The Influence of Upper Lip Length and Lip Mobility on Maxillary Incisal Exposure

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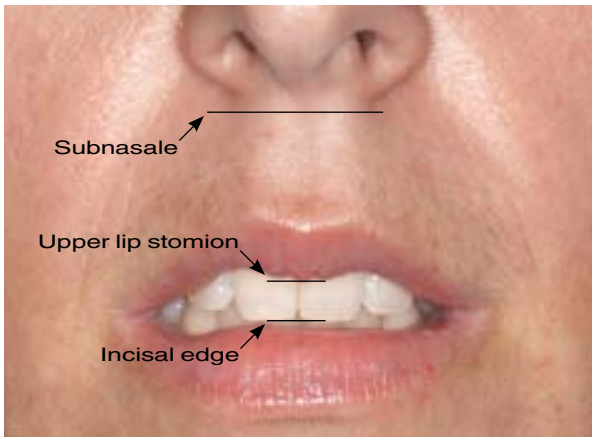
This study evaluated the influence of upper lip length on maxillary incisal exposure at the rest position and categorized these findings according to sex in a young population. The degree of lip mobility between the rest position and maximum smile were also quantified. A total of 120 subjects (60 men and 60 women) with a mean age of 26.5 years (range: 18 to 35 years) participated in this study. Standardized photographs were taken of each subject at the rest position and at maximum smile. The following factors were evaluated and quantified: upper lip length at the rest position (categorized as short or normal lip length), maxillary incisal exposure at the rest position, dentogingival exposure at maximum smile, and overall lip mobility. Data were analyzed using the independent *t* test at a significance level of $\alpha = .05$. In both men and women, there were significant differences between the normal and short lip groups in the amount of maxillary incisal exposure at rest ($P < .05$) but not in the amount of dentogingival exposure or overall lip mobility ($P > .05$). At maximum smile, all groups exhibited an approximately 30% decrease in upper lip length compared to the rest position. While the amounts of incisal and dentogingival exposure at rest and maximum smile may be used to evaluate facial/smile esthetics, there is a wide range of esthetically acceptable values. *(Am J Esthet Dent 2012;2:116–125.)*

It has been well established that the position of the maxillary central incisors serves as the foundation for developing successful esthetic, phonetic, and functional outcomes.[1,2] The clinician must consider multiple factors for each patient to establish an acceptable position for the maxillary central incisors. These factors include the age of the subject,[2–6] sex,[2–4,7–9] phonetics,[1,10–12] facial structure,[3,7,13–15] muscle capacity,[15,16] and ethnicity.[3,8]

Regarding the relationship between upper lip length and maxillary incisal exposure, significant differences have been confirmed between patients with normal and short lip lengths at the rest position.[3] Further, the amount of dentogingival exposure appears to be proportional to the degree of lip mobility.[16,17] Since upper lip length and lip mobility have a direct effect on dentogingival exposure at the rest and maximum smile positions, quantitative analysis of these two factors would provide valuable information to the clinician when evaluating smile esthetics.

The purpose of this study was to evaluate the influence of upper lip length on maxillary incisal exposure at the rest position and to categorize the findings according to sex in a subject population aged between 18 and 35 years. Although the average incisal exposure at the rest position has been reported previously,[3,6,8,9] no studies have investigated the relationship between lip length and incisal exposure in terms of sex. The degree of lip mobility between the rest position and maximum smile were also quantified.



Figs 1a and 1b Anatomical landmarks at the *(left)* rest and *(right)* maximum smile positions.

MATERIALS AND METHODS

Subject selection

This study was approved by the Institutional Review Board of Loma Linda University and was conducted in the Loma Linda University School of Dentistry, Center for Prosthodontics and Implant Dentistry, Loma Linda, California. The inclusion criteria were as follows: subjects between 18 and 35 years of age, presence of all maxillary anterior teeth, and acceptable esthetic tooth display at the rest and maximum smile positions as determined by the subject and the examiners. Subjects with dental irregularities (eg, apparent loss of incisal tooth structure due to attrition, fracture, dental caries, or restorative treatment) or any lip malformations were excluded.

Data collection

All participants were asked to attend one clinical session in which standardized photographs were taken at rest and at maximum smile. Subjects were asked to focus on a distant point at eye level to create a natural head position.[18] All photographs were taken using a Nikon D2Xs digital single-lens reflex camera using a 105-mm f/2.8D AF Micro-Nikkor lens (Nikon) at a 1:5 fixed magnification. Images were imported into presentation software (Keynote 2009, Apple) at a resolution of 1,920 × 1,080. To calculate the number of line pixels for a determined length, a digital photograph of a measuring device (millimeter ruler) was also taken at the same magnification. The known length (10 mm) was calculated in pixel values (170 line pixels). Dentofacial measurements were converted to the nearest 0.1 mm using the following equation:

True value in mm = x / 17.0

where x equals the line pixels measured in Keynote.


Figs 2a and 2b Female subject displaying a normal upper lip length (18.0 to 22.0 mm).

Upper lip length

Subjects were divided into groups according to sex and upper lip length at rest (Figs 1 to 5). The upper lip length was defined as the distance between the base of the nose (subnasale) and the inferior part of the upper lip (upper lip stomion) (Fig 1a). Subjects were classified as having a normal (N) upper lip when they displayed an upper lip length between 18.0 and 22.0 mm for females (FN) and 20.0 and 24.0 mm for males (MN).[19] Subjects with upper lip lengths below these ranges were categorized as having a short (S) upper lip length (< 18.0 mm = FS and < 20.0 mm = MS).[19] Subjects with lip lengths greater than the normal range were excluded from the study.

Maxillary incisal exposure

Maxillary incisal exposure at rest was defined as the distance from the inferior part of the upper lip (upper lip stomion) to the incisal edge (see Fig 1a).

Dentogingival exposure

Dentogingival exposure was defined as the distance from the inferior part of the upper lip (upper lip stomion) to the incisal edge when the upper lip was at the maximum smile position (see Fig 1b).

Lip mobility

Upper lip mobility was defined as the amount of lip movement that occurs when the patient smiles.[20] This was calculated by subtracting the incisal exposure at rest from the dentogingival exposure during maximum smile.

Decrease in upper lip length

The decrease in upper lip length during maximum smile was expressed as a percentage using the following formula:

(lip mobility / upper lip length at rest) × 100


Figs 3a and 3b Female subject displaying a short upper lip length (< 18.0 mm).


Figs 4a and 4b Male subject displaying a normal upper lip length (20.0 to 24.0 mm).


Figs 5a and 5b Male subject displaying a short upper lip length (< 20.0 mm).

Reproducibility

The intraexaminer reliability of the measurements was determined using double assessments of 10 randomly selected photographs of subjects at the rest and maximum smile positions. These measurements were made 1 month apart by one examiner (PR) and expressed as the intraclass correlation coefficient.

Data analysis

The following data were recorded for each subject: age, sex, upper lip length at rest, maxillary incisal exposure at rest, dentogingival exposure at maximum smile, and overall lip mobility. Data were analyzed using the independent *t* test at a significance level of $\alpha = .05$.

RESULTS

A total of 120 subjects (60 men and 60 women) with a mean age of 26.5 years (range: 18 to 35 years) were evaluated in this study. The high intraclass correlation coefficient (0.99) indicated that the measurement method was reliable and reproducible.

Upper lip length

The mean upper lip length was 20.4 ± 1.3 mm for the FN group and 17.4 ± 0.7 mm for the FS group. For the MN and MS groups, the mean upper lip length was 22.7 ± 1.1 mm and 19.1 ± 0.6 mm, respectively.

Maxillary incisal exposure

At the rest position, there were significant differences in the mean maxillary incisal exposure between the FN group (3.2 ± 1.5 mm) and FS group (4.5 ± 1.9 mm) ($P = .010$, Table 1) as well as between the MN group (2.3 ± 1.4 mm) and MS group (3.7 ± 1.3 mm) ($P = .003$, Table 2).

Dentogingival exposure

At the maximum smile position, there were no significant differences in the mean dentogingival exposure between the FN group (9.0 ± 2.0 mm) and FS group (9.5 ± 1.8 mm) ($P = .712$, Table 1) or between the MN group (8.9 ± 2.3 mm) and MS group (9.4 ± 1.6 mm) ($P = .801$, Table 2).

Twenty-six subjects (21.7%) presented with a continuous band of gingiva from canine to canine in the maximum smile position. Of these 26 subjects, 65.4% were women and 34.6% were men, and 38.5% were in the normal lip group and 61.5% were in the short lip group.

Lip mobility

There were no significant differences in mean lip mobility between the FN group (5.8 ± 1.7 mm) and FS group (5.0 ± 1.3 mm) ($P = .216$, Table 1) or between the MN group (6.7 ± 1.5 mm) and MS group (5.7 ± 1.1 mm) ($P = .057$, Table 2).

Table 1 Comparison of dentolabial measurements (mean ± SD) between the FN and FS groups (independent *t* test)

			Rest position		Maximum smile		
Group	n	Age (y)	Upper lip length (mm)	Incisal exposure (mm)	Dentogingival exposure (mm)	Lip mobility (mm)	Upper lip length decrease (%)
FN	30	27.6	20.4 ± 1.3	3.2 ± 1.5	9.0 ± 2.0	5.8 ± 1.7	28.3
FS	30	25.7	17.4 ± 0.7	4.5 ± 1.9	9.5 ± 1.8	5.0 ± 1.3	28.8
P				.010*	.712	.216	.725

SD = standard deviation; FN = female normal lip length; FS = female short lip length.
*Statistically significant.

Table 2 Comparison of dentolabial measurements (mean ± SD) between the MN and MS groups (independent *t* test)

			Rest position		Maximum smile		
Group	n	Age (y)	Upper lip length (mm)	Incisal exposure (mm)	Dentogingival exposure (mm)	Lip mobility (mm)	Upper lip length decrease (%)
MN	30	27.0	22.7 ± 1.1	2.3 ± 1.4	8.9 ± 2.3	6.7 ± 1.5	29.6
MS	30	26.7	19.1 ± 0.6	3.7 ± 1.3	9.4 ± 1.6	5.7 ± 1.1	29.8
P				.003*	.801	.057	.824

SD = standard deviation; MN = male normal lip length; MS = male short lip length.
*Statistically significant.

Decrease in upper lip length

There were no significant differences in the mean decrease in overall lip length at maximum smile between the FN group (28.3%) and FS group (28.8%) ($P = .725$, Table 1) or between the MN group (29.6%) and MS group (29.8%) ($P = .824$, Table 2).

DISCUSSION

Comprehensive assessment of dentofacial esthetics requires the clinician to evaluate and reproduce the patient's natural social posture and head position. Therefore, it has been recommended that facial esthetics be assessed in relation to the natural head position of the subject.[18,21-26] The natural head position reflects the orientation of an individual's head when his or her eyes are focused on a distant point at eye level.[18] In addition to head position, studies investigating smile dynamics have suggested the use of two easily reproducible postures of the upper and lower lips: the position of the lips at rest and the position of the lips at maximum smile.[27] This approach was used in the present study.

Table 3 Range of dentolabial measurements between all study groups

Group	Incisal exposure (mm)	Dentogingival exposure (mm)	Lip mobility (mm)	Upper lip length decrease (%)
FN	0.6–5.2	4.6–14.3	3.0–9.2	14.2–43.9
FS	0.0–9.1	4.5–13.0	2.6–8.1	14.5–45.3
MN	0.0–5.5	5.5–13.2	3.4–9.9	15.5–42.9
MS	0.0–5.4	4.3–11.3	3.9–7.9	21.9–39.7

FN = female normal lip length; FS = female short lip length; MN = male normal lip length; MS = male short lip length.

Previous research has shown that there are significant differences in the upper lip length and amount of tooth exposure between individuals with normal and short lip lengths.[3] Further, a significant difference in upper lip length has been noted between the sexes, with female subjects exhibiting an upper lip length approximately 2 mm shorter than male subjects at the rest position.[27] This difference appears to be one factor that may account for the increased maxillary incisal exposure in female subjects in both the rest and maximum smile positions, particularly in subjects with a short lip.[16,27,28] In this study, a significant difference in the amount of maxillary incisal exposure was observed between the normal and short upper lip groups in both sexes (Tables 1 and 2). The mean maxillary incisal exposure for the FN, FS, MN, and MS groups was 3.2 ± 1.5 mm, 4.5 ± 1.9 mm, 2.3 ± 1.4 mm, and 3.7 ± 1.3 mm, respectively. These findings are similar to those of previous studies.[3,6,8,9] Nevertheless, it is important to note that regardless of the wide range of maxillary incisal exposures noted in each study group (Table 3), the amount of exposure was esthetically acceptable to both the subjects and examiners.

In the maximum smile position, the mean dentogingival exposure for the FN, FS, MN, and MS groups was 9.0 ± 2.0 mm, 9.5 ± 1.8 mm, 8.9 ± 2.3 mm, and 9.4 ± 1.6 mm, respectively. Subjects with shorter lip lengths displayed a greater amount of the maxillary incisors at rest. A wide range of esthetically acceptable dentogingival exposure was observed in all study groups irrespective of upper lip length (Table 3). These results support the findings of Peck et al,[16] who stated that dentogingival exposure appears to be dependent on the combined effects of several variables (greater muscle capacity, anterior vertical maxillary excess, excessive interlabial gap at rest, and the degree of overjet and overbite).These variables appeared to have a stronger influence on the degree of dentogingival exposure when smiling than upper lip length.[16] In the present study, 21.7% (26/120) of subjects showed a continuous band of gingiva from canine to canine at maximum smile (mean: 1.8 mm,

range: 0.8 to 4.0 mm). Of these 26 subjects, 65.4% were women and 61.5% belonged to the short lip group. These results indicate that while dentogingival exposure in the maximum smile position is more prevalent in the short lip group, it is not uncommon in the normal lip group (38.5%). Therefore, when evaluating a smile, it is important to remember that dentogingival exposure in the maximum smile is an esthetically acceptable anatomical variation.[16] The degree of dentogingival exposure should be evaluated in terms of the unique facial esthetics of that particular individual.[16]

In addition to lip length, the degree of upper lip mobility has a direct effect on dentogingival exposure. Peck and Peck[17] reported an average lip mobility of 5.2 mm (23% decrease) from an initial lip length of 22.3 mm during posed smiles. In a study evaluating spontaneous smiles, Tarantili et al[29] reported a 28% decrease in the initial upper lip length. In the present study, the overall mean lip mobility for groups FN, FS, MN, and MS was 5.8 ± 1.7 mm, 5.0 ± 1.3 mm, 6.7 ± 1.5 mm, and 5.7 ± 1.1 mm, respectively. It is interesting to note that regardless of upper lip length and sex, the decrease in overall lip length during the maximum smile was similar for all groups (see Tables 1 and 2, $P > .05$). However, despite this similarity, a wide range was observed for all groups (14.2% to 45.3%) (Table 3). These findings indicate the amount of lip mobility that should be expected at maximum smile in relation to the upper lip length at the rest position, irrespective of sex and lip type. This information can aid the clinician in determining how much dentogingival exposure to anticipate.

An analysis of subjects with a greater than normal upper lip length would have provided further insight into the relationship between upper lip length and lip mobility in maxillary incisal exposure. However, such a group was excluded from this study due to the inadequate number of subjects encountered (5/125) who met the inclusion criteria. This was not surprising considering the age of the subjects evaluated in this study (mean: 26.5 years, range: 18 to 35 years), since an increase in upper lip length is commonly associated with increased age.[3]

CONCLUSIONS

While the amount of incisal and dentogingival exposure at the rest and maximum smile positions may be used to evaluate facial/smile esthetics, the wide range of the esthetically acceptable values observed in this study suggests that such evaluations are not objective. An esthetic smile depends on many factors that are present in all types of people but unique to each individual.

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