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Assessment of smile parameters in skeletally class I orthodontic patients

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Abstract

Introduction: The smile is an important form of facial expression which heralds the attractiveness of an individual. In orthodontics smile design is an important treatment goal. The skeletal pattern of a patient can affect the characteristics of their smile. This study will help establish averages for various components of smile parameters in our population and to find out their correlation with the skeletal pattern. This knowledge will help in orthodontic diagnosis and treatment planning.

Material and methods: Data of 289 skeletally class I patients was collected out of a total of 1500 cases registered at the department of orthodontics. The patient records were checked for demographic variables (age and gender) and vertical skeletal class (high, normal or low angle). Pretreatment smiling photographs were used to analyze the smile parameters namely smile line, smile arc, buccal corridors and number of teeth displayed.

Results: The relationship between high smile line and vertically high angle patients was found to be statistically significant. Smile arc, buccal corridors and number of teeth visible on smile did not have a statistically significant relationship with the vertical skeletal class but they are clinically significant.

Conclusions: Vertically high angle patients are more likely to have a high smile line. This knowledge must be kept in mind during orthodontic diagnosis and treatment planning of patients. Data collected in this study can be used in further studies.

Keywords: Smiling; dental esthetics; orthodontic extrusion

Introduction

Smile design in orthodontics helps to achieve an optimized dentofacial proportion. People with bright smiles have been proven to be more successful in life. They get better job opportunities as employers associate a sunny smile with intelligence, an extrovert personality and confidence.[1] Dental esthetics of the smile must be kept in mind during orthodontic treatment planning.

The smile line or lip line is the amount of tooth show of maxillary anterior teeth when the patient is smiling. It can be classified as high, average and low. According to the 3-grade scale classified by Mc Namara et all if anterior tooth show is less than 75% it is classified as a low smile line. If 75-100% of anterior teeth are displayed on smile along with less than 1 mm of gum show it is an average smile line. Complete tooth show along with more than 1 mm of gum show is classified as high smile line.[2]

The smile arc is the relationship of the curvature of the maxillary anterior teeth and upper border of the lower lip. It has been classified into 3 categories by Ackerman and

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Sarver.[3] A "consonant" smile is one where the curvature of the incisal edges of the maxillary teeth follows the curvature of the lower lip. A "straight or flat" smile arc is one in which the teeth are in a straight line and do not follow the curvature of the lower lip. A "reverse" smile arc is one in which the maxillary anterior teeth form a reverse curve in relation to the lower lip.[4]

The buccal corridors are the space present between the inner corners of the lips of the patient and the buccal most surface of the maxillary posterior teeth when the patient smiles.[5] Moore et all classified it as broad (2%), medium broad (10 %), medium (15%) and medium narrow (22 %) and narrow (28%).[6]

The number of teeth displayed in the smile of a patient is variable. Patients may display teeth from the right canine to the left canine while smiling. Others have a premolar-to-premolar smile.[7] Few patients may even have the 1st molars visible on smile. This can also affect the attractiveness of a person's smile and may need to be assessed when deciding the need for orthodontic extractions.[8]

Material and Methods

This retrospective observational study was conducted after the ethical approval of institutional review board (Ref #IMDC/DS/IRB/167) at Department of Orthodontics, Islamabad Dental Hospital, Islamabad Medical and Dental College, Islamabad. All patients between the ages of 12-35 who reported to the Department from Jan 2013 to June 2021 were included in the sample. Patients with missing or carious anterior teeth or incomplete photographic records were excluded from the sample.

The WHO sample size calculator was used to calculate a minimum sample size of 289 patients. Non probability convenience sampling technique was used to collect the data of 289 skeletally class I patients out of a total of 1500 files. Patient record files of selected patients were checked for vertical skeletal class (high angle/ normal angle /low angle) and demographic variables (age and gender). Out of 289 patients 192 were female and 97 were male. The percentage distribution is given in figure 1. Amongst the 289 patients, 77 patients had a high angle (Maxillomandibular angle of ≥ 28 °), 177 had moderate angle (Maxillomandibular angle of 22 ± 5 °) and 35 had low angle (maxillomandibular angle ≤ 16 °). Percentage distribution is shown in figure 2.

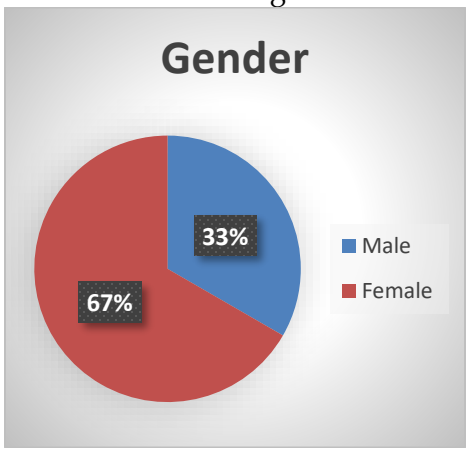

Figure 1: Gender distribution of sample

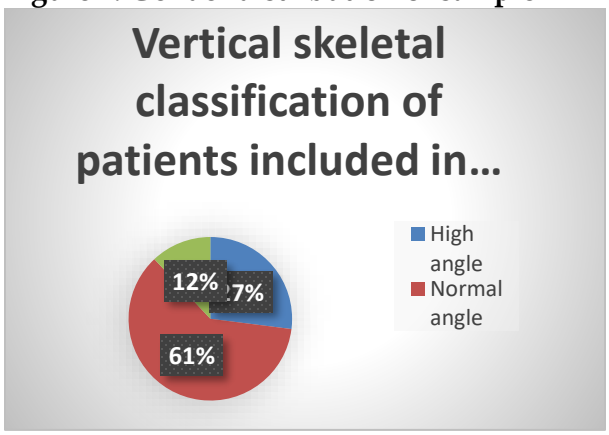

Figure 2: Vertical skeletal class distribution of sample.

Smile line, smile arc, buccal corridors and number of teeth displayed were all evaluated and measured on standardized digital photographs in Microsoft Photos using a digital ruler as shown in figure 3-13 and recorded in a proforma.

To classify smile line if there was complete tooth show along with more than 1 mm of gum show it was classified as high smile line (figure 3). If 75-100% of anterior teeth were displayed on smile along with less than 1 mm of gum show it was classified as an average

smile line (figure 4). If anterior tooth show was less than 75% it was classified as a low smile line (figure 5).

Figure 3: High smile line.

Figure 4: Average smile line.

Figure 5: Low smile line.

To classify smile arc if the curvature of the incisal edges of the maxillary teeth followed the curvature of the lower lip it was classified as a consonant smile. If the teeth were in a straight line and did not follow the curvature of the lower lip it was classified as a straight or flat smile arc. If the maxillary anterior teeth form a reverse curve in relation to the lower lip it was classified as a reverse smile arc.

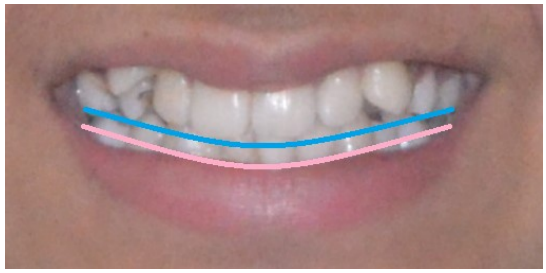

Figure 6: Consonant smile arc.

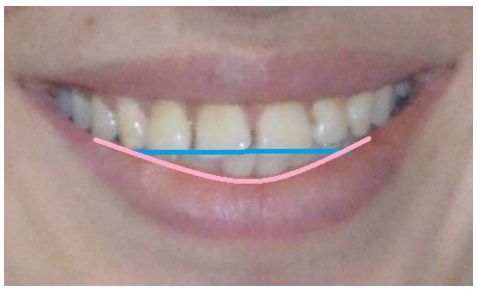

Figure 7: Straight smile arc.

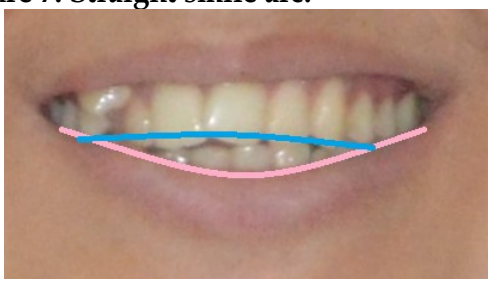

Figure 8: Reverse smile arc.

To measure buccal corridors the space present between the inner corners of the lips of the patient and the buccal most surface of the maxillary posterior teeth when the patient smiles was measured (X+X) as shown in figure 9. Then the total length of the commissure was measured (Y). X+X was divided by Y to calculate the percentage of visible buccal corridors. It was classified as broad (≤ 2%), medium broad (≤ 10%), medium (≤ 15%) and medium narrow (≤ 22 %) and narrow (≤ 28%).

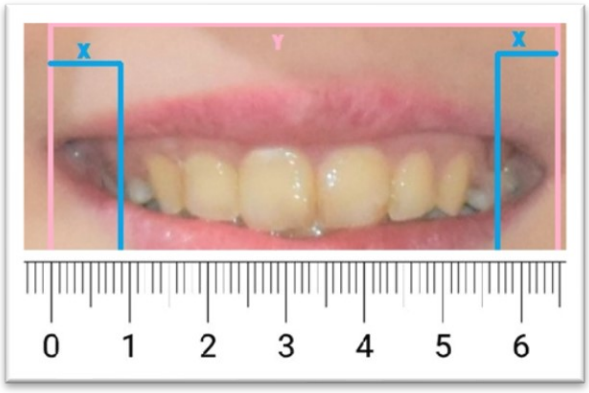

Figure 9: Buccal corridor measurement.

The number of teeth displayed while smiling was counted on the photographs. This was classified as canine to canine smile (figure 10), right 1st premolar to left 1st premolar (figure 11), right 2nd premolar to left 2nd premolar (figure 12), right 1st molar to left 1st molar (figure 13).

Figure 10: Smile displaying canine to canine.

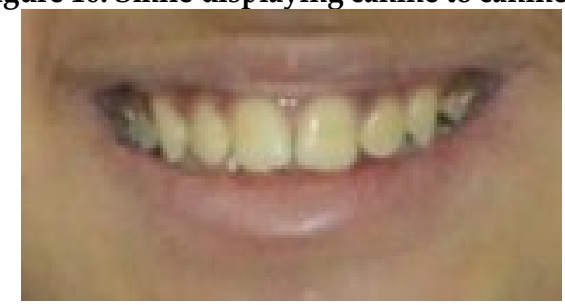

Figure 11: Smile displaying right 1st premolar to left 1st premolar

Figure 12: Smile displaying right 2nd premolar to left 2nd premolar.

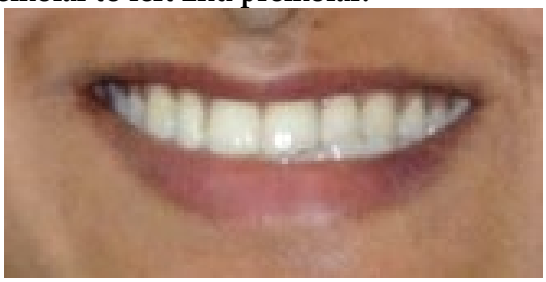

Figure 13: Smile displaying right 1st molar to left 1st molar.

The data was analyzed by SPSS version 22. Chi square test was used to find out the relationship between vertical skeletal class, smile line, smile arc, buccal corridors and number of teeth visible on smile. Spearman rank correlation was used to find out association between vertical skeletal class and smile line. The p value ≤ 0.05 was considered significant at 95% confidence interval.

Results

To determine association between the vertical skeletal class and smile line, chi square test was applied. The results are displayed in Table I. The p value was 0.003 which was found to be statistically significant. This shows that high smile line is usually found in patients with a vertical skeletal high angle. Low smile line is found more frequently in patients with a vertical low angle. However, majority of the patients in our sample had an average smile line. In addition, Spearman rank correlation was found to be significant for smile line and vertical skeletal class.

Table I: Chi square to show association between smile line and vertical skeletal class.

Vertical skeletal class	High smile line	Average smile line	Low smile line
High angle	32.5%	61%	6.5%
Normal angle	16.4%	67.8%	15.8%
Low angle	14.3%	57.1%	28.6%
Total	20.4%	64.7%	14.9%

Chi square test was used to determine association between the vertical skeletal class and smile arc. The results are displayed in Table II. The p value was 0.065 which was found to be statistically insignificant. However, the results show that most patients who had a reverse smile arc were skeletally low angle patients. A consonant smile arc was found more in patients who had a normal vertical angle.

Table II: Chi square to show association between smile arc and vertical skeletal class.

Vertical skeletal class	Consonant smile arc	Flat smile arc	Reverse smile arc
High angle	70.1 %	18.2%	11.7%
Normal angle	78%	14.7%	7.3%
Low angle	60%	17.1%	22.9%
Total	73.7%	15.9%	10.4%

To determine association between the vertical skeletal class and buccal corridors chi square test was applied. The results are displayed in Table III. The p value was 0.21 which was

found to be statistically insignificant. However, we found that most of the patients in our study had a medium buccal corridor ≤ 15%.

Table III: Chi square to show association between buccal corridors and vertical skeletal class.

Vertical skeletal class	Broad buccal corridor ≤ 2%	Medium broad buccal corridor ≤ 10%	Medium buccal corridor ≤ 15%	Medium narrow buccal corridor ≤ 22%	Narrow buccal corridor ≤ 28%
High angle	3.9%	19.5%	45.5%	29.9%	1.3%
Normal angle	4.5%	16.9%	59.9%	16.9%	1.7%
Low angle	2.9%	22.9%	42.9%	25.7%	5.7%
Total	4.2%	18.3%	54%	21.5%	2.1%

Chi square test was used to determine association between the vertical skeletal class and number of teeth visible on smile. The results are displayed in Table IV. The p value was 0.58 which was found to be statistically insignificant. However, we found that majority of our patients displayed right 1st premolar to left 1st premolar while smiling. The least common was the canine-to-canine smile.

Table IV: Chi square to show association between number of teeth visible on smile and vertical skeletal class.

Vertical skeletal class	Canine to canine smile	right 1st premolar to left 1st premolar	right 2nd premolar to left 2nd premolar	right 1st molar to left 1st molar
High angle	5.2%	45.5%	32.5%	16.9%
Normal angle	4.0%	45.8%	33.3%	16.9%
Low angle	11.4%	37.1%	40.0%	11.4%
Total	5.2%	44.6%	33.9%	16.3%

Discussion

This study was carried out to determine the association between the vertical skeletal class and different smile parameters. We also found the frequency of different types of smile line, smile arc, buccal corridors and number of teeth visible while smiling recorded in patients reporting to Department of Orthodontics, Islamabad Dental Hospital.

The skeletal pattern of a patient significantly determines the characteristics of a patients smile. Ackerman and Ackerman stated that Skeletal class I patients with a vertically high angle usually have an increased gum show on smiling.[9] Our findings agree with this observation as most patients with a high smile line belonged to the high angle group. Conversely, a flat or reverse smile arc is found in patients with a vertically low angle.[10-12] Our findings agree with this observation as well. Therefore, the treatment plans for different facial types should be different, with special precautions taken during incisor intrusion in the low angle patients as they are prone to smile arc flattening. Similarly in high angle patients' orthodontic extrusion of incisors can lead to worsening of a high smile line.[13]

We found that in patients with a vertical low angle the frequency of a low smile line was 29%. In such patients care must be taken to correct the smile line with extrusive mechanics. In normal angle and high angle patients the frequency of low smile line was 15% and 7% respectively which is lesser than the low angle cases. Conversely in high angle patients we found that 33% patients had a high smile line which was the most out of the three groups. These patients may present with a gummy smile and thus intrusive mechanics to correct the smile line must be considered. In low angle and normal angle cases the frequency of a high or gummy smile was 14% and 16% which was less than the vertically high angle cases. In treatment planning the smile line correction must be one of the treatment goals of the orthodontist and the vertical skeletal pattern of the patient must be taken into account to devise mechanics accordingly.

Lindauer et al found that orthodontic correction of the overbite may cause some degree of flattening of the smile arc during treatment. The intrusion arch for example, will decrease the maxillary incisor exposure due to the intruding mechanism and can lead to significant flattening of the smile arc.[14] In our study 73.3 % patients had a consonant smile arc, 15.9 % had a flat smile arc and 10.9 % patients had a reverse smile arc at the

pretreatment stage. Care must be taken at the treatment planning stage to avoid orthodontic intrusion of the incisors in patients with a flat or reverse smile arc.[15-18]

Cheng et al studied smile esthetics for different malocclusions and found that a smile with greater maxillary incisor show, a greater number of displayed teeth, and broad buccal corridor ratio was considered more esthetic.[19] In 1958, Frush and Fisher defined buccal corridors, which is the lateral negative space that appears, when a person smiles, between the labial surface of maxillary posterior teeth and the inner mucosa of the soft tissues that form the corners of the mouth.[20] This space arises from the dark background of the mouth, and depends on the shape and width of the upper dental arch and facial muscles which are responsible for the breadth of the smile.[21] In our study we did not find a correlation between vertical skeletal class and the amount of buccal corridors visible. Statistically in our sample, 54% patients had medium buccal corridors, 21.5% had medium narrow and 18.3 % had medium broad buccal corridor. A small percentage namely 4.2% had a broad buccal corridor and 2.1% had a narrow buccal corridor. In patients with narrow buccal corridors, during treatment planning, expansion may be considered instead of extraction treatment to decrease the negative space and improve smile esthetics. Conversely, in patients with broad buccal corridors expansion treatment may be avoided to ensure a natural looking smile as opposed to an artificial denture type smile. Studies show conflicting views to this opinion. Mayer AH et al found no differences in buccal corridor widths measured between the extraction and non-extraction subjects.[22] Zange S demonstrated that laypersons were more critical compared to orthodontists in perceiving buccal corridors as undesirable in a smile. Expansion can be justified in cases where buccal corridors are very narrow.[23]

Studies have shown that the number of teeth visible on smile varies from individual to individual.[7] In our study we found no correlation between the number of teeth visible on smiling and the vertical skeletal class. However, we found that majority of the patients displayed right 1st premolar to left 1st premolar while smiling (52.6 % males and 40.6 % females) followed by right 2nd premolar to left 2nd premolar (30.9% males and 35.4 % females) and molar to molar smile (10.3% males and 19.3 % females). The least common was the canine-to-canine smile (6.2% males, 4.7% female). In orthodontic treatment planning evaluation of a patient's pretreatment photograph must be done to evaluate need for extractions which can reduce the number of teeth visible in smile and could compromise smile esthetics in a patient with a canine-to-canine smile. According to Dunn et al, laypersons find having a greater number of teeth displayed more attractive.[24]

Conclusions

This study helps to establish averages for various components of smile parameters in our population. A significant correlation was found between vertically high angle patients and a high smile line. This knowledge must be kept in mind during orthodontic diagnosis and treatment planning of patients.

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