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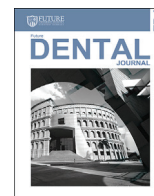
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# Analysis of Smile Characteristics of Adult Female Subjects with Skeletal Class II Division 2 Malocclusion

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## ABSTRACT

**Aim:** The objective of this study was to evaluate the smile characteristics of adult females with Angle Class II division 2 malocclusion compared to Angle Class I malocclusion. **Materials and Methods:** Two frontal photographs were taken for 30 orthodontically untreated female adult subjects with age range (18-30) years, at rest and posed smile from a fixed (1.5m) distance between the camera and the subjects. The 30 subjects were divided into 2 groups, 15 for Class II div 2 subjects and 15 for Class I subjects. The camera was focused only on the mouth, showing from the nose to the chin. Included in the capture area frame, an L shaped ruler with millimeter markings mounted on an adjustable tripod on the right side of the patient which was used to standardize the capture area. The photographs were exported to a computer, and uploaded to Adobe Photoshop CS2 where 13 soft tissue land marks were analyzed. **Results:** comparison between 13 soft tissue land marks for Class II div2 females and Class I females showed significant difference in lower facial height, lower lip thickness, lower lip length, maxillary incisal display, smile height and smile arch. And showed insignificant difference in rest of the measured parameters. **Conclusions:** Angle's Class II div.2 female subjects have significant lower mean values of the lower facial height, lower lip length, lower lip thickness than Class I female subjects. They also have significant shorter smile height. Incisor display than Class I female subjects. A higher percentage of non-consonant smile arcs were found among Class II division 2 females and it was found to be statistically significant between both groups.

## 1. INTRODUCTION

Orthodontics has experienced the re-emergence of the soft tissue paradigm in recent years with greater focus on soft tissues around the mouth in general and the smile in particular. Obtaining a beautiful smile is always the main objective of any esthetic dental treatment. After all, it is the beauty of the smile that will make the difference between an acceptable or pleasing aesthetic result for any given treatment.

For decades, diagnosis and treatment planning focused on esthetics through the profile view of the patient and the need for its improvement without considering the frontal view as well, or focusing only on skeletal structure than on soft tissue ones.

The smile is a facial expression that is globally known as a sign of happiness, a means of communication, and an important factor influencing the esthetic and attractiveness of the face. It also affects the success of social relations and the oral health-related quality of life. Improved facial balance during smiling is an essential treatment objective and adds an important dimension to successful orthodontic treatment. Although a perfect smile should have perfect teeth, it also should have all its components in harmony with each other. Thus, orthodontists should make every effort to develop a harmonious balance between the various soft and hard tissue structures that

will produce an attractive smile. So far, there have been few studies in the field of orthodontics that investigates the smile esthetics of different types of malocclusion for clinical reference. Few studies have been performed to evaluate the smile characteristics of Class II Division 2 malocclusion thus, this study was designed to focus on the smile characteristics of Angle Class II division 2 females compared to females having Angle Class I malocclusion.

## 2. MATERIALS AND METHODS

### Sample Size Calculation:

The power analysis used the incisor display as the primary outcome. In a previous study by Abu Nassif (2013)<sup>1</sup> the response within each subject group was normally distributed with a standard deviation of 0.51. If the true difference between Group I and Group II division means was (3.22- 2.76) =0.46 for females, we will need to study 13 subjects per group to be able to reject the null hypothesis that the population means were equal with probability (Power) 80%. The Type I error probability associated with this test of this null hypothesis is 0.05 thus, a sample size of 15 female subjects was included for each group in this study.



### Data collection methods:

Two frontal photographs were taken for each subject, at rest and subject's commissure-to-commissure posed smile. The posed smile position was captured for each subject which according to <sup>2</sup> being considered as the most repeatable smile. Photographs were taken for each Ackerman et al. patient in the natural head position (NHP). The head was held in an upright posture and eyes were focused on a point in the distance at eye level such that the visual axis was horizontal. All selected photographs were taken in a standardized manner. If head position required correction, the researcher helped the subject into natural head orientation. Photographs were taken at 1.5 meters from the standing subject using a digital camera which was mounted on a tripod. The camera lens was adjusted to be parallel to the floor by adjusting the mount head of the tripod guided by the leveling indicator that is built in the tripod, the camera was focused only on the mouth, showing from the nose to the chin. The photographs were taken in the same environment under the same lighting conditions. Included in the capture area frame was an L shaped ruler with millimeter markings mounted on an adjustable tripod on The right side of the patient which was used to standardize the capture area, and photos were taken at rest, then another photograph was taken on smiling.

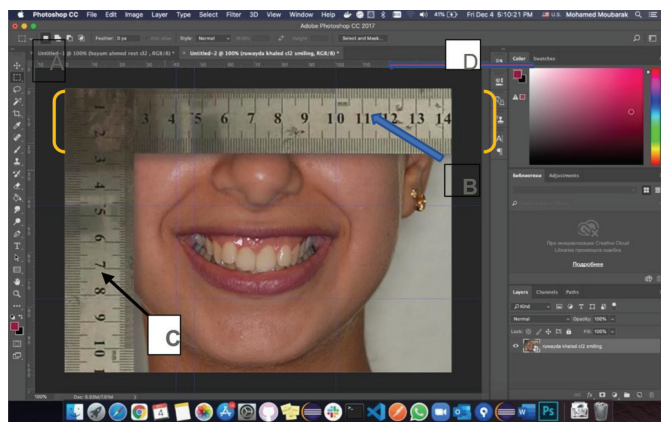


Figure (1) — Horizontal and vertical soft tissue measurements on smiling.  
a: marquee tool      b: mm ruler adjusted on the horizontal ruler  
c: vertical ruler      d: horizontal ruler

### Standardization and Calibration:

The photographs were downloaded to a computer; Photographs were then uploaded to Adobe Photoshop CS2,<sup>3,4</sup> and then adjusted to a standardized image size by using the mm ruler in the capture frame which is considered representative to check for magnification error. The resolution of the photographs was adjusted to 751 pixels/width and 1051 pixels/height. The most accurate linear found to represent measurements of the photograph is image resolution 7:5 ratio. The ruler function in the Photoshop was chosen and set to millimeters to match the L shaped frame ruler. To check the accuracy, two readings were performed for a 10mm distance on the ruler, if both readings read 10mm, and then direct measurements were recorded from the JPEG file. The horizontal and vertical ruler tools were used to measure vertical and horizontal soft tissue measurements respectively, and then the rectangular marquee tool was used to read the measurements between each of the two rulers to the nearest 0.1mm.



Figure (2) — Upper lip length

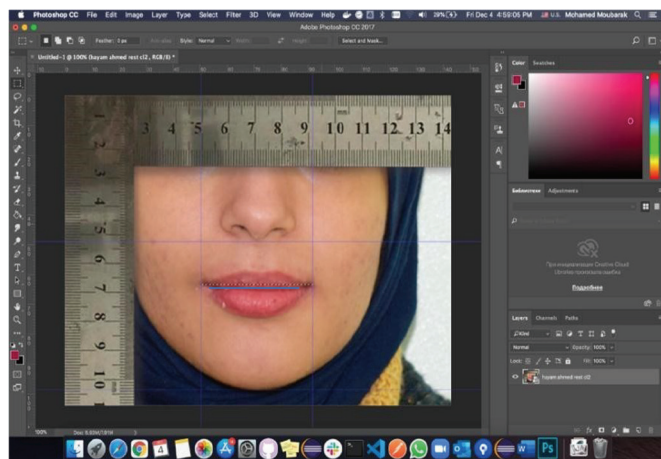


Figure (3) — Inter commissural width



Figure (4) — Lower facial height

### Smile Analysis:

Standard soft tissue landmarks were identified (Appendix). For each participant's frontal rest and smiling photographs the following measurements were analyzed.

**Table (1)**

Appendix

Landmark	Definition
Upper lip length	The distance between subnasale and stomion superius.
Upper lip thickness	The distance between superior point of the cuspids bow to the most inferior portion of the tubercle of the lower lip
Inter commissural distance	Horizontal distance between the 2 corners of the mouth
Lower facial height	Vertical distance between subnasale to soft tissue menton
Lower lip thickness	Distance between stomion to labrale inferius
Lower lip length	Vertical distance between stomion to sulcus inferius
Chin height	Distance from sulcus inferius to soft tissue gnathion
Max. incisor display	The amount of tooth exposure during smiling
Buccal corridor	Distance between most distal mas dentition and the commissure
Gingival display	Amount of gingival exposure during smiling
Smile width	Horizontal distance between the outer commissures of the lips on smiling
Smile arch	The relationship of the curvature of the incisal edges of the maxillary incisors and canines to the curvature of the lower lip

### Statistical Analysis:

Quantitative variables were described by the Mean, Standard Deviation (SD), the Range (Minimum – Maximum), Standard Error (SE) and 95% confidence interval of the mean. Qualitative categorical variables were described by proportions and Percentages. Shapiro-Wilk test of normality was used to test normality hypothesis of all quantitative variables for further choice of appropriate parametric and nonparametric tests. Mostly the variables were found normally distributed allowing the use of parametric tests. Independent samples t-test was used for comparing the means of two groups. For both inter and intra observer reliability analysis, Dahlberg error and Relative Dahlberg Error (RDE) were used together. with Concordance Correlation Coefficients (CCC) including the 95% confidence limits of the coefficient. Significance level was considered at  $P < 0.05$  (S); while for  $P < 0.01$  it was considered highly significant (HS).

### 3. RESULTS

**Comparison between Class I and Class II div.2 females at rest:** The mean lower facial height was found to be significantly shorter for Class II div 2 females (70.76mm+5.45) compared to Class I females (75.41mm+4.92) ( $P$ -value  $< 0.021$ , Effect size =2.45). In addition, the lower lip length was found to be significantly shorter for Class II division 2 females (18.39mm+2.48) compared to Class I females (20.53mm+2.31) ( $P$ -value  $< 0.021$ , Effect size=2.44) and the lower lip thickness was found to be significantly less for Class II division 2 (12.88mm+2.02) compared to Class I females (14.54mm+2.36). There was statistically insignificant difference for the chin height, upper lip length and thickness between both groups.

The inter-commissural width was found to be less wide for Class II div 2 (59.96mm+7.40) compared to (63.28mm+6.89) for Class I females however, it was found to be statistically insignificant.

**Comparison between Class I and Class II div.2 females on smiling:** The mean maxillary incisor display for Class II div 2 was found to be significantly less (8.74mm+1.70) compared to Class I females (11.32mm+1.68) ( $P$ -value  $< 0.001$ , Effect size = 4.18) in addition, the smile height was found to be significantly less for Class II division 2 (10.98mm+2.75) compared to Class I females (13.70mm+3.05). However, insignificant difference was found for the gingival display and buccal corridor between both groups with a mean value of (2.16mm+2.43), (8.71mm+1.68) for Class II div.2 females compared to (1.24mm+2.17) and (7.87mm+1.41) for Class I females respectively. Moreover, insignificant difference was found for the mean value of the smile width for Class II div 2 (74.59mm+8.29) compared to Class I females (76.77mm+11.89).

**Table (2)** Comparison between soft tissue measurements of Class II div.2 and Class I females at rest.

Landmark		N	Mean	SD	SEM	Mean Difference	SE Difference	Effect Size	Lower	Upper	t	df	P Value
Upper lip length	Class I	15	23.94	3.50	0.90	1.47	1.26	1.17	-1.11	4.05	1.17	28	0.25368 P>0.05 NS
	Class II	15	22.47	3.41	0.88								
Upper lip thickness	Class I	15	10.08	1.86	0.48	0.79	0.65	1.21	-0.55	2.13	1.21	28	0.23678 P>0.05 NS
	Class II	15	9.29	1.71	0.44								
Inter commissural distance	Class I	15	63.28	6.89	1.78	3.32	2.61	1.27	-2.02	8.67	1.27	28	1.21324 P>0.05 NS
	Class II	15	59.96	7.40	1.91								
Lower facial height	Class I	15	75.41	4.92	1.27	4.65	1.89	2.45	0.76	8.53	2.45	28	0.02070 P>0.05 S
	Class II	15	70.76	5.45	1.41								
Lower lip thickness	Class I	15	14.54	2.36	0.61	1.66	0.80	2.07	0.02	3.31	2.07	28	0.04751 P>0.05
	Class II	15	12.88	2.02	0.52								
Lower lip Length	Class I	15	20.53	2.31	0.60	2.14	0.88	2.44	0.34	3.93	2.44	28	0.02121 P>0.05 S
	Class II	15	18.39	2.48	0.64								
Chin height	Class I	15	28.79	2.84	0.73	-0.99	1.12	0.89	-3.28	1.30	-0.89	28	0.38243 P>0.05 NS
	Class II	15	29.78	3.26	0.84								

\*Significant at  $P < 0.05$

**Class II div.2 and Class I females at rest.****Table (3):**

Comparison of soft tissue measurements between Class II div 2 and Class I females at rest

Landmark		N	Mean	SD	SEM	Mean Difference	SE Difference	Effect Size	Lower	Upper	t	df	P Value
<b>Maxillary incisor display</b>	Class I	15	11.32	1.68	0.43	2.58	0.62	4.18	1.32	3.85	4.18	28	0.00026 P<0.001 HS
	Class II	15	8.74	1.70	0.44								
<b>Buccal corridors</b>	Class I	15	7.87	.41	0.36	-0.84	0.57	1.48	-2.00	0.32	-1.48	28	0.14930 P>0.05 NS
	Class II	15	8.71	1.68	0.43								
<b>Gingival display</b>	Class I	15	1.24	2.17	0.56	-0.93	0.84	1.10	-2.65	0.80	-1.10	28	0.27946 P>0.05 NS
	Class II	15	2.16	2.43	0.63								
<b>Smile width</b>	Class I	15	76.77	11.89	3.07	2.18	3.74	0.58	-5.48	9.85	0.58	28	0.56455 P>0.05 NS
	Class II	15	74.59	8.29	2.14								
<b>Smile height</b>	Class I	15	13.70	3.05	0.79	2.73	1.06	2.57	0.56	4.90	2.57	28	0.01567 P< 0.05 s
	Class II	15	10.98	2.75	0.71								

**Class II div. 2 and Class I females at smile.****Table (4):**

Comparison between consonant and non consonant smile archs.

	<i>Consonant</i>		<i>Non Consonant</i>		<i>Total</i>	<i>Chi squared</i>	<i>P Value</i>
	No	Percent	No	Percent			
<i>Class I</i>	10	66.67%	5	33.33%	15	4.82	0.02811 <b>P &lt; 0.05 S</b>
<i>Class II</i>	4	26.67%	11	73.33%	15		
<i>Total</i>	14	46.67%	16	53.33%	30		

**Comparison between smile arcs of Class II division 2 and Class females:** The results of the study showed that 66.67% of Class I females had consonant smile arcs which was statistically significantly greater compared to Class II division 2 females (26.67%) while, non-consonant smile arcs represented 73.33% for Class II division 2 females which was statistically significantly higher compared to Class I females (33.33%) (P<0.05)

**4. DISCUSSION**

The smile is one of the most important expressions contributing to facial attractiveness. An attractive or pleasing smile clearly enhances the acceptance of an individual in the society by improving the initial impression in interpersonal relationships.<sup>5</sup>

There are two forms of smiles - the enjoyment or Duchenne smile and the posed or social smile. The posed smile is voluntary and not elicited by an emotion in other words, it is reliably reproducible and can be sustained. Posed smiles, therefore, have an importance in orthodontic diagnosis and treatment planning while, the un-posed or social smile, however, is involuntary and is induced by joy as it is a natural response since it expresses authentic human emotion. With patients becoming increasingly conscious of their dental appearance, smile esthetics has become the primary objective for seeking orthodontic treatment.<sup>6</sup> The objective of orthodontic treatment is shifting away from the creation of ideal dental and skeletal relationships but instead is placing more emphasis on the facial soft tissue.<sup>7</sup> The most important esthetic goal in orthodontics is to achieve a balanced smile, which can be best described as an appropriate positioning of teeth and gingiva within the dynamic display

zone. A significant portion of maxillary incisors is visible during speech, mastication and various facial expressions.<sup>8</sup> Esthetic considerations are paramount in treatment planning; however, rigid rules cannot be applied to this process because almost an infinite variety of faces could be esthetic.<sup>9</sup>

The present study aimed to determine the smile characteristics of Class II division 2 females compared to skeletal Class I female adults to provide a guideline for an esthetic smile for Class II cases. The subjects of this study were selected at the Orthodontic Department of the Faculty of Oral and Dental Medicine, Future University in Egypt. The sample included 30 females which was equally divided to 15 Class II division 2 and 15 skeletal Class I subjects having a mean age of 18 to 30 years in order to minimize the effects of growth on facial appearance. All subjects had full permanent dentition with no previous orthodontic treatment while, those with fixed bridges, crowns visible on smiling, malformed teeth, lip irregularities, facial asymmetries, excessive dental attrition, history of lip surgery or enhancement were excluded from the study.

Frontal photographs at rest and on smiling were taken for each subject at a fixed distance of 1.5 which meters was found to be the nearest distance to the subject which shows the selected capture area with best resolution and without the need to crop the photographs .

The photographs were then uploaded to Adobe Photoshop CS2, this images resolution represented a 7:5 ratio which was found to represent the most accurate linear measurements on the photographs. This ratio was obtained by comparing direct measurements and digital measurements to achieve similar linear numbers on both patients and digital photos.



The vertical aspects of smile anatomy are the degree of maxillary anterior tooth display (Morley ratio),<sup>10</sup> upper lip drape, and gingival display where both skeletal and dental relationships contribute to these smile components.<sup>11</sup> According to Mackley<sup>12</sup> the amount of gingival display is considered to be one of the most important features of the smile where he reported that the upper lip should be at the height of the gingival margin of the maxillary central incisors in an attractive smile. According to Singer (1974)<sup>12</sup> & Peck and Peck

(1970)<sup>13</sup> gingival display on smiling was influenced by the upper lip length, vertical maxillary excess and greater muscular capacity to raise the lips.<sup>13,14</sup> Peck et al reported that lip coverage of the maxillary incisors increases with age therefore, a high smile that shows 100% of the maxillary incisors and a continuous band of gingiva is characteristic of a younger population. In this study, the amount of gingival display was insignificantly different between Angle Class II division 2 (2.16 mm) and Class I females (1.24mm). The amount of maxillary incisor show during smiling is a critical parameter esthetically, as it is one of the decisive components in esthetic judgment. In a youthful smile, 75–100 % of the maxillary central incisors should be positioned below an imaginary line drawn between the commissures. According to Gillen et al (1994)<sup>15</sup> the average crown height of the maxillary central incisor was 9.7mm in females and reported that a short clinical crown may contribute to inadequate tooth display and poor esthetics. The percentage of incisor display, when combined with crown height, helps the clinician decide how much tooth movement is required to improve the smile index.<sup>16</sup> In this study, the maxillary incisor display was found to be significantly greater in Class I (11.32 mm) compared to Class II Div 2 females (8.74mm) which could be due to the lingual inclination of upper central incisors commonly seen in Class II division 2 malocclusion these finding were supported by a study performed by Chou et al<sup>17</sup> and Grover et al<sup>18</sup>

Buccal corridors (negative or black spaces) are the spaces between the facial surfaces of posterior teeth and the corners of lips when a person is smiling.<sup>19</sup> There seems to be a difference of opinion among investigators about the esthetic value of buccal corridors. Some concluded that they have no esthetic value, others believe that visible buccal corridors are unattractive.<sup>20,21</sup> Most recent studies reported that buccal corridors leave little impact on smile esthetics and do not influence the overall rating of a smile by orthodontists, general dentists, and laypersons.<sup>22,23</sup> In this study, the mean buccal corridor for Class II div 2 group was (8.71mm) compared to (7.87 mm) for Class I group which was found to be statistically insignificant between both groups which came in agreement with **Rashed and Heravi**<sup>24</sup> who pointed out that there were no differences in the buccal corridors among different malocclusion groups, Moreover these results were similar to the results of McNamara et al<sup>25</sup> and Krishnan et al.<sup>26</sup>

The lower facial height was found to be significantly less for Class II division 2 (70.76mm) compared to (75.41) for Class I females which may be attributed to the horizontal facial growth pattern seen in Class II division 2 subjects.

The smile height was found to be statistically significantly less for Class II division 2 (10.98mm) compared to Class I females (13.7mm) in addition, the smile width was found to be slightly less wide for Class II division 2 females (74.59mm) compared to Class I females (76.77mm) but it was found to be statistically insignificant. Abraham et al<sup>27</sup> reported a positive correlation between the lower facial height and smile width which was in similarity to the findings of this study.

The upper lip length of Class II division 2 females was found to be slightly shorter (22.47mm) compared to Class I subjects (23.94mm) which was in harmonious with the findings of Al Hamadany<sup>28</sup> where Class I subjects possessed higher values of upper lip length than Class II followed by Class III adults. In addition, the chin height was found to be slightly longer for Class II division 2 (29.78mm) females compared to Class I (28.79mm). Lower lip length was found to be significantly shorter for Class II division 2 (18.39mm) compared to Class I females (20.53). Insignificant difference was found in

the Upper lip thickness between both groups which was in agreement with the results of Alkhalaf and Al-Sabagh<sup>29</sup> study where the lip thickness showed insignificant difference between both skeletal Class I and Class II groups. However, the lower lip thickness between was significantly greater in class I group (14.54 mm) compared to class II div 2 group (12.88 mm) these findings were not in accordance to those reported by McIntyre et al.<sup>30</sup> who found that Class II division 2 subjects had thicker upper and lower lips compared to Class I subjects.

There was no statistical difference in The Inter commissural width between Class I (63.28 mm) and Class II division 2 females (59.96 mm) (P > 0.05). In the present study, the inter commissural width for Class I was found to be wider compared to the findings of Kurien et al<sup>31</sup> where the inter commissural width for Class I females aged 20 to 49 years was (47 mm).

The width of the smile was also found to be less for Class II division 2 (74.59mm) compared to Class I females (76.77mm) however, it was found to be statistically insignificant. These findings were greater than the findings of Grover et al<sup>17</sup> and Malhotra et al<sup>32</sup> for Class I females who showed that subjects with Class I showed maximum smile width (66 mm). The smile arc is the relationship between the curvature of the incisal edges of the maxillary anterior teeth and the curvature of upper border of the lower lip.<sup>33</sup> The ideal relationship on smiling is considered to be parallel and is known as a consonant smile, with flatter maxillary incisal curvature to the upper border of lower lip, it is called a non-consonant smile. In this study the percentage of non-consonant smile arcs was (73.33%) for Class II div 2 compared to (33.33%) for Class I females which was found to be statistically significant.<sup>34</sup> These results were in disagreement with the findings of Rashed and Heravi<sup>23</sup> who concluded that no significant difference in smile arcs was found among all malocclusion groups.

## 5. CONCLUSIONS

Class II div 2 female subjects characterized by shorter facial height than Class I female subjects, this shortening was concentrated in the lower facial third ( from lower lip to the chin ) , on the other hand both groups had similar smile features except for maxillary incisor display and smile arc which would be related to the retroclined upper incisors in Class II div 2 subjects.

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