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Tooth and Gingival Display in the Anterior Region at Rest and during Smiling of different Age Groups: A Comparative Study

Riyad Al-Habahbeh BDS, Raghda Al-Shammout BDS*, Mona Alganane m BDS*, Osama Al-Jabrah BDS*, Nidal Al Habahbeh BDS**

ABSTRACT

Objective: To investigate the effect of age on the degree of maxillary and mandibular anterior teeth and associated gingival display when the lips are at rest and during smiling among a group of Jordanian population.

Methods: A total of 127 subjects (74 females and 53 males) were included in this study. Subjects had all natural anterior teeth present with no caries, restorations, extreme occlusal wear, extrusion, obvious deformities, or tooth mobility. Crown length, displayed portions of maxillary and mandibular anterior teeth and associated gingiva at rest and during smiling were measured using a "Fowler Electronic Digital Calliper", which had a resolution of 0.01mm. The measurements were taken by two independent Dental Clinicians and they were repeated 3 times and the mean value was calculated for further analysis. SPSS (V 11) software was used to analyse the data. Statistical analyses were performed by Student's t-test and ANOVA. Level of significance was set to 0.05.

Results: At rest and during smiling; maxillary tooth display decreased, and mandibular tooth display increased with increasing age, but the differences between age groups were not significant, with the exception of the display maxillary central incisor that reduced significantly as age increased ($P<0.001$). Gingival display during smiling followed a similar pattern and did not present any statistically significant differences between different age groups in the anterior region. However, maxillary gingival display was the highest below the age of 20; and above the age of 60 for the mandibular gingival display, but statistically significant differences were not recorded between age groups.

Conclusion: Differences in tooth display in relation to aging should be considered when providing esthetic prosthodontic treatment that involves replacement of anterior teeth.

Key words: Esthetics, Anterior teeth, Gingival display, Tooth display, Tooth visibility.

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Introduction

The presence of maxillary anterior teeth plays an important role in facial esthetics[1,2] The amount of visible anterior teeth, with lip at rest or during function, is an important esthetic factor in determining the outcome of any prosthodontic treatment.[3] Variations in tooth display have been reported between subjects of

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different gender and age,[4-6] age influences the amount of tooth visibility. The amount of maxillary tooth displayed is inversely proportional to increasing age whereas the amount of mandibular teeth is directly proportional to increasing age.[7-9] Therefore, a young person will display more maxillary than mandibular teeth, whereas an older individual will show more mandibular rather than maxillary teeth.[4,10] The result of aging is reduced tonicity of the orofacial muscles and laxness of tegumental relief in the lower third of the face resulting information of the labial, nasolabial, and mental grooves and ridges. The loss of elasticity of the upper lip, with increasing tooth support by the gingival two-third of the maxillary incisors, accounts for less maxillary and more mandibular incisor tooth display.[11] The extent of tooth display at rest and during smiling is highly determined by the upper and lower lip positions and their movements during function.[12] Individuals with shorter upper lips display more maxillary central incisor surface than people with longer upper lips, and those with longer upper lip show more mandibular central incisors.[13] The upper and lower lips frame the display zone of the smile. Within this framework, the components of the smile are the teeth and the gingival scaffold. The soft-tissue determinants of the display zone are lip thickness, intercommissure width, interlabial gap, smile index (width/height), and gingival architecture.[12] In addition, the inferior border of the upper lip (lip line), as the lip moves vertically during smiling, determines the extent of tooth display, [14] which is influenced by muscle position that varies from one person to another.[13] A decreasing amount of maxillary, and an increasing amount of mandibular tooth visibility is seen from Caucasians to Asians to blacks. Racial differences in the amount of displayed maxillary central incisors were also reported; with the white Americans showing more tooth surface than the blacks. [1] Teeth exposed during smiling are an important part of the anatomy of an esthetic smile.[15] As a consequence, variables such as the number of teeth visible in a smile, size, shape, position and colour of artificial teeth, as well as margin placement of artificial prostheses must be considered during the construction of a prostheses. [16] Placement of fixed prosthetic restoration margins in the anterior tooth region into the gingival sulcus has become a common procedure in clinical practice.[17] Decisions about restorative margin placement are, however, directly related, among other parameters, to the amount of gingival display at different functional lip positions, such as during speech, exaggerated smile and the rest position of the mandible,[18] although numerous studies reveal that this can lead to gingival inflammation and attachment loss.[19] Increased esthetic demands in fixed and removable prosthetic restorations have focused mainly on the maxillary anterior teeth at rest [3] and in smiling.[8] Thus, it is of clinical interest to investigate the effect of age on the degree of tooth and gingival display in the maxillary and mandibular anterior region at rest and smiling as sufficient data are lacking at present. The identification of any possible correlations between tooth and gingival display,[15] gender [6,20] and age is of interest as they could be used as guidelines to esthetic considerations in prosthetic restorations of teeth.[13]

The aim of this study was to investigate the effect of age on the degree of maxillary and mandibular anterior teeth and associated gingival display when the lips are at rest and during smiling among a group of Jordanian population.

Methods

This study was conducted out at the Department of Dentistry, Prince Rashid Hospital, Irbid, Jordan; over six months period from September 2009 to March 2010.

The sample for the present study was selected from a general population of patients who attended a Conservative dental clinic. A total of 127 participants were selected and accepted to participate in this study. There were 74 (58.3%) females and 53 (41.7%) males of Jordanian population, aged between 18 and 67 years with a mean age of 34.3 (±10.76).

Inclusion/exclusion criteria:

The selected subjects had not undergone orthodontic or surgical treatment (i.e. gingival

surgery or extraction of teeth). They had maxillary and mandibular natural anterior teeth present without caries, extreme occlusal wear, and any kind of restoration, extrusion, obvious deformities or tooth mobility. Subjects with a history of congenital anomalies, lips trauma, or facial surgery were excluded.

Fig. 1: Fowler Electronic Digital Calliper used in the measurements.

Measurements:

Measurements were performed using a Fowler Electronic Digital Calliper (Kevelaer, Germany) to the nearest tenth of a millimetre for specific measured dimensions in each patient. The calliper has two edges; external and internal (Fig 1); the internal edges were used in the measurements to avoid lip distortion. For measurements of patients at rest position, the visible portions of anterior teeth were measured vertically from the lower border of upper lip and the upper border of the lower lip to the incisal edge for the incisors, and to the cusp tip, for the canines, at the midpoint of the tooth at the rest position (when the lips and the lower jaw were at the rest position) for the maxillary and mandibular anterior teeth, respectively. For measurements of patients during maximum smiling; the portion of anterior teeth (maxillary and mandibular) and the displayed gingivae were measured by:[(1)] Measuring the displayed clinical crown length (distance between incisal edges of the central and lateral incisors, and cusp tip of the canines, and the most vertical, superior point at the gingival margin of the maxillary anterior teeth; and the most vertical, inferior point at the gingival margin of the mandibular anterior teeth).[(2)] Measuring the displayed teeth and of the gingivae from the incisal edges of the maxillary central and lateral incisors and tip of canines to the inferior border of the upper lip, and from the incisal edges of the mandibular central and lateral incisors and tip of canines to the superior border of the lower lip.[(3)] The displayed portion of the gingival was calculated by subtracting the amount of the displayed teeth and associated gingivae from the amount of the displayed clinical crown length. The measurement was considered to be zero if the tooth could not be seen regardless of how short it was. Measurements were performed of the opposing anterior teeth on the right side, and they were repeated 3 times and the mean value and standard deviation were calculated for further analysis. Measuring gauge had a resolution of 0.01mm and measured dimensions were recorded to this degree of accuracy. The measurements were taken by two independent Dentist examiners and they were repeated 3 times and the mean value was calculated for further analysis

Statistical analysis:

Statistical Package for Social Sciences, Version 11 (SPSS-V11) software was used for the analyses. All recorded data were analysed by analysis of variance (ANOVA). One-way analysis of variance (ANOVA) was performed to reveal statistically-significant differences in mean values of the parameters evaluated (clinical crown length, amount of teeth display, and gingival display at rest and in maximum smile). Differences between different age groups for each group of teeth and associated gingiva were investigated by using Bonferroni multiple comparisons *post hoc* tests in the ANOVA at 5% significant level.

Results

Age and sex distribution of the participants are shown in Table I.

Table II shows the difference in the visible amount of teeth between the six age groups. With increasing age, the amount of maxillary anterior teeth that was visible at rest decreased and the opposite was true for the mandibular anterior teeth. Among the anterior teeth, the amount of visible maxillary central incisors was most significantly affected by aging ($p < 0.005$). The mean amounts of visible tooth surface and associated gingivae in smiling are shown in Tables III. With increasing age, the amount of anterior teeth and associated gingivae that were displayed during smiling decreased for the maxillary and increased for the mandibular teeth,

Table I: Age and sex distribution of subjects.

	Male		Female		Total	
Age (years)	**Number**	**%**	**Number**	**%**	**Number**	**%**
<20	5	9.43	8	10.81	13	10.24
21-30	12	22.65	16	21.62	28	22.05
31-40	17	32.08	22	29.73	39	30.71
41-50	11	20.75	14	18.92	25	19.68
51-60	6	11.32	9	12.16	15	11.81
>60	2	3.77	5	6.76	7	5.51
Total	53		74		127	

Table II: Mean amounts of displayed tooth surface at rest.

		Maxillary anterior teeth			Mandibular anterior teeth		
Age (years)	**Number**	**Central incisor**	**Lateral incisor**	**Canine**	**Central incisor**	**Lateral incisor**	**Canine**
<20	13	3.27±1.62	1.73±1.47	0.60±0.91	0.67±0.89	0.64±0.97	0.57±0.95
21-30	28	2.75±1.65	1.59±1.38	0.57±0.77	0.86±1.26	0.87±1.06	0.67±1.09
31-40	39	2.37±1.73	1.50±1.34	0.46±0.87	0.94±1.45	0.93±1.15	0.74±1.18
41-50	25	1.74±1.51	1.12±1.22	0.37±1.05	1.15±1.10	1.23±1.10	0.82±1.16
51-60	15	0.87±1.42	0.79±1.03	0.29±0.76	1.30±1.34	1.37±1.52	0.94±1.48
>60	7	0.58±1.33	0.41±0.94	0.22±0.83	1.42±1.17	1.45±1.46	1.17±1.37
F ratio		7.02	2.12	1.01	1.62	2.05	0.93
P-value		0.0002	0.088	0.28	0.17	0.093	0.37
Significance level		<0.005	NS	NS	NS	NS	NS

± = standard deviation
NS= not significant

Table III: Mean amounts of displayed tooth surface (and associated gingivae) in smiling.

		Maxillary anterior teeth			Mandibular anterior teeth		
Age (years)	**Number**	**Central incisor**	**Lateral incisor**	**Canine**	**Central incisor**	**Lateral incisor**	**Canine**
<20	13	8.93±1.59	7.47±1.51	8.68±1.07	2.00±1.13	2.03±1.21	2.01±0.94
21-30	28	8.61±1.68	7.29±1.44	8.54±0.94	2.10±1.26	2.13±1.35	2.12±1.13
31-40	39	8.37±1.60	7.20±1.37	8.35±1.04	2.39±1.44	2.42±1.29	2.39±1.30
41-50	25	8.29±1.47	7.02±1.18	8.00±1.16	2.61±1.10	2.65±1.17	2.59±1.05
51-60	15	7.92±1.39	6.84±1.11	7.80±0.85	2.77±1.23	2.89±1.53	2.90±1.36
>60	7	7.58±1.26	6.57±0.91	7.47±0.93	3.06±1.51	3.09±1.64	3.13±1.57
F ratio		7.02	2.12	0.16	1.54	1.87	0.66
P-value		0.0002	0.088	0.85	0.17	0.096	0.46
Significance level		<0.005	NS	NS	NS	NS	NS

± = standard deviation
NS= not significant

Table IV: Number and percentages of subjects displaying gingiva associated with anterior tooth during smiling.

		Maxillary anterior teeth						Mandibular anterior teeth					
		Central incisor		**Lateral incisor**		**Canine**		**Central incisor**		**Lateral incisor**		**Canine**	
Age (years)		n	%	n	%	n	%	n	%	n	%	n	%
<20	13	6	46.15	7	53.85	6	46.15	3	23.08	2	15.38	1	7.69
21-30	28	12	42.86	14	50.00	10	35.71	7	25.00	6	21.43	5	17.86
31-40	39	12	30.77	18	46.15	12	30.77	10	25.64	9	23.08	8	20.51
41-50	25	6	24.00	10	44.00	7	28.00	7	28.00	8	32.00	6	24.00
51-60	15	3	20.00	6	40.00	4	26.67	5	33.33	5	33.33	4	26.67
>60	7	1	14.29	2	28.57	1	14.29	3	42.86	3	42.86	2	28.57
Total	127	40	31.50	57	44.88	40	31.50	35	27.56	33	25.98	26	20.47

Table V: Mean amounts of gingival display among age groups (in mm).

Age (years)	Number	Maxillary anterior teeth			Mandibular anterior teeth		
		Central incisor	Lateral incisor	Canine	Central incisor	Lateral incisor	Canine
<20	13	2.84±1.74	3.14±1.46	3.62±1.67	0.20±0.09	0.14±0.11	0.07±0.02
21-30	28	2.27±1.42	2.41±1.28	2.58±1.78	0.21±0.11	0.17±0.15	0.08±0.07
31-40	39	1.85±1.36	2.16±1.50	2.54±1.55	0.25±0.20	0.20±0.13	0.10±0.07
41-50	25	1.75±1.15	2.07±1.68	2.33±1.82	0.27±0.17	0.22±0.12	0.11±0.08
51-60	15	1.63±1.40	1.74±1.10	1.92±1.38	0.29±0.23	0.23±0.18	0.12±0.08
>60	7	1.60±1.37	1.72±1.64	1.75±1.35	0.31±0.28	0.27±0.12	0.14±0.11
F ratio		2.06	1.65	1.88	1.17	1.32	0.94
P-value		0.062	0.15	0.094	0.28	0.23	0.67
Significance level		NS	NS	NS	NS	NS	NS

± = standard deviation
NS= not significant

but the differences were not statistically significant, with the exception of the maxillary central incisor and associated gingival display in smiling which was statistically significant ($p < 0.005$). Table IV shows the number and percentages of subjects displaying gingiva associated with anterior teeth during smiling. Gingivae associated with maxillary central incisors and canines were displayed equally in 31.5% of subjects. In addition, approximately 45% of subjects displayed gingivae associated with maxillary lateral incisors. However, gingival display associated with mandibular anterior teeth was recorded in approximately one-fourth of subjects for the incisors and 20% for the canines. The mean amounts of gingival display among the different age groups are shown in Table V. Differences of gingival display during smiling with increasing age were not statistically significant. Differences in gingival display between maxillary and mandibular anterior teeth followed an opposite pattern with the highest amounts of gingival display associated with the maxillary anterior teeth were recorded for subjects below the age of 20 and above the age of 60 for the mandibular anterior teeth.

In summary, at rest and during smiling; maxillary tooth display decreased, and mandibular tooth display increased with increasing age, but the differences between age groups were not significant, with the exception of the display maxillary central incisor that reduced significantly as age increased ($P<0.001$).

In smiling, approximately 45% of subjects displayed gingivae associated with maxillary lateral incisors and 31.5% of subjects displayed gingiva in the region of maxillary central incisor and canine teeth. However, gingiva associated with mandibular anterior region were only displayed in about one-fourth of subjects.

Gingival display was the highest below the age of 20 and above the age of 60 for the maxillary and mandibular gingivae, respectively. However, an inverse pattern of gingival display was recorded between the maxillary and mandibular gingivae but statistically significant differences were not recorded between age groups.

Discussion

This study was conducted to investigate the amount of tooth and gingival display in the anterior region in relation to age at rest and among smile, the sample was representative of a group of Jordanian population of dental patients that attended conservative dental clinic for a period of 6 months. The amount of tooth exposure at rest which is predominantly a muscle-determined position that varies from one person to another,is known as the static position.[13] On the other hand, the dynamic position is typically characterised by a smile.[5,16,21-23] With the increasing age, the amount of maxillary central incisor exposed when the lips are at rest decreased significantly from 3.27 mm in young subjects below the age of 20 to 0.58 mm in elderly subjects above the age of 60 (Table II), and from 8.93mm in young subjects below the age of 20 to 7.58mm in elderly subjects above the age of 60 (Table III) during smiling. However, the amount of mandibular teeth display, insignificantly, increased with increasing age. The display of maxillary anterior teeth in younger age groups, particularly below the age of 20, could be

resulted from passive eruption of maxillary anterior teeth that continues at least until the age 18-19 years.[24] In dentate patient the facial aging is believed to be totally due to soft tissue changes.[11] As age increases, lips become less elastic and the tissues surrounding the mouth sag, resulting in less maxillary tooth display,[7] and the amount of mandibular anterior teeth that is visible increases.[21] In addition, a slight decrease can probably be attributed to incisal and occlusal wear which increases with age reducing the clinical crown length of teeth.[25,26] In the present study, the investigation of anterior tooth display during smiling did not reveal a statistically significant gradual decrease with age for maxillary lateral incisor and canine teeth, however a statistically significant decrease of maxillary central incisor tooth display with age was recorded. In addition, mandibular anterior teeth display increased with increasing age, but the differences were not significant. Differences of gingival display during smiling with increasing age were not statistically significant. Differences in gingival display between maxillary and mandibular anterior teeth followed an opposite pattern with the highest amounts of gingival display associated with the maxillary anterior teeth were recorded for subjects below the age of 20 and above the age of 60 for the mandibular anterior teeth (Table V). The decrease in gingival display with age could be explained by increased recession of gingival tissues.[27] Recording gingival recession in combination with gingival display would provide substantial information in determining the extent to which this factor may or may not affect the amount of gingival display in different age groups.[28] An important outcome from this study was that approximately 45% of subjects had gingival display in maxillary lateral incisor region. This important finding reveals the necessity for increased esthetic awareness in restoring maxillary incisors. The significant occurrence of gingival display in the anterior region is further amplified by the fact that gingival display did not include the values in the areas of interdental papillae, which would increase the overall amount of anterior teeth associated gingival display. However, a reverse interpretation of the present findings reveals that more than half the population does not display gingiva associated with the anterior region in smiling, and from this point of view the routine subgingival placement of esthetic crowns would be an unnecessary overtreatment that might compromise periodontal health. In removable dentures, the artificial tooth arrangement, along with other guides to occlusal level orientation, should be evaluated clinically for proper tooth and gingival display on the basis of individual smiling characteristics. For complete denture patients, a guideline was suggested to adjust the vertical length of the maxillary occlusion rim in the anterior region by extending it approximately 2mm below the relaxed lip to establish the lip length-incisal edge relationship and accordingly the visible amount of the anterior teeth.[29] However, younger patients may reasonably be expected to show 4-5mm of tooth beneath the resting lip, especially if the patient had a class II division 1 profile.[30] Thus, treating all patients using the same therapeutic values regardless of age differences is not acceptable since it contributes greatly to the obvious "denture smile",[31] or "denture appearance".[32] The display of mandibular incisor teeth has been largely neglected in considering esthetics of prostheses. In complete dentures the incisal edges of mandibular incisors are established by positioning the central incisor 0.5 mm vertical overlap with the maxillary central and a 1 to 2 mm horizontal overlap.[1] These guidelines do not necessarily lead to the appropriate amount of visible tooth structure that is compatible with the patient's age or upper lip length. It has been shown that the maxillary central incisor is superior reference than the rest of the anterior teeth in regards to the amount of visible tooth surface, in addition, they are the most dominant anterior teeth in the dental arch because they can be seen in their full size.[2] The opinion of the patient must be considered in treatment planning as professional opinions regarding evaluation of esthetics may not coincide with the perceptions and expectations of patients.[9,33,34] In the present study, patient's perception of the importance of anterior teeth and their associated gingival display was not investigated, accordingly the present findings concerning gingival and tooth display in the anterior region could be used as guidelines to esthetic considerations in restoring maxillary and mandibular anterior teeth, their

clinical implications should be complemented with patient's perception of an attractive dental appearance. In order to create a pleasing esthetic result, the degree of tooth visibility should not be considered separately from other esthetic determinants for the degree of visibility of tooth structure must be in harmony with contours, size, incisal edges, occlusal plane, lip line, smile line, and the location of the midline.[30] One of the most helpful guidelines in determining the appropriate vertical dimension of occlusion is the visible amount of tooth of the anterior teeth. This general guideline will be more accurate if the patient's age, sex, race, and upper lip length are considered as variables that may affect the visible amount of tooth statistically and dynamically.[13,14,30] The subjects of this study attained a smiling position after being asked to smile with lips in maximum tension. In this way, no specific "lip borders" were defined, complicating the precise and accurate reproduction of this particular lip position. This could probably have induced some unpredictable variations in tooth or gingival display measurements. It has been reported that the width of the left and right maxillary central incisors varies little in the same patient.[35,36] Thus, the width of the maxillary right central incisor was therefore used as a parameter to assess age differences Accordingly, some variations were obvious concerning tooth and gingival display of the contralateral side that were not recorded in this study, as only the right side display was measured.

Conclusion

Differences in tooth display in relation to aging should be considered when providing esthetic prosthodontic treatment that involves replacement of anterior teeth

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