Original Article

Incisor display during speech and smile: *Age and gender correlations*

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ABSTRACT

Objective: To evaluate age- and gender-related changes in the soft tissues, incisors, and gingival display during rest, speech, and posed smile.

Materials and Methods: A total of 265 participants (122 men, 143 women) ranging in age from 19 years to 60 years were recruited for this study. Participants were divided into one of the following four age groups: 19 to 24 years, 25 to 34 years, 35 to 44 years, and 45 to 60 years. Image capture was performed using standardized videographic methods. Each video produced pictures where measurements were performed: rest, speech, and smile positions.

Results: A statistically significant gender dimorphism was apparent in most of the variables. There was a significant increase in the upper lip length and lip commissures height with aging and more markedly in men. A greater exposure of mandibular incisor with increasing age was a feature in both genders. With increasing age there was a significant decrease in maxillary incisor display, especially for men.

Conclusions: After 25 years of age there is significant difference in the aging process between men and women. Gingival and maxillary incisor display during speech and smile is a youthful and feminine characteristic. (*Angle Orthod.* 2016;86:631–637.)

KEY WORDS: Aging; Smile; Orthodontics; Gender; Video recording

INTRODUCTION

Orthodontists must work with two dynamics while planning treatment. The first dynamic is the observation of soft tissue at rest and during animation, and the second is the facial changes that occur throughout the life of the individual.[1]

Time has recently been recognized as the fourth dimension when evaluating facial esthetics.[1,2] Aging is an inevitable process that leads to many skeletal and soft tissues changes. This process particularly affects the lips and causes numerous changes, including thinning, inversion, redundancy, and an increase in length.[3]

Digital videography facilitates patient observation during rest, conversation, and smiling, providing information that cannot be visualized with a static image.[1,2,4,5] Digital videography is also a helpful tool for studying the changes resulting from the aging process.[1,4]

The lip-tooth relationship changes over time, with a decrease in the extent of maxillary incisor exposure. Furthermore, men and women present distinct patterns related to the lip-tooth relationship. Knowledge of age-related dentofacial changes has become critical to achieving clinical success, maximizing smile esthetics and obtaining healthy and long-lasting results for patients of all age groups.[3,6]

The purpose of this study was to dynamically evaluate the exposure of the perioral soft tissues, incisors, and gingival display during rest, speech, and smile to investigate age- and gender-related changes.

MATERIALS AND METHODS

This study was conducted with 265 participants selected from students, residents, faculty, patients, and parents or guardians of patients at the School of Dentistry of Rio de Janeiro State University. There were 143 women and 122 men ranging in age from 19

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Table 1. Distribution of the Study Population According to Gender and Age Group

	Age Group				
	1 (19–24 Years)	2 (25–34 Years)	3 (35–44 Years)	4 (45–60 Years)	Total
Women	33	44	31	35	143
Men	31	31	30	30	122
Total	64	75	61	65	265

years to 60 years. The sample was divided into four age groups and was analyzed according to gender (Table 1). All participants presented with clinically healthy maxillary and mandibular incisors and good periodontal attachment and dental alignment.

The exclusion criteria were as follows: active orthodontic treatment or completed treatment in the past 5 years, orthognathic surgery or facial plastic surgery, periodontal surgery in the region of the incisor, veneers or prosthetic crowns on the incisors, prosthetic or cosmetic increase in the crown length of the maxillary incisors, severe periodontal disease affecting the incisors, limitation in facial mobility, severe dentofacial deformity, botulinum toxin in the perioral region within the 12 months prior to the study, missing teeth in the anterior region, fractured or worn incisors, or malocclusions that could affect the outcome of the study, such as a deep overbite, an increased overjet, an anterior open bite, and crossbites.

This study was approved by the Ethics Research Committee of Pedro Ernesto Hospital, Rio de Janeiro State University, under protocol 2704/2010 (CAAE: 0149.0.228.000-10). Each individual who voluntarily agreed to participate signed an informed consent.

A digital video of the lower portion of the face of each participant was obtained. A natural head position was chosen for standardization, and for this reason, a cephalostat was used to stabilize the head of each subject, restricting and limiting excessive movement.

A mini digital video (DV) video camera (DCR-HC52, Sony, Tokyo, Japan) was placed on a tripod approximately 90 cm from the participant. This distance was standardized and represented the distance during a social conversation.[7] A second tripod with an acrylic plate with a millimeter marker was positioned flush to the participant's lips for later image calibration using a computer program. The camera lens was adjusted vertically to be parallel to the occlusal plane, and the camera was focused only on the lower face so that the mouth was in the center of the display. The frame was captured from the nose to the chin, protecting the anonymity of the subject.

A sentence in Portuguese, "*Tia Ema torcia pelo antigo time da Tchecoslováquia,*" followed by a smile was created as the script for participants under the guidance of a speech therapist, who translated the sentence phonetically from its original in English: "*Chelsea eats cheesecake on the Chesapeake*." The sentence was created by Ackerman and Ackerman[5] in 2002 to capture the greatest exposure of the incisor teeth during speech. According to Morley and Eubank,[8] enunciation of the phoneme "M" is used to obtain the exposure of the incisor teeth at rest. This phoneme was therefore added to the recording to determine the least exposure of the incisor. Recording began approximately 5 seconds before the participant began speaking and ended after the smile.

Video Editing

The video clips were transferred to a computer containing software (Adobe Premiere Pro, version 2.0, Adobe, San Jose, Calif) that was used to observe the dynamics of speech and smile.

Each video was analyzed and fragmented during rest, speech, and smile. Four static frames (photos) were selected that best represented a resting position, the least exposure of the maxillary central incisor during speech, the greatest exposure of the maxillary and mandibular central incisors during speech, and a posed smile.

To facilitate the selection of frames corresponding to each phoneme, measurements were made within the selected frames with a specific freeware program (VIDEOMED 1-16.9.2002 ALPHA, version PAEDD), which allowed the investigator to view the images while hearing the speech of the participants. The same operator performed all procedures. This method has been previously described in detail.[9]

The videos were 12 seconds in duration on average, with an average resolution size of 47 Mb. In total, there were approximately 360 frames per video.

Measurements

The following measurements (see Figures 1 to 4) of the teeth and soft tissue were recorded:

- rest frame: (1) upper lip length, (2) right lip commissure height, and (3) left lip commissure height;
- pronunciation of phoneme "M": (4) the least exposure of the maxillary central incisor during speech;
- pronunciation of the syllable "chee": (5) the greatest exposure of the maxillary central incisor and (6) the mandibular central incisor during speech; and
- posed smile: (7) maximum exposure of the maxillary central incisor and (8) gingival display.

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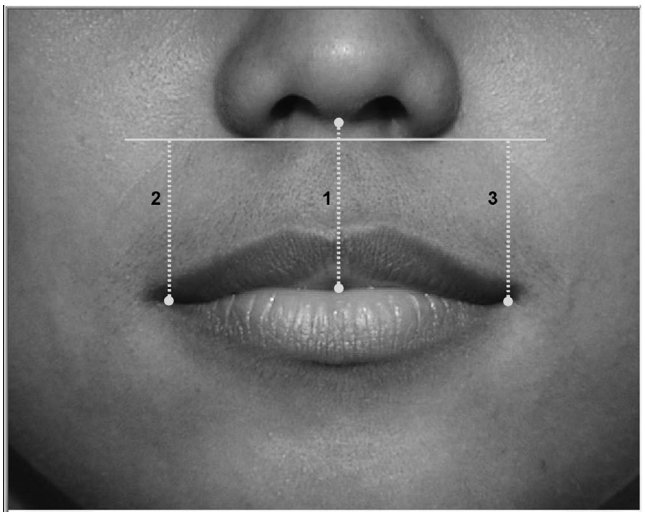

Figure 1. Measurements taken on rest frame: (1) upper lip length, (2) right lip commissure height, and (3) left lip commissure height.

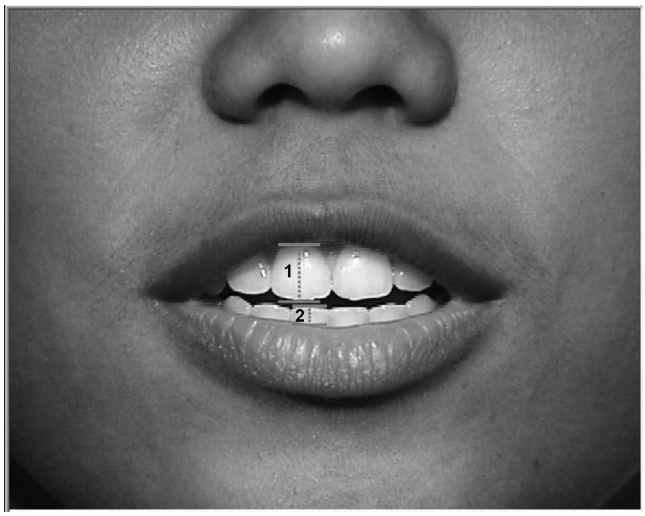

Figure 3. Measurements taken of the greatest exposure of the maxillary central incisor (1) and the mandibular central incisor during speech (2).

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences version 18 (SPSS Inc, Chicago, Ill, USA). Descriptive statistics (means and standard deviations) were obtained for each measurement. The Kolmogorov-Smirnov test showed a normal distribution of all variables.

The groups were compared to evaluate the effect of age in men and women separately by analysis of variance (ANOVA). If the ANOVA revealed statistical significance, a Tukey's post hoc test was used to identify which age groups were associated with the differences.

The groups were also compared to evaluate the gender dimorphism within each age group using a *t*-test. The significance level was set at .05.

RESULTS

The results are shown in Tables 2 through 5. Statistically significant gender dimorphism was apparent in most of the measured variables.

Soft Tissue Changes

The upper lip length presented larger values in the men ($P = .001$). This distance was higher in group 4 when compared with the other groups. Post hoc analysis revealed statistically significant differences between groups 1 and 3 ($P = .020$) and between groups 1 and 4 ($P = .001$). Furthermore, the upper lip lengths of the men in group 2 ($P < .05$), group 3 ($P < .05$), and group 4 ($P < .05$) were found to

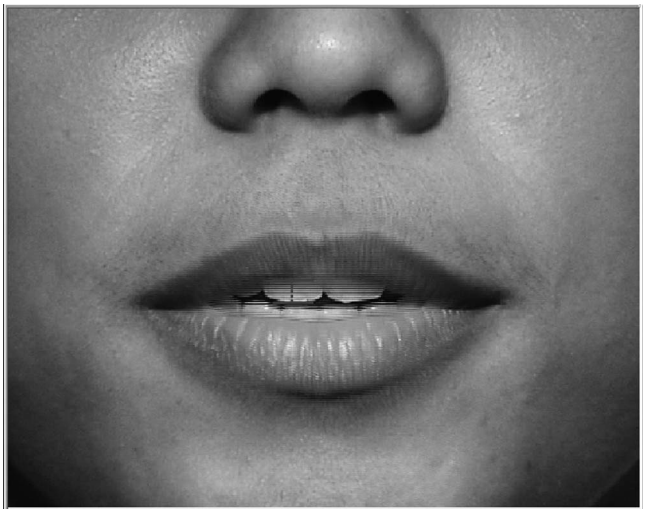

Figure 2. Measurement taken of the least exposure of the maxillary central incisor during speech.

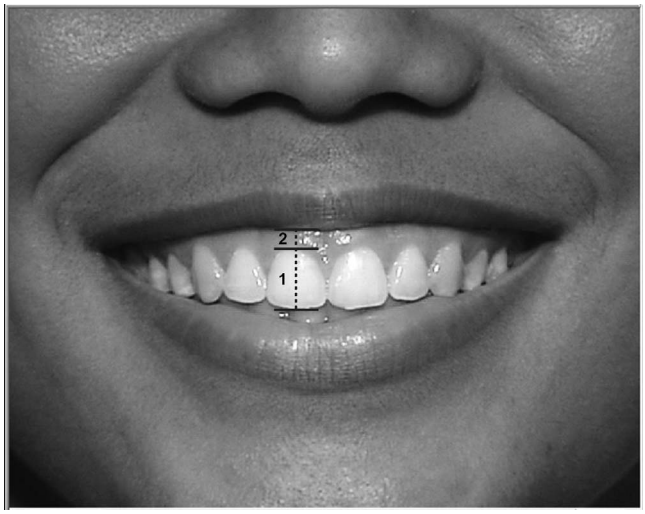

Figure 4. Measurements taken on posed smile frame: (1) maximum maxillary central incisor exposure and (2) gingival display.

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Table 2. Descriptive Statistics of Resting Frame Measurements According to Age Group and Gender

Linear Measurements in Rest Frame, mm	Age Group	Gender				
		Women		Men		
		Mean	SD[a]	Mean	SD	*P* Value (*t*-Test)
Upper lip length	1	21.44	2.40	21.60	2.02	.783
	2	21.32	1.91	22.60	2.22	.009
	3	21.58	2.32	23.33	1.91	.002
	4	21.93	2.45	23.85	2.88	.005
P value (ANOVA[a] test)		.673		.001		
Left lip commissure height	1	22.25	2.01	22.86	1.52	.177
	2	22.29	1.96	24.23	2.01	***
	3	22.96	1.61	25.25	1.48	***
	4	23.07	1.84	26.23	2.22	***
P value (ANOVA test)		.136		***		
Right lip commissure height	1	22.44	1.98	23.05	1.51	.177
	2	22.23	1.44	24.54	2.10	***
	3	23.50	1.78	25.22	1.54	***
	4	23.50	2.05	26.29	2.34	***
P value (ANOVA test)		.002		***		

[a] SD indicates standard deviation; ANOVA, analysis of variance.
*** $P < .001$.

be significantly higher when compared with the women.

Left lip commissure height showed gradually greater values in the men ($P < .001$). This distance was larger in group 4. Differences related to gender dimorphism were found in group 2 ($P < .001$), group 3 ($P < .001$), and group 4 ($P < .001$).

In group 4, both men and women presented larger values for the right lip commissure height. In the women, post hoc tests revealed significant differences between groups 2 and 3 ($P = .017$) and between groups 2 and 4 ($P = .013$), whereas in the men, significant differences were observed between groups 1 and 2 ($P = .014$), groups 1 and 3 ($P < .001$), groups 1 and 4 ($P < .001$), and groups 2 and 4 ($P = .003$). Differences related to gender dimorphism were found in group 2 ($P < .001$), group 3 ($P < .001$), and group 4 ($P < .001$).

Changes in Incisor Display

In both men and women, measurement of the least exposure of the maxillary central incisor during speech decreased significantly from group 1 to 4 ($P < .001$). Gender dimorphism was detected in groups 2 ($P = .004$), 3 ($P = .006$), and 4 ($P < .001$).

The greatest exposure of the maxillary central incisor during speech measurement gradually decreased from group 1 to 4. This effect was more marked in men than in women ($P < .001$). Gender dimorphism was observed in every age group.

Measurement of the exposure of the mandibular central incisor during speech increased from group 1 to 4 for both men and women. This was the only variable in the study that did not significantly differ between genders.

The maximum maxillary central incisor exposure values, which were measured in posed smile images, decreased gradually from group 1 to 4. This effect was greater in men ($P < .001$).

Gingival Exposure Changes

Gingival display while smiling values decreased from group 1 to 4. This effect was more pronounced

Table 3. Comparisons of Resting Frame Measurements Between the Four Age Groups for Women and Men Using the Post Hoc Tukey Test

Comparison	Upper Lip Length		Left Lip Commissure Height		Right Lip Commissure Height	
	Women	Men	Women	Men	Women	Men
Group 1 vs Group 2	NS[a]	.318	NS	.021	.956	.014
Group 1 vs Group 3	NS	.020	NS	***	.094	***
Group 1 vs Group 4	NS	.001	NS	***	.084	***
Group 2 vs Group 3	NS	.599	NS	.139	.017	.508
Group 2 vs Group 4	NS	.150	NS	***	.013	.003
Group 3 vs Group 4	NS	.818	NS	.167	1.000	.138

[a] NS indicates not significant.
*** $P < .001$.

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Table 4. Descriptive Statistics of Speech and Smile Measurements According to Age Group and Gender

Linear Measurements in Speech and Smile Frames, mm	Age Group	Gender				
		Women		Men		
		Mean	SD[a]	Mean	SD	*P* Value (*t*-Test)
The least exposure of the maxillary central incisor during speech	1	3.15	1.22	2.62	1.38	.113
	2	2.89	1.10	2.15	0.96	.004
	3	1.55	1.10	0.79	0.96	.006
	4	1.69	1.22	0.61	1.02	***
P value (ANOVA[a] test)		***		***		
The greatest exposure of the maxillary central incisor during speech	1	6.66	1.70	5.47	1.72	.008
	2	6.34	1.62	4.38	1.55	***
	3	5.16	1.47	3.24	1.40	***
	4	5.14	2.07	2.89	1.79	***
P value (ANOVA test)		***		***		
Mandibular central incisor exposure during speech	1	3.56	1.38	3.33	1.52	.531
	2	4.08	1.93	4.00	1.33	.833
	3	4.28	2.43	5.07	1.40	.127
	4	5.28	1.54	4.78	2.21	.285
P value (ANOVA test)		.002		***		
Maximum maxillary central incisor exposure in a posed smile	1	8.90	1.17	8.53	1.58	.285
	2	9.20	1.25	7.88	1.59	***
	3	8.15	1.53	6.52	1.56	***
	4	8.09	1.86	6.07	1.66	***
P value (ANOVA test)		.002		***		
Gingival display in a posed smile	1	0.48	1.99	−1.40	1.75	***
	2	0.11	1.79	−2.42	2.01	***
	3	−0.90	2.10	−3.49	1.75	***
	4	−0.99	2.28	−3.98	1.93	***
P value (ANOVA test)		.005		***		

[a] SD indicates standard deviation; ANOVA, analysis of variance.
*** $P < .001$.

in men ($P > .001$). Gender dimorphism was observed between all age groups.

DISCUSSION

The aging process affects the skin, soft tissues, and structural support tissues. Many of the facial manifestations of aging reflect the combined effects of gravity, progressive bone remodeling, decreased tissue elasticity and atrophy, and the loss of facial fullness.[10] Therefore, it is important to consider the effect of age on the smile.

In this study, the upper lip length increased by 2.25 mm in men and by 0.49 mm in women as age increased from 19 years to 60 years. The mean values for all age groups were greater for men; therefore, significant differences were found only between the men in groups 1 and 3 ($P = .020$) and groups 1 and 4 ($P = .001$). We also found that, beginning at the age of 25 years, there was a significant difference in the upper lip length between men and women (between groups 2, 3, and 4).

Consistent with our study, Chetan et al.[11] reported that upper lip length increased with age in males and

Table 5. Comparisons of Speech and Smile Frame Measurements Between the Four Age Groups for Women and Men Using the Post Hoc Tukey Test

Comparison	The Least Exposure of the Maxillary Central Incisor During Speech		The Greatest Exposure of the Maxillary Central Incisor During Speech		Mandibular Central Incisor Exposure During Speech		Maximum Maxillary Central Incisor Exposure in a Posed Smile		Gingival Display in a Posed Smile	
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
Group 1 vs Group 2	.776	.338	.860	.047	.610	.385	.816	.395	.853	.146
Group 1 vs Group 3	***	***	.004	***	.408	***	.178	***	.036	***
Group 1 vs Group 4	***	***	.002	***	.001	.005	.112	***	.017	***
Group 2 vs Group 3	***	***	.023	.036	.969	.059	.015	.007	.152	.121
Group 2 vs Group 4	***	***	.014	.003	.026	.260	.006	***	.082	.008
Group 3 vs Group 4	.955	.929	1.000	.836	.133	.900	.999	.698	.998	.740

*** $P < .001$.

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females from 16 years to 55 years, with higher mean values for males in all age groups. The authors attributed this finding to the loss of resting muscle tone, increased flaccidity, and redundancy. Miron et al.[12] also verified the occurrence of gender dimorphism in most of their variables and reported that the upper lip length was 3 mm shorter in women than in men ($P < .01$).

Complementing the study of the upper lip, the present research evaluated the lip commissure height and concluded that this value gradually increased with age in both genders. In participants aged older than 25 years, statistically significant differences in relation to gender dimorphism were found between groups 2, 3, and 4 ($P < .001$) for both right and left lip commissure height. Dickens et al.[6] also observed an increase in the lip commissure height over time, with the mean values for all age groups greater among men than women, which is in accordance with our study. However, these authors did not identify significant differences related to gender dimorphism.

Changes occur in the perioral region with aging. Due to the proximity of the structures and joint action in facial dynamics, it is possible to assume that changes in the soft tissues may be reflected by changes in incisor and gingival exposure during speech and smile, leading to an aged appearance.

Our study analyzed the maxillary central incisor display in three different perspectives: rest, speech, and smile. With increasing age, we observed a significant decrease in the maxillary incisor display in all measures evaluated in both men and women, and this effect was more significant in men. Vig and Brundo[13] reported a reduction in the maxillary central incisor exposure of approximately 3.4 mm as age increased from 30 years to 60 years. Dickens et al.[6] stated that the maxillary central incisor display at rest and smile decreased with age in men and women from the age of 20 years. Desai et al.[2] reported a significant reduction in the maxillary incisor display after 40 years of age, but that study included both men and women in the same groups. Our investigation revealed that besides the effect of age, there is a gender dimorphism in maxillary central incisor exposure starting at the age of 25 years in all measurements evaluated, with men exhibiting less incisor display than women.

In this study, the least, greatest, and maximum exposure of the maxillary central incisor were evaluated separately. Morley and Eubank[8] reported that the pronunciation of the phoneme "M" assists in the biomechanics of orthodontic treatment, attributing older or younger features in appearance. These authors reported that younger patients exhibited an exposure of the maxillary central incisors of 2-4 mm, and that this was reduced with increasing age, even resulting in the disappearance of the maxillary incisor display. Ackerman et al.[14] verified differences in maxillary incisor exposure during smile and the pronunciation of the syllable "chee." For these reasons, the authors sought to evaluate all of these variables and perform a complete study to better understand the vertical position of the maxillary central incisor through rest to smile during a video clip.

The mandibular incisor display during speech increased with age in both men and women, but this was the only variable in the study that did not present a significant difference between genders in any of the age groups evaluated. Thus, the greater display of the mandibular incisor with increasing age should be seen as a characteristic of aging common in men and women. Sackstein,[15] Motta et al.,[16] and Jacobson et al.[17] also reported an increase in the mandibular incisor display with increasing age.

The changes in maxillary and mandibular incisor display were not determined by changes in the positions of the teeth but, rather, by age-related modifications in the facial tissues, including the loss of lip elasticity and the effect of gravity on the lips.[18]

The gingival display during smile decreased with increasing age in both men and women. Our findings suggest that gingival exposure during smile should be considered a youthful and feminine characteristic because the average values of this variable were negative in men in all age groups. Dickens et al.[6] reported a decrease in gingival exposure in men and women with aging, with this process beginning at approximately 20 years of age. Miron et al.[12] and Tjan and Miller[19] described a high smile pattern as a female norm and a low smile pattern as a male norm, which are consistent with our findings. A complete explanation of the gender dimorphism in the frequency of gingival exposure on smiling remains undetermined.[20]

Data from this study indicate that there are specific issues that need to be considered for each age group when developing a treatment plan. As a general rule, it is preferable to rejuvenate the patient rather than accelerate aging. In deep bite cases, particularly in adults, it is advisable to intrude the mandibular incisors rather than the maxillary incisors because there is a natural tendency for reduced maxillary incisor display. This way it is possible to ensure a more youthful smile at the end of treatment without compromising esthetics. With regard to exaggerated gingival exposure, it is preferable to treat a gummy smile in a less aggressive way because aging will naturally reduce this characteristic.

The aging process of male and female faces shares many common features. The present study clearly demonstrates a gender dimorphism in many lip and tooth measurements. Our results suggest that, starting

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at the age of 25 years, it is possible to identify differences in aging between men and women. It is therefore prudent to consider these findings when evaluating a patient to arrive at the most appropriate treatment plan according to age and gender.

CONCLUSIONS

- With increasing age, there is an increase in the upper lip length and lip commissures height, particularly in men.
- Aging leads to a significant decrease in the maxillary central incisor display at rest, speech, and smile, notedly in men.
- A greater display of the mandibular incisor with increasing age is a common characteristic in both genders.
- Gingival exposure during smile should be considered a youthful and feminine characteristic.
- From the age of 25 years, it is possible to identify differences in the aging process in soft tissue and incisor display between men and women.

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