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ORIGINAL ARTICLE

THE EFFECT OF AGE AND GENDER ON THE DISPLAY OF MAXILLARY AND MANDIBULAR ANTERIOR TEETH DURING REST, SPEECH AND SMILING

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ABSTRACT

Purpose: To measure and compare the display of maxillary and mandibular anterior teeth during rest, speech and smiling and to determine the effect of age and gender on tooth visibility during the above mentioned expressions in a group of Indian population.

Materials and methods: A digital videographic technique was used to record 120 subjects when they were smiling and speaking and at rest. Individual frames of interest were captured and the tooth visibility was measured with the help of software presentation tools. ANOVA, Tukey HSD and t tests were used to analyse the collected data and to f ind out age and sex correlations. (P<=0.05)

Results: Mandibular anterior teeth were more visible during speech as compared to maxillary anterior teeth which were displayed more during smiling and at rest. As the age increased, the display of maxillary anterior teeth decreased during smiling, speech and rest while the display of mandibular anterior teeth increased during smiling only. In Females, maxillary anterior teeth were more visible during speech than males, who display more of mandibular anterior teeth. Females displayed more maxillary anterior teeth than males during smiling and at rest.

Conclusion: This study offers guidelines for achieving an esthetic outcome taking into consideration the changes taking place in the visibility of anterior teeth with age and the differences in the two genders.

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INTRODUCTION

The anterior teeth are important not only to dental esthetics, but also to facial esthetics. The goal of an esthetically planned treatment is to have the anterior teeth restore optimal dentolabialrelations in harmony with the overall facial appearance. Therefore, anterior tooth display should be predicted and controlled for an esthetic outcome in patients seeking prosthodontic treatment (Oh *et al*., 2009). Since human beings engage in the actions of speech and facial expressions to a greater degree than they do in mastication, it is imperative for clinicians to determine anterior tooth visibility during these activities (Martone and Edwards, 1962). Most research workers have done studies primarily on arrangement of maxillary teeth since they are considered to be visible amongst a large population during the function of speech. Very little research has been done on the visibility of mandibular teeth as some researchers feel that they play a minor role in esthetics and are not readily visible (Joseph Nassif, 1970; Vig and Brundo, 1978). Guidelines advocated in order to establish optimum anterior tooth visibility do not offer any information regarding the changes that take place in the amount of exposure of anterior teeth with age (Vig and Brundo, 1978). Also, the difference in anterior tooth visibility in men and women is a less talked about matter. In view of the importance of positioning anterior teeth for esthetics, it will be beneficial if data is made available regarding teeth exposure in different age groups during variety of facial expressions. Therefore it was thought desirable to undertake a study of this nature in both the sexes amongst different age groups.

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Aims and objectives of the study

- To measure the amount of maxillary and mandibular anterior teeth display during rest, speech and smiling.
- To compare the anterior teeth display during the above

mentioned expressions in different age groups and sexes.

MATERIALS AND METHODS

The study was planned on 120 subjects between 18 and 70 years of age with equal number of males and females. The subjects were selected randomly and were divided into three groups according to their age:

Group 1: 40 subjects 18-30 yrs of age
Group 2: 40 subjects 31-50 yrs of age
Group 3: 40 subjects 51-70 yrs of age
Each group had 20 males and 20 females.

All the selected subjects were dentulous and had full complement of upper and lower anterior teeth. Subjects having not more than one prosthetic anterior replacement were selected. Subjects unable to smile normally, with atypical condition such as traumatized lips, mobile or extruded anterior teeth, extreme abrasion and attrition, extreme crowding, anatomic short lip, vertical maxillary deficiency and mandibular protrusion with open bite were excluded. An informed consent was taken from the subjects. Clearance from the Nitte University Ethical Committee was obtained to conduct the study. A digital videographic method as described by Sackstein was used (Sackstein, 2007; Sackstein, 2008). The subjects were made to stand straight against a background with a fixed vertical calibrated ruler positioned as close to the lips as possible and the mandibular arch was made parallel to the floor. Each person was recorded with a digital camera (Sony Cyber-shot 8.1 megapixels, Sony, Tokyo, Japan) mounted on a tripod stand at a distance of 6 inches from the subject. The recordings were made in video mode so that the markings on the ruler were clearly visible on the left border of the frame (Fig.1).

Fig.1. Making the digital video recording

Subjects were be made to close mouth, without teeth in contact and with the lips gently parted to determine anterior tooth visibility at rest. They were then asked to pronounce "ah" three times, closing the mouth and resting between each sound. Then, "six" was pronounced three times. Finally, a smile was evoked. The movie files were played in a slow motion and individual frames of interest were selected. For the 'ah' sound, frames showing the lips and teeth at peak opening were selected. For 'six', frames were captured at the moment when the vowel was pronounced after the s sound. For smiling, those frames were captured in which the subject showed spontaneous smiling. (Fig.2)

Fig.2. Photographs snapshot from the video for various expressions

Each image was inserted into a slide for presentation (Microsoft Power Point 2007). With the help of software presentation tools, horizontal lines were drawn along the most incisal point of maxillary and mandibular teeth and the upper and lower lip edges until they corresponded to the markings of the photographed ruler. The distance between these two lines was calculated for each photograph and recorded as anterior tooth display (Van der Geld *et al*., 2008). (Fig 3)

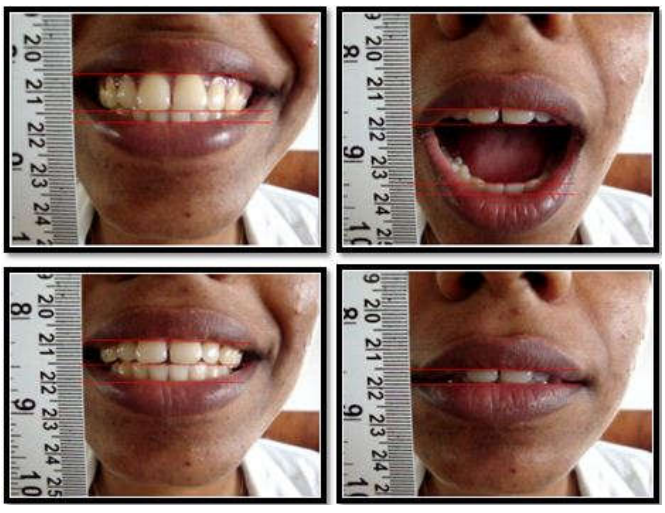

Fig.3. Measurement of the display of anterior teeth at various expressions

The data thus obtained was tabulated and statistically analyzed to arrive at certain conclusions. ANOVA, Tukey HSD and t

tests were applied using SPSS software version11. P value of less than 0.05 was considered statistically significant.

RESULTS

The results obtained from the study are illustrated in Fig. 4 and Tables 1-5. As seen in Fig. 4, maxillary teeth were displayed upto a greater extent than the mandibular teeth in all the expressions except speech, where mandibular teeth were displayed more.

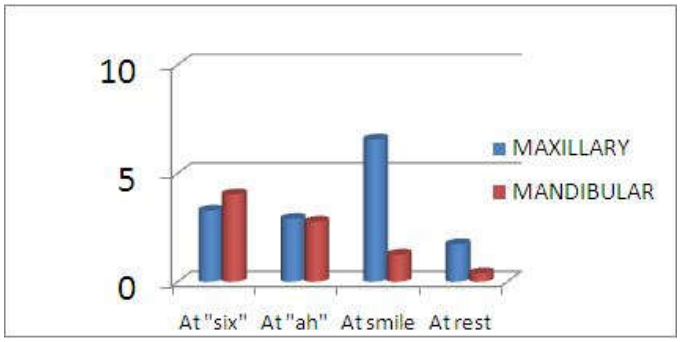

Fig.4. The total amount of maxillary and mandibular anterior tooth display by all the subjects who participated in the study during speech, smiling and rest

Table 1 shows the descriptive analysis of the amount of display of anterior teeth according to age groups.

Table 1. The amount of maxillary and mandibular anterior tooth display in millimeters at speech, smiling and rest in each of the three age groups

Age group	At "six"		At "ah"		At smile		At rest	
	Max.	Mand.	Max.	Mand.	Max.	Mand.	Max.	Mand.
18-30 yrs	3.95±1.58	3.89±1.51	3.64±1.75	2.26±1.14	6.86±1.57	0.81 ±1.19	2.87±1.72	0.27 ±0.62
31-50 yrs	3.53±2.03	4.05±1.41	3.22±2.07	3.07±1.18	7.11±2.04	1.09 ±1.26	1.54±1.75	0.36 ±0.85
51-70 yrs	2.37±1.76	4.15±1.72	1.85±1.65	2.97±1.51	5.70±2.42	1.84 ±1.70	0.79±1.11	0.53 ±0.86

* Max. = Maxillary, Mand.= Mandibular

As can be seen by Table 2, subjects in group 2 displayed more of mandibular anterior teeth than the subjects in group1 when they pronounced 'ah'. Also, subjects in group1 displayed more of maxillary anterior teeth when they were at rest than the subjects in group 2. Any other statistically significant findings were not observed when the rest of the parameters were compared.

Table 2. Comparison of the anterior tooth display at speech, smiling and rest between the age groups 18-30years (group 1) and 31-50 years (group 2)

Dependent Variable	Mean Difference (I-J)	Std. Error	Sig.
Maxillary anterior tooth display at 'six'	.42500	.40232	.543
Mandibular anterior tooth display at 'six'	-.16250	.34699	.886
Maxillary anterior tooth display at 'ah'	.41250	.40959	.574
Mandibular anterior tooth display at 'ah'	-.81250[a]	.28774	.015
Maxillary anterior tooth display at smiling	-.25000	.45673	.848
Mandibular anterior tooth display at smiling	-.27500	.31418	.657
Maxillary anterior tooth display at rest	1.33750[a]	.34839	.001
Mandibular anterior tooth display at rest	-.10000	.17624	.838

When group 1 and 2 were compared (Table 3), it was seen that subjects in group 2 displayed more of maxillary anterior teeth than the subjects in group 3 during the speech expressions of 'six' and 'ah' while the difference in the mandibular anterior teeth display was not found to be statistically significant. During smiling, subjects in group 2 displayed more of maxillary anterior teeth than the subjects in group 3 who displayed more of mandibular anterior teeth while smiling. All these findings were statistically significant.

Table 3. Comparison of the anterior tooth display at speech, smiling and rest between the age groups 31-50 years (group 2) and 51-70 years (group 3)

Dependent Variable	Mean Difference (I-J)	Std. Error	Sig.
Maxillary anterior tooth display at 'six'	1.15000[b]	.40232	.014
Mandibular anterior tooth display at 'six'	-.10000	.34699	.955
Maxillary anterior tooth display at 'ah'	1.37500[b]	.40959	.003
Mandibular anterior tooth display at 'ah'	.10000	.28774	.936
Maxillary anterior tooth display at smiling	1.41250[b]	.45673	.007
Mandibular anterior tooth display at smiling	-.75000[b]	.31418	.048
Maxillary anterior tooth display at rest	.75000	.34839	.084
Mandibular anterior tooth display at rest	-.17500	.17624	.583

Subjects in group 1 displayed more of maxillary anterior teeth than the subjects of group 3 while pronouncing 'six' while there was no difference found in the display of mandibular anterior teeth between the age groups during the same expression of speech (Table 4). When the subjects pronounced 'ah' and during smiling, more of maxillary anterior teeth were displayed by the subjects of group1 than the subjects in group 3 who displayed more of mandibular anterior teeth during the same expressions of speech. At rest, it was found that subjects in group 1displayed more of maxillary anterior teeth than the subjects in group 3 which was statistically significant. There was no statistically significant difference found in the amount of mandibular anterior teeth display between the two groups when the subjects were at rest.

Table 4. Comparison of the anterior tooth display at speech, smiling and rest between the age groups 18-30 years (group 2) and 51-70 years (group 3)

Dependent Variable	Mean Difference (I-J)	Std. Error	Sig.
Maxillary anterior tooth display at 'six'	-1.57500[c]	.40232	.000
Mandibular anterior tooth display at 'six'	.26250	.34699	.730
Maxillary anterior tooth display at 'ah'	-1.78750[c]	.40959	.000
Mandibular anterior tooth display at 'ah'	.71250[c]	.28774	.039
Maxillary anterior tooth display at smiling	-1.16250[c]	.45673	.033
Mandibular anterior tooth display at smiling	1.02500[c]	.31418	.004
Maxillary anterior tooth display at rest	-2.08750[c]	.34839	.000
Mandibular anterior tooth display at rest	.27500	.17624	.267

Comparing males and females (Table 5), when the subjects pronounced 'six', there was no statistically significant difference found in the maxillary and mandibular anterior tooth display when both the groups were compared. Females were found to display more of maxillary anterior teeth and the males

Table 5. Comparison of the amount of maxillary and mandibular anterior tooth display at speech, smiling and rest between males and females

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Maxillary anterior tooth display at 'six'	-1.444	118	.151	-.50000	.34623
Mandibular anterior tooth display at 'six'	.324	118	.746	.09167	.28269
Maxillary anterior tooth display at 'ah'	-2.236	118	.027	-.79167	.35409
Mandibular anterior tooth display at 'ah'	2.422	118	.017	.57500	.23741
Maxillary anterior tooth display at smiling	-3.322	118	.001	-1.23333	.37127
Mandibular anterior tooth display at smiling	1.286	118	.201	.34167	.26574
Maxillary anterior tooth display at rest	-2.199	118	.030	-.70000	.31835
Mandibular anterior tooth display at rest	.866	118	.388	.12500	.14435

displayed more of mandibular anterior teeth when the subjects pronounced 'ah'. While smiling and at rest, females were found to display more of maxillary anterior teeth than males. There was no statistically significant difference in the mandibular anterior tooth display between the two groups during both the expressions of smile.

DISCUSSION

Anterior teeth are the predominantly visible teeth during the expressions of smiling, speaking as well as during rest. They dictate the overall esthetics of the mouth as well as the face during these activities but because of various reasons, changes in the visibility of anterior teeth may take place with age (Vig and Brundo, 1978; Sackstein, 2008; Van der Geld *et al*., 2008; Al-Habahbeh *et al*., 2013; Cade, 1979; Jacobson *et al*., 2013; Al Wazzan, 2004; Dong *et al*., 1999). Also, many researchers have found that there exists a difference in the anterior tooth display between men and women during the functions of speech and smiling (Cade, 1979; Al Wazzan, 2004; Dong *et al*., 1999; Al-Habahbeh *et al*., 2009). Most of the studies that were conducted previously have employed mainly two methods of recording the display of anterior teeth during facial expressions. First method is to ask the patient to speak and smile and the display is calculated with the help of a measuring instrument. The disadvantage of this method is that the measuring instrument interferes with the natural behaviour of the subject. Also, only a posed smile can be measured by this method which is not as accurate as a spontaneous smile. Second method is to record the display by means of photographs. A drawback of this method is that ear rods are often used for standardization of the head position which is not a favourable position to elicit a spontaneous smile in the subjects (Van der Geld *et al*., 2007). The dynamic nature of spontaneous smiling and speech requires a dynamic registration method. Therefore, a less intrusive dynamic registration method based on videographic measurement of spontaneous smiling and speech was used in the current study. Also, when compared with single frame capture method with photography, standardized digital videography provides the clinician a wider range of images for selecting the parameters of lip-tooth relationships during facial animation (Van der Geld *et al*., 2008; Ackerman *et al*., 2004; Cosendey *et al*., 2012; Van der Geld *et al*., 2011)

The results of the present study revealed these findings:

Mandibular anterior teeth were displayed more than the maxillary teeth during speech. During smiling and at rest it was observed that the maxillary teeth were displayed to a larger extent than the mandibular anterior teeth. When the variables of speech, smiling and rest were compared within each age group, the following observations could be made:

During speech, subjects in the age group 18-30 years displayed more of maxillary anterior teeth than the subjects in the age group 31-50 years although this difference was not statistically significant. Maxillary anterior tooth display was found out to be more for the subjects in the age group 18-30 years and 31-50 years than the subjects in the age group 51-70 years whereas more of mandibular anterior teeth were visible in the age group 31-50 years and 51-70 years than the subjects in the age group 18-30 years. These results indicate that the maxillary anterior tooth display during speech decreases as the age progresses, which are in agreement with Van Der Geldwho found out that during speech, the effect of decreasing lip line heights with age was significantly manifested in the maxillary anterior region (Van der Geld *et al*., 2008). These observations are also comparable with Cade's findings (Cade, 1979). During smiling, there was no statistically significant difference in display of anterior teeth between the subjects in the age group 18-30 and 31-50 years. Subjects in the age group 18-30 years and 31-50 years displayed more of maxillary anterior teeth than the subjects in the age group 51-70 years which was statistically significant. These findings lead to a suggestion that the display of maxillary anterior teeth on smiling decreases with age. The results of Van der Geld's study also suggest that (Van der Geld *et al*., 2008). Subjects in the age group 31-50 years displayed more mandibular anterior teeth than the subjects in the age group 18-30 years although this difference was not statistically significant. Display of mandibular anterior teeth was more for the subjects in the age group 51-70 years than the subjects in both the age group 31-50 years and 18-30 years which was statistically significant. Van der Geld, Cade and Hababeh *et al* stated that there was an increase in mandibular anterior teeth visibility at smiling in individuals with age, which complements the results of the present study (Van der Geld *et al*., 2008; Al-Habahbeh *et al*., 2013; Cade, 1979). At rest, subjects in the age group 18-30 years displayed more of maxillary anterior teeth than the subjects in both the age group 31-50 years and 51-70 years, while the subjects in the age group 31-50 years displayed more maxillary anterior teeth than the subjects in the age group 51-70 years, although the difference was not statistically significant. There was an increase in the display of mandibular anterior teeth at rest as the age progressed but the differences between each age group were not found to be statistically significant.

According to Van der Geld, anterior tooth display in the natural rest position showed a significant decrease with age (Van der Geld *et al*., 2008). Vig and Brundoconcluded that while maxillary anterior tooth display showed a steady decrease with ageing, the mandibular anterior teeth showed a corresponding increase (Vig and Brundo, 1978). Studies by Al Wazzanand Da Motta also agree to the same (Al Wazzan, 2004; da Motta *et al*., 2010). A similar study was conducted in Indian population by Padmasree *et al* which also concluded that there was a

decrease in the maxillary and an increase in mandibular incisor visibility as the age progresses. Maxillary incisor visibility also decreased as there was an increase in the lip length (Padmasree *et al*., 2016). Now, the question arises why does the amount of display of the anterior teeth change with age? Many researchers have provided explanations for the same. Heartwell and Rahnhave contended that the interincisal distance increases with age and therefore the mandibular teeth become more visible (Heartwell and Rahn, 1969). Increased visibility can result from loss of muscle tonus which can allow the lower lip to sag and the upper lip to drop. Fudalej has stated that upper lip elongation is a continuous process (Piotr Fudalej, 2008). From the ages of 16 to 31, the post adolescent growth of the craniofacial skeleton balances the increase in upper lip length. In the third and fourth decades of life, after growth of the craniofacial skeleton is minimal, elongation of the upper lip exceeds vertical growth of the face. Dickens, Sarver and Proffithave stated the following reasons for the change in display of anterior teeth with age *(1)* inferior migration of the surrounding soft tissue, and *(2)* attrition and wear of the anterior teeth resulting in shortening of the teeth (Dickens *et al*., 2002). They have also asserted that an interesting effect of ageing is the tendency for philtrum height to increase at a faster rate than commissure height, starting in early adulthood. This finding explains the decrease incisal display at rest and smiling with increasing age. As the study suggests, mandibular anterior teeth play an important role in establishing the esthetics of face and mouth. Contrary to the previous researches done, this study proposes that these teeth are visible in all the expressions of speech smiling and rest and are the teeth which are visible to the highest amount during speech as compared to the maxillary teeth.

After the comparison within age groups, difference in the display of anterior teeth between males and females was also assessed in the present study. During speech, females displayed more of maxillary anterior teeth than males and males displayed more of mandibular anterior teeth than females. These findings go hand in hand with the findings of Cade's study who also concluded that men display more mandibular anterior teeth than females (Cade, 1979). A Survey done by Galagali *et al* in young Indian population provides measurement of visible teeth surface area of the upper and lower anterior teeth during speech but no comparison has been made between two sexes (Galagali *et al*., 2015). There is a dearth of studies comparing the display of anterior teeth during speech in males and females and more research is needed on this subject. The results of the present study are expected to shed some light on the matter. During smiling, females displayed more of maxillary anterior teeth than males. There was no statistically significant difference found in the display of mandibular anterior teeth between the two groups during smiling. These results can be explained based on the findings of Tjan and Miller's study who put forward that women tend to have a higher smile line than men (Tjan and Miller, 1984). Peck *et al*stated that high smile lines appeared to be a female lineament, and low smile lines appeared to be a male lineament (Peck *et al*., 1992). But according to Žagar and Zlataric, there is no significant difference in the maximum maxillary central incisal display at smile between men and women (Žagar and Zlataric, 2011). Also, during smiling, no gender differences were seen in the display of anterior teeth between males and females by Al-Hababeh *et al*. (2009). These findings are not congruent with the findings of the present study.

At rest, females were found to display more of maxillary anterior teeth than males. This finding was in accordance with the findings by Vig and Brundo (1978). Another study done by Al Hababah *et al* demonstrated that at rest, males display more mandibular anterior teeth than females which was in unison with the study done by Al Wazzan as well as with the results of Da Motta's study (Al Wazzan, 2004; Al-Habahbeh *et al*., 2009; da Motta *et al*., 2010). However, in the present study, there was no statistically significant difference found in the display of mandibular anterior teeth between the two groups when the subjects were at rest which was in contradiction with the findings of the previously mentioned studies but similar results were found in the study by Padmasree *et al*. (2016). The difference in the display of anterior teeth in males and females can be attributed to the different timing and extent of the adolescent growth spurt which affects both the soft and hard tissues of the face and to a somewhat different pattern of age changes in males and females as stated by Dickens, Sarver and Proffit (1969). Another reason for the difference may be due to the variation in upper lip lengths in both genders. Burstonein 1967 conducted a study in normal adolescent sample of boys and girls and concluded that boys had a greater lip length than girls (Burstone, 1967). Peck *et al* have found in their study that there was a significant sex difference in upper lip length: the male subjects exhibited a longer upper lip than the female subjects (Peck *et al*., 1992). A similarly significant male-female difference was seen in the skeletal maxillary height measurement: the male sample showed a 2.2 mm mean vertical maxillary increase over the female sample. In the present study, age groups and genders of the individuals have been compared as a whole, but to get more insight into the matter, further investigations can be planned and comparison of males within each age group and comparison of females within each age group can be done.

Conclusion

Within the limitations of this study, the following conclusions could be drawn:

1. During speech, the display of mandibular anterior teeth is more than the display of maxillary anterior teeth. During smiling and at rest, the maxillary anterior teeth are more visible than the mandibular anteriors.
2. The display of maxillary and mandibular anterior teeth in the age group 18-30 years during speech on an average is 3.8mm and 3 mm respectively. During smile is 6.9 mm and 0.8 mm respectively and at rest is 2.9mm and 0.3mm respectively. The display of maxillary and mandibular anterior teeth in the age group 31-50 years during speech on an average is 3.4mm and 3.6 mm respectively. During smile is 7mm and 1mm respectively and at rest is 1mm and 0.4 mm respectively. The display of maxillary and mandibular anterior teeth in the age group 51-70 years during speech on an average is 2.1mm and 3.5 mm respectively. During smile is 5.7mm and 1.8mm respectively and at rest is 0.8mm and 0.5mm respectively.
3. During speech the display of maxillary anterior teeth decreases as the age progresses. During smiling, the display of maxillary anterior teeth decreases and the display of mandibular anterior teeth increases as the age progresses. During rest, the display of maxillary anterior teeth decreases as the age progresses.

4. Females display on an average 3.4mm of maxillary anterior teeth and 3.2mm of mandibular anterior teeth during speech. Males display 2.7 mm of maxillary anterior teeth and 3.5mm of mandibular anterior teeth during the same. 7.17mm of maxillary anterior teeth and 1.07mm of mandibular anterior teeth are displayed by females during smiling. Males on an average display 5.94mm of maxillary anterior teeth and 1.42mm of mandibular anterior teeth during the same. At rest, females display 2.08mm of maxillary anterior teeth and 0.32mm of mandibular anterior teeth. Males display on an average 1.38mm of maxillary anterior teeth and 0.45mm of mandibular anterior teeth.
5. During speech, females display more maxillary anterior teeth than males who display more of mandibular anterior teeth, during rest and smiling also, females display more maxillary anterior teeth than males.

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