): 0-3 mm
- Moderate (Type 2): between 3 mm-6 mm
- High (Type 3): >6 mm [14].

STATISTICAL ANALYSIS

Participants' socio-demographic data including age, gender, occupation and education level were gathered by using a questionnaire and measurements made digitally were then analysed statistically using software Statistical Package for Social Sciences (SPSS) version 21.0 (International Business Management (IBM) SPSS version 21.0). The collected data was normally distributed and hence, parametric tests: Pearson's correlation, Scatter plots, Student's t-test and one-way Analysis of Variance (ANOVA), post-hoc Tukey-Kramer test were used to make inter and intra group comparisons (significant when p<0.05).

RESULTS

A total of 324 participants participated in the study, out of which 180 were male and 144 were female subjects. A total of 154 (47.5%) subjects had straight lip form, 144 (44.4%) had moderate and only 26 (8.1%) subjects had high lip form, hence, straight lip form was the most common among elderly Indian population. The average of maxillary and mandibular incisal displays observed in

elderly population was 2.26 mm±1.6 SD and 1.29 mm±1.4 SD, respectively with more incisal display in female subjects with a mean of 2.82±1.12 SD as compared to male subjects with a mean of 1.8±1.41 SD, respectively [Table/Fig-2]. On the basis of age, subjects were divided into four groups: Group I (31-45 years, n=157), Group II (46-55 years, n=107), Group III (56-65 years, n=47) and Group IV (above 65 years, n=13) [Table/Fig-3].

The correlation between type of lip form and maxillary and mandibular incisal display was done with the help of Pearson's correlation. The Pearson's coefficient value between maxillary incisal display and lip form was r=0.388, p-value=0.001 and between mandibular incisal display and lip form was r=0.409 with a p-value=0.001 (significant when p<0.005) which was statistically significant [Table/Fig-4].

Pearson's Correlation- strong to moderate as per rule of thumb as 'r' equal to or <0.3; average value of lip form measured in mm is taken for comparison with average of maxillary and mandibular incisal display. {One of the subjects had the value of lip form as 9.3 mm and mandibular incisal display as 11.1 mm. As it was high lip form and the patient had more mandibular incisal display, hence, the value was more than 10 mm, (as shown in [Table/Fig-5])}. Therefore, incisal display (maxillary and mandibular) showed a positive correlation with lip form as shown in scatter plot [Table/Fig-5].

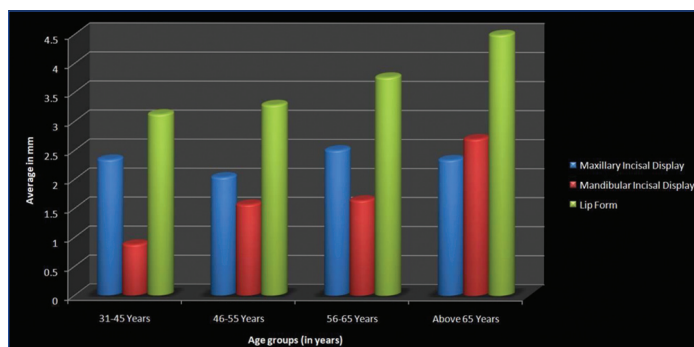
The correlation coefficient between incisal display and lip form for male and female subjects' was r=0.319 and r=0.434, respectively with a p-value=0.001 which was statistically significant. Hence, a positive correlation between lip form and incisal display was found in both male and female groups [Table/Fig-6] as depicted by trend lines on scatter plot. This means that as lip form increases from straight to high, incisal display (both maxillary and mandibular) also increases. So, if a patient with high lip form needs anterior restorations, then more incisal display is kept as compared to straight or moderate lip form.

Independent sample t-test/Student's t-test was used to compare means of incisal display and lip form between groups on gender basis. A statistically significant difference was found in maxillary incisal display and lip form between male and female groups (T=-5.934, p-value=<0.001 and T=-2.367, p-value=0.019, respectively) but no statistically significant difference was found in mandibular incisor display between male and female groups (T=1.832, p-value=0.068) [Table/Fig-7].

Hence, females above 30 years of age had more maxillary incisal display as compared to males but almost same mandibular incisal display. Also, straight lip form was more common among elderly male subjects (63.5% as compared to females 36.4%) but females had moderate lip form most commonly (52.1% as compared to males 47.9%). High lip form was reported equally in both male and female subjects with 50% in each group [Table/Fig-2].

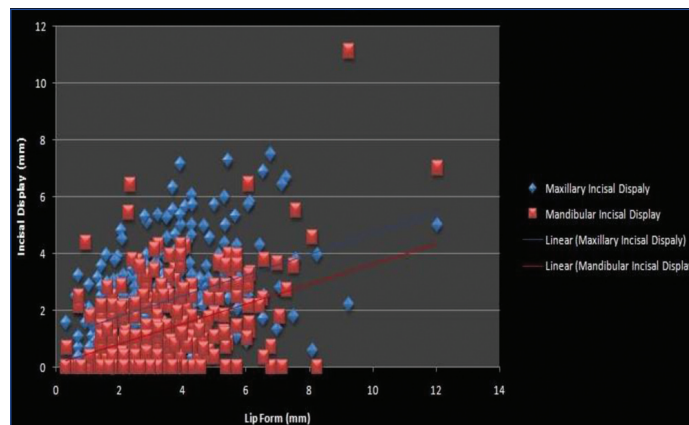
Characteristics	Study population N (%)	Straight lip form n (%)	Moderate lip form n (%)	High lip form n (%)	Maxillary incisal display (Mean) (mm)	Mandibular incisor display (Mean) (mm)
Gender						
Male	180 (55.6)	98 (63.6)	69 (47.9)	13 (50)	1.8145	1.4193
Female	144 (44.4)	56 (36.4)	75 (52.1)	13 (50)	2.8216	1.1228
Total	324 (100)	154 (100)	144 (100)	26 (100)	2.2558	1.2875
Age groups (Years)						
31-45	157 (48.4)	83 (53.9)	64 (44.4)	10 (38.5)	2.3377	0.8572
46-55	107 (33.1)	54 (35.1)	44 (30.6)	9 (34.6)	2.0359	1.5656
56-65	47 (14.5)	13 (8.4)	30 (20.8)	4 (15.4)	2.5030	1.641
>65	13 (4.0)	4 (2.6)	6 (4.2)	3 (11.5)	2.3379	2.6691
Total	324 (100)	154 (100)	144 (100)	26 (100)		

[Table/Fig-2]: Age and gender-wise distribution lip form and incisordisplay of study population (Total N=324).



[Table/Fig-3]: Comparison of maxillary and mandibular incisal display between different age groups with measurements of lip forms.

(Measurement of the lip form of all three types of lip form. For this comparison lip form measurements done in mm of all the patients are taken without classifying them into straight, moderate and high lip form)

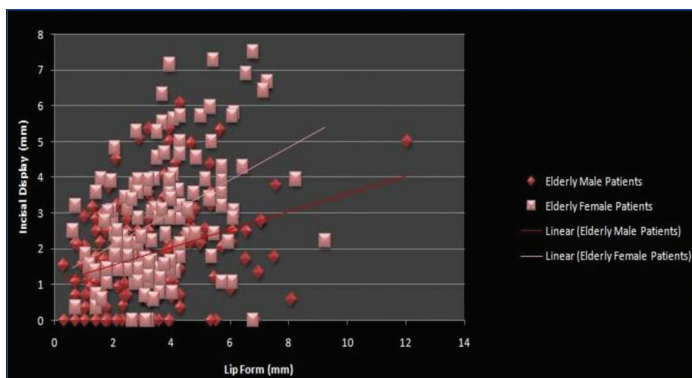


[Table/Fig-5]: Scatter plot showing correlation and trend lines between lip form and maxillary and mandibular incisal display of all the subjects.

Groups	Parameters	N	Pearson's correlation	p-value
Male	Lip form			
	Maxillary incisal display	180	0.319	<0.001
	Mandibular incisal display	180	0.490	<0.001
Female	Lip form			
	Maxillary incisal display	144	0.434	<0.001
	Mandibular incisal display	144	0.334	<0.001
All subjects	Lip form			
	Maxillary incisal display	324	0.388	<0.001
	Mandibular incisal display	324	0.409	<0.001

[Table/Fig-4]: Correlation between incisal display and lip form in various groups (Pearson's Correlation).

One-way ANOVA test was performed to assess how the study groups' (on basis of age groups) incisal display is related to each other. Multiple comparisons between various age groups were performed by post-hoc Tukey-Kramer test. No significant difference was found in maxillary incisal display between various groups but a statistically significant difference was found in mandibular incisal display between various age groups as shown in [Table/Fig-8]. Subjects above 65 years of age were observed with highest mandibular incisal display and subjects between 31-45 years of age group had minimum mandibular incisal display [Table/Fig-8].



[Table/Fig-6]: Scatter plot showing correlation and trend lines between lip form (average of all three types) and maxillary and mandibular incisal display of male and female groups ($r=0.319$ and $r=0.434$, respectively showing moderately strong correlation on basis of thumb rule).

Parameters	Gender	N	Mean	Std. Deviation	T value	p-value	95% Confidence interval of the difference	
							Lower	Upper
Maxillary incisal display	Male	180	1.8145	1.37582	-5.934	0.001	-0.134098	-0.67316
	Female	144	2.8216	1.67923				
Mandibular incisal display	Male	180	1.4193	1.50801	1.832	0.068	-0.02185	0.61495
	Female	144	1.1228	1.36812				
Lip form	Male	180	3.1215	1.75792	-2.367	0.019	-0.81863	-0.07555
	Female	144	3.5686	1.59892				

[Table/Fig-7]: Comparison between male and female groups using Independent t-test (N=324).

Parameters	Age groups	N	Mean	Std. Deviation	p-value	Post-hoc
Maxillary incisal display	31-45 years	157	2.3378	1.57593	0.309	3>2,1,4
	46-55 years	107	2.0359	1.56610		
	56-65 years	47	2.5030	1.68534		
	Above 65 years	13	2.3379	1.73066		
Mandibular incisal display	31-45 years	157	0.8753	0.99139	0.001	4>1,2,3
	46-55 years	107	1.5657	1.50849		
	56-65 years	47	1.6410	1.56956		
	Above 65 years	13	2.6992	2.98841		

[Table/Fig-8]: Comparison between different age groups using one-way ANOVA and Tukey-Kramer test.

DISCUSSION

One of the primary aim of a prosthodontic treatment is to achieve and maintain facial attractiveness/aesthetics. Smile and facial attractiveness are strongly connected to each other. The smile of a person influences his/her perceived attractiveness and is the important aspect of social interaction [19]. In each arena, aesthetics/attractiveness was found to be equally important for both men and women. In modern dentistry, smile analysis and design have become key elements of Prosthodontic diagnosis and treatment planning.

It is difficult to develop an accurate and reproducible method of assessing maxillary and mandibular incisal display at rest and smile that can be adopted universally. Several factors such as age, gender, emotional status, muscle in coordination and circadian rhythms can affect the incisal display at rest [20,21]. Various articles and studies were focused on creating standards for “smile analysis”. Most of the studies that evaluated dental and facial aesthetics used upper and lower gingival exposure, midline and incisal plane tilting, upper and lower incisal visibility etc. The present study specifically focused on age and gender specific effects on maxillary and mandibular incisal display and its correlation with lip form in elderly Indian population.

Tjan AH and Miller GD and Peck S and Peck L found that low smile lines are a predominantly male characteristic and a high smile line is predominantly female [22,23]. They found significant sexual dimorphism, i.e., the Gingival Smile Line (GSL) appears to

be a female lineament and the low smile line seems to be a male lineament. In the present study also, it was found that average incisal display of females is more as compared to males. Vig RG and Brundo GC conducted a survey that correlates measurements of upper lip type, sex, race, and age of dentulous patients with the amount of exposure of the maxillary and mandibular anterior teeth with the lips gently parted and in the resting position [13]. They found that maxillary anterior tooth display was almost twice as often in women as in men, the men displayed much more of the mandibular incisors, and females were found to be twice as likely as males to have a gummy smile. The results of the present study also favour the results of their study. Also, they found that there is gradual reduction in the amount of maxillary central incisor exposure with an increase in age, accompanied by a gradual increase in the mandibular tooth exposure. The results of the present study also confirmed the results of their study.

Lip form measurements thus measured was used to determine the type of lip forms according to Kim J et al., and correlation between lip form and incisor visibility was determined [14]. The findings of this study on the age-related changes in maxillary and mandibular incisal display confirms the results of previous studies by Padmasree S et al., and Motta AFJ et al., that when the lips were at rest, young people display more of their maxillary incisors as compared to elder people [11,24]. But the present study, first time studied the type of lip forms and their correlation with incisal display in elderly Indian population.

Female subjects had moderate lip form most commonly as compared to male subjects and a strong correlation exists between lip form and incisal display of both men and women as shown by scatter plots [Table/Fig-5,6]. These findings may have important implications for prosthodontic treatment planning which tend to ignore long-term changes in the incisor-lip relationships [24]. The incisor visibility given in complete/partial dentures and anterior aesthetic rehabilitations with either conventional Fixed Partial Denture (FPD) or implants have to be modified according to the age and sex of the patients. If not, then the prostheses will end-up in denture/artificial look. A Prosthodontist should understand the age and sex-related changes in the facial tissues and the effect of gravity on the lips. As in this study, only correlation between lip form and incisal display has been studied, studies including more parameters like central incisor and canine relation to maxillary lip, incisal edge position, occlusal plane and midline position etc., with large number of subjects can be done.

Limitation(s)

The number of subjects in 65 years or above age group was less; more subjects could have been included. Also, only frontal view photographs were taken, close-up view and side profile views can be studied.

CONCLUSION(S)

Within the limitation of the study, it could be concluded that, the most common type of lip form in elderly Indian male is straight lip form and in elderly Indian female is moderate lip form. A significant

difference in incisal visibility according to gender was reported. With increasing age, males maxillary incisal display decreased and mandibular incisal display increased. But, females with increasing age showed more of maxillary incisors and less of their mandibular incisors. A strong correlation exists between lip form and incisal display in all age and gender groups. Hence, the present study concluded that, the range of central incisor visibility varies according to age and lip form, and average values cannot be used as a guide for all cases in clinical practice. The study opens the scope of further research in the subject, to substantiate the result of the research.

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