

Influence of upper lip form on incisal display of maxillary central incisors at repose

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ABSTRACT

Introduction: Knowledge of various factors that can influence the upper incisal display is very crucial in order to provide more aesthetically driven restorations and prosthesis. The purpose of this study was to evaluate the influence of upper lip form on incisal display of maxillary central incisors at repose. After correctly identifying the lip form and its relation with incisal display, one can provide more aesthetically pleasing restorations and prosthetic rehabilitations to their patients.

Methods: This is a cross-sectional observational study done at Department of Prosthodontic, NAMS, Bir Hospital. The study subjects included 170 volunteers (87 males and 83 females) aged 18-35 years. Standardized photographs were taken with DSLR camera, and measurements were performed using the keynote application. Lips were classified as straight, moderate, and high. Maxillary incisal display at repose was measured. The independent sample t-test was used to assess the means of incisal display.

Results: The results suggested that the moderate lip form was the most prevalent type. The average amount of incisal display was slightly greater in females for each lip form compared to males. However, the finding was not statically significant. (p-value=0.513)

Conclusion: The moderate lip form, which accounts for 60% of each group, was the most common lip form in both genders. There was a greater incisal display in females in all the lip forms. The influence of lip form on incisal display and sexual dimorphism was clinically obvious, but the values were not statistically significant.

Keywords: Keynote; Lip form; Maxillary incisal display; Repose.

INTRODUCTION

Aesthetics in dentistry is the theory and philosophy that deals with beauty and the beautiful, especially with respect to the

appearance of a dental restoration, as achieved through its form and/or color; those subjective and objective elements and principles underlying the beauty and attractiveness of an object, design or principle.¹ The visibility of anterior tooth surfaces with lips at rest is an important esthetic factor in determining outcome of fixed and removable prosthodontic care, implant dentistry, operative dentistry, anterior aesthetic procedures and orthognathic surgery.² Data on the ideal incisor display to optimize dentofacial aesthetics in wide age range of patients is no less than a blessing.³

Conflict of Interest: None

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Lips provide a beautiful frame to smile. Length and curvature of the lips greatly influence tooth display at rest.⁴ According to Zachrisson, if aesthetics is the starting point, the evaluation should start at the position of the maxillary central incisors to the upper lip. In addition to the person's age and gender, the degree of maxillary incisal display (MID) is determined by a variety of hard and soft tissues that surround and support the maxillary incisors.^{2,5} When discussing soft tissues that affect the incisal display, lip morphology is another crucial consideration.⁶ Under lip morphology, the literature has largely focused on lip length, lip type, and their influence on incisal display.^{7,8} However, literature about the influence of lip form on incisal display has been least reported.^{5,9,10}

Cutbirth suggested three different lip forms (straight, moderately arched and maximally arched) yet he failed to define parameters and procedures for obtaining that classification.¹¹ Kim et al first described the lip form with standard parameters. He defined 3 lip forms (straight, moderate and high) based on distance between the highest portion of the lower vermilion border of upper lip to the line drawn between the commissures.⁵ Many authors had given different guidelines for the upper incisal display regardless of different lip forms. Bouchers and his associates suggested the fabrication of a maxillary occlusal rim so that it would gently touch the lower lip during the pronunciation of the letter 'f'. Accepted prosthodontic guidelines recommend the displaying of 2-4 mm of maxillary incisal teeth at rest position of the lip.¹² This is true if the patient has a horizontally straight lip in repose.¹³ Lip and the upper incisal display are unique to an individual and are governed by multiple factors.

There is sexual dimorphism present in the mean maxillary incisal display. Studies found mean maxillary incisor display in men was less than in women at rest.^{2,7,8} On average the

incisal display of women is twice that of men.⁷ This information aids in replacing or restoring the maxillary incisors more aesthetically. The mean upper lip length is more in men as compared to women.¹³ This too may be among the contributing factors for the lesser incisal display of maxillary incisors in men. Likewise, prevalence of specific lip forms in men and women could be another contributing factor for this discrepancy in MID. Perioral tissues sag and become less elastic and more immobile, displaying of less maxillary and more display of mandibular teeth as age advances.² Reduction in the amount of anterior teeth visibility predispose one to the perception of premature aging.¹

So, making the denture in similar manner using constant therapeutic values, incisal display 2 mm below the relaxed lips, for all patients irrespective of their sex, and gender would greatly result in fabrication of denture with typical lifeless 'denture look'. Teeth restored without considering these factors would also lead to aesthetically inharmonious MID.⁷ In order to provide more aesthetically driven restorations and prosthesis it is essential to have in depth knowledge of various factors that can influence the upper incisal display.⁶

Literatures pertaining to influence of lip form on upper incisal display is very limited.^{5,9,10} In available literature, samples were collected through online electronic platform such as Facebook, Instagram and this method of sample collection raise the question on authenticity of collected photos. With a goal to overcome this shortcoming of previous studies, this study intends to collect data by directly taking the photographs of volunteers. The aim of this study was to evaluate the influence of upper lip form on incisal display of maxillary central incisors at repose.

METHODS

This cross-sectional observational study was

conducted at prosthodontic unit, department of dental surgery, NAMS, Bir hospital, Kathmandu after ethical clearance from institutional review board (reference no.72912079180). The duration of study was from 21st November 2022 to 1st October 2023. All volunteers were thoroughly explained the nature, risks and benefits of the investigation and associated procedures and written consents were obtained before their inclusion.

The sample size was determined using the research of the Jordanian population, who observed a correlation between upper lip length and the display of maxillary incisors at rest.^{11,12} In order to determine the sample size, the power was set at 90% and alpha was maintained at 0.05, which revealed that a sample of 170 volunteers was necessary. This produced a total sample of 170 volunteers with an age range of 18 to 35 (87 men and 82 women). Sample included volunteers with presence of intact natural maxillary anteriors without caries, extreme occlusal wear, restorations, extrusion, obvious deformities, or tooth mobility. Volunteers with a history of congenital anomalies, lip trauma, or facial surgery, orthodontic movement of maxillary anterior teeth, plastic surgery involving the lips, existing prostheses in the maxillary anterior region, protrusive maxilla, or lack of incisal display at rest were excluded.

The mesiodistal width of both central incisors were measured with the help of divider and metallic scale for standardization of the Digital Smile Design (DSD) ruler. The mesiodistal measurements were taken at maximum dimension. To accomplish natural head position (NHP), volunteers were given the initial instructions to sit erect on an office adjustable chair with their feet on the ground. They were asked to hold their head in a relaxed, unsupported position and fix their gaze on a point positioned at eye level on the wall. This ensured that the horizontal visual axis remained

parallel to the floor and that head posture was standardized during image acquisition.¹⁴ The lip position at repose was recorded by asking the volunteer to pronounce the word “Emma” three times, after which a photograph was captured. This approach reflects the concept of repose, representing the natural state of rest, relaxation, or tranquility of the lips.

Standardized extraoral photographs were obtained using a Canon EOS 250D DSLR (2019, Japan) from a frontal view capturing the region from the philtrum to the menton. The camera was mounted on a tripod placed 5 feet from the subject, aligned parallel to the floor, and its level was verified using the tripod’s builtin bubble gauge to maintain consistent angulation and minimize measurement error.¹⁵

The images were subsequently imported into the Keynote (version-11.2). DSD ruler was calibrated in reference with clinically measured mesiodistal width of incisors for each patient. Then the lip forms were classified as proposed by Kim et al classification of lip form.⁵ The distance from the highest aspect of lower vermilion border of upper lip to an imaginary line drawn between the commissures were measured. If right and left commissures were not aligned in straight line then commissure at lower level were taken as reference.¹⁶ Lip was called straight lip form if the distance between aforementioned landmarks was 0 to 3 mm in height. Lip form was called moderate lip form if distance between them is 3 mm to 6 mm. Lip form was high lip form, when distance was greater than 6 mm in height. When there were overlapping in measurements, for example 1-3 as straight and 3-6 as moderate, classifications were governed subjectively.

Maxillary incisal display at rest was measured as a distance from the inferior part of the upper lip most specifically from stomion to the incisal edge of maxillary central incisors at the midpoint of right and left maxillary central

incisors and average of it was taken as final maxillary incisal display for that particular lip form.¹³ Data analysis was performed using R version 4.3.1.

DATA ANALYSIS

A descriptive analysis of the data was done by calculating standard deviation for quantitative variables. Results were evaluated by using chi square test and independent t – test. The level of significance was set at $p < 0.05$. The results were presented in the form of tables and boxplot.

RESULTS

A total of 170 participants were included, comprising 87 males and 83 females. The overall mean incisal display was 3.65 ± 1.48 mm in males and 4.05 ± 1.98 mm in females. The mean distance from the lower border of the upper vermillion to the commissure was 4.07 ± 1.91 mm in males and 4.22 ± 1.73 mm in

females. No statistically significant differences were observed for incisal display ($t = -1.434$, $p = 0.153$) or vermillion-to-commissure distance ($t = -0.527$, $p = 0.384$) among males and females.

The results in Table 1 suggested that the lip form categorized as 'moderate' was the most prevalent, making up more than 60% of the cases in both groups. There was no significant relationship between lip form and gender.

The average amount of incisal display was slightly greater in females for each lip form compared to males. However, no significant difference between males and females was found, as indicated in Table 2.

The average distance from the lower border of the upper vermillion to the commissures was determined to be 4.22 for females, slightly greater than that of males. However, no statistically significant difference was observed in these results as shown in Table 4.



Figure 1: Female volunteers with different lip forms. A. Straight lip form, B. Moderate lip form and C. High lip form



Figure 2: Males volunteers with different lip forms. A. Straight lip form, B. Moderate lip form and C. High lip form

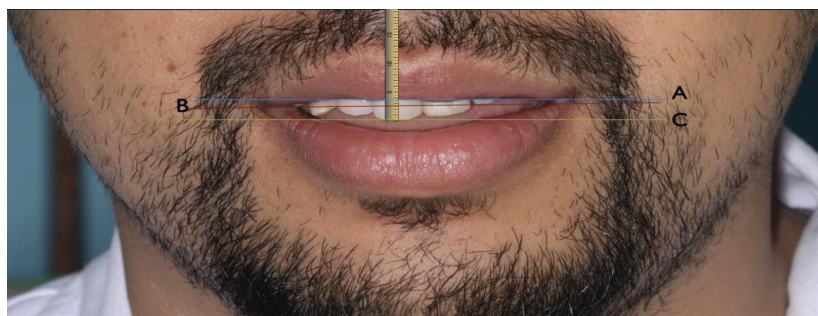


Figure 3: Different horizontal reference lines in male volunteer. A. Line drawn from the highest point of lower vermilion border of upper lip. B. Line drawn from the incisal edges of maxillary central incisors. C. Line drawn from the commissures of the mouth.

Table 1: Lip forms among females and males

Gender	Lip Form (Frequency and Percentage)			P- value
	High N (%)	Moderate N (%)	Straight N (%)	
Female	20 (24.09)	52 (62.65)	11 (13.25)	.97
Male	22 (25.28)	53 (60.91)	12 (13.79)	

Table 2: Incisal display among females and males

Lip Form	Incisal Display		t-value	p-value
	Female Mean $\pm$ SD (mm)	Male Mean $\pm$ SD (mm)		
Straight	2.52 $\pm$ 1.34	2.15 $\pm$ 0.90	1.071	0.29
Moderate	4.12 $\pm$ 1.37	3.68 $\pm$ 1.37	1.63	0.105
High	6.5 $\pm$ 1.5	6.25 $\pm$ 2.09	0.32	0.747

Table 3: Gender and incisal display

Gender	Frequency	Mean(mm)	SD(mm)	t-value	p-value
Male	87	3.65	1.848	-1.434	0.153
Female	83	4.05	1.798		

Table 4: Gender and distance from the lower border of upper vermillion to commissures

Gender	Frequency	Mean (mm)	SD (mm)	t	P-value
Male	87	4.07	1.913	-0.527	0.384
Female	83	4.22	1.734		

DISCUSSION

Developing a consistently applicable, precise, and reproducible technique for evaluating the influence of lip form on maxillary incisal display is challenging. Several factors, such as age, sex, emotional state, and circadian rhythm, can influence orofacial muscle activity and incisal exposure.⁶ Furthermore, natural facial expressions and speech make standardized evaluation difficult. Hence, this study included a sample of young adults (18–35 years) at repose, with nearly equal male and female representation. Since the degree of anterior tooth display at rest is an important esthetic determinant in prosthodontic, implant, restorative, and orthognathic treatments, consideration of individual lip form remains crucial for achieving natural esthetics.

In this study, moderate lip form was most prevalent (60%), with no significant gender-based difference. This contrasts with Kundu's findings, where straight lip form was most common, possibly due to ethnic variation between Nepalese and Indian populations.² Al-Wazzan also noted racial variations in incisal display among Arabs, African Blacks, and East Asians, while Moshiri et al. reported that Black individuals exhibited less incisor exposure than Whites.^{4,8,17} These observations suggested that both lip form and incisal display can vary with ethnicity and race.

Female participants consistently showed greater incisal display than males (4 ± 1.79 mm, $3.65 \pm$

1.84 mm respectively, $p = 0.15$), demonstrating sexual dimorphism that was clinically relevant but not statistically significant. Differences may be attributed to variations in facial anatomy, including shorter clinical crowns, thicker zygomaticus major muscles, and a higher prevalence of Class II jaw relationships among females, contributing to greater incisal exposure.^{18,19} The findings of this study contrasts with findings from Al-Wazzan et al.², Al-Hababbeh et al.¹², Roe et al.¹³, and Awad et al.¹⁸, who reported statistically significant gender differences in maxillary display. The results of the present study align with those of Zaini et al.²⁰ and Suh et al.²¹, where females showed higher mean incisal display than males, although the differences between genders did not reach statistical significance. Age demonstrated a negative correlation with incisal display, consistent with studies indicating a gradual decrease in incisal exposure with advancing age.^{7,22-24}

To enhance reliability, both direct (ruler-based) and indirect (digital photographic) measurement methods were employed and calibrated in Keynote. This hybrid approach improved measurement accuracy compared to studies using only manual tools or online photographs, thereby increasing validity. Despite efforts to standardize methodology, the study has limitations. The ruler used for direct measurements had a 0.5 mm precision, lower than that of vernier calipers (0.01 mm), which may have slightly affected accuracy.

Additionally, although participants were instructed to fix their gaze at eye level to maintain a natural head position (NHP), the absence of a cephalostat may have introduced minor variability.

Nevertheless, by focusing on a young age group, standardized repose position, and inclusion of both direct and indirect measurements, this study achieved reliable and clinically relevant results.

CONCLUSION

Within the limitation of the study following conclusions were drawn:

The moderate lip form was the most prevalent (60%) in both genders.

Incisal display increased progressively from straight to moderate to high lip forms, and for the same lip form, females showed greater incisal display than males. Although these trends were clinically evident, they were not statistically significant.

There was a greater incisal display in females in all the lip forms, however the values were not statistically significant.

Future studies should include larger and more diverse populations to improve generalizability.

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