Original Article

Evaluation of Smile Characteristics in Three Different Sagittal Malocclusions Before and After Nonextraction Orthodontic Treatment

Parisa Salehi, Shabnam Ajami, Neda Babanouri, Sanaz Abbasi

Department of Orthodontics, Orthodontic Research Center, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Introduction: To investigate the smile esthetics variables in three malocclusion classifications of angle to find out if the final smile esthetics was correlated with the initial types of malocclusion. **Materials and Methods:** This cross-sectional study was performed on 90 adult patients (18–28 years old) with three classes of malocclusion (n = 30 for each class), who were just treated by an orthodontist based on standard edgewise (0.018 inch). A standardized smile mesh analysis was used to evaluate seven smile characteristics. **Results:** Orthodontic treatment improved all the smile characteristics in the three groups. All groups showed an increase in smile width, smile index, and vertical indices; while, the transverse indices decreased. Significant increase was observed in four smile measurements in patients with Class II malocclusion. Comparing the smile characteristic changes among the three groups revealed that the changes induced by orthodontic treatment were significantly higher in patients with Class II malocclusion. **Conclusion:** The smile esthetics in all the three types of malocclusion benefited from the orthodontic treatment; however, the changes were more significant in Class II malocclusions. None of the three malocclusion types showed significant difference between the pre- and post-treatment smile characteristics.

Keywords: *Smile esthetics, smile mesh analysis, standardized analysis*

Introduction

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.[1,2] It also affects the success of social relations and the oral health-related quality of life (OHRQoL). Most OHRQoL indices or questionnaires include a part on the subjects' satisfaction with their smile.[3,4] Several health professionals including orthodontists try their best to improve the attractiveness of the patients' smile.[5,6] In addition to aligning the teeth, orthodontics control and modify the facial growth and improve the harmony between facial components including both the hard and soft tissues.[7,8] Thus, it is very important for the orthodontists to fully understand the soft-tissue changes that occur following the alterations made in the hard tissues by different types of treatments.[9] Smile analysis has always been of interest to orthodontists and has recently become a key element of almost all orthodontic treatment plans.

Even if performed for objectives other than changing the patient's soft-tissue profile, orthodontic treatments may affect the soft tissue including the position of lips. For instance, the treatment of Class II division 1 malocclusion usually includes a course of retrusion of the anterior teeth which significantly affects the lips position and consequently the smile.[10] Altering the position of lower anterior teeth has also been proven to affect the patients' smile.[11]

Many studies have evaluated some smile features and their influences on attractiveness. Isiksal *et al*. evaluated some smile characteristics in patients with Class I malocclusion in three groups of extraction, nonextraction, and control group. They found that the smile attractiveness could benefit from the treatment in both extraction and nonextraction groups.[12] Likewise, Mackley observed that the orthodontic treatment improved the smile attractiveness in patients with all types of malocclusion.[13]

Maganzini *et al*. evaluated nine lip-teeth characteristics in two groups of severe and mild malocclusions after the orthodontic treatment. They reported that the smile

How to cite this article: Salehi P, Ajami S, Babanouri N, Abbasi S. Evaluation of smile characteristics in three different sagittal malocclusions before and after nonextraction orthodontic treatment. Contemp Clin Dent 2018;9:625-9.

Address for correspondence:
Dr. Neda Babanouri, Department of Orthodontics, Orthodontic Research Center, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran.
E-mail: nedababanouri@yahoo.com

Access this article online

Website: www.contempclindent.org

DOI: 10.4103/ccd.ccd_554_18

Quick Response Code:

characteristics in both groups of patients equally benefited from the treatment.[14]

Although smile improvement has always been among the objectives of orthodontic science, the patients' demand for changing the smile has dramatically increased in the 21st century. The digital technology has enabled both clinicians and researchers to cope with this increasing demand. In the 20th century, a few papers were published about the effects of orthodontic treatment on the smile of patients with different malocclusions; but in the early 21st century, several studies of this kind were carried out. Apparently, the orthodontics must now focus on the details of soft-tissue esthetic, such as the fine characteristics of smile.[12,15]

Despite the large number of published studies, there is no agreement about the effects of orthodontic treatment on the patients' smile. The effect of treatment on a specific group of patients was found to be significant in some studies and insignificant in some others.[10,12,16,17] A number of new studies even ruled out the old, long-standing concerns of specific orthodontic treatments such as extraction of premolars.[17,18] Although plenty of studies were performed on this issue, there was no such study on seven of the most important features of smile before and after orthodontic treatment in the three malocclusion types. The previous study showed that the prevalence of Class I, Class II division 1, Class II division 2, and Class III malocclusions in urban Iranian population was 41.8, 24.1, 3.4, and 7.8%, respectively.[19] Since little information was available on the effect of orthodontic treatment on smile esthetics in Iranian population, this study was conducted to compare the changes of smile characteristics in Iranian patients with one of the three Angle's classes of malocclusion following the standard edgewise treatment.

Materials and Methods

Study samples

In this cross-sectional study, simple sampling was employed to select 90 adult patients (18–28 years old) with each of the Class I, II, or III malocclusion (n = 30 in each group) from those referring to an orthodontic clinic in Shiraz, Iran. The patients were all treated by the same orthodontist based on the standard edgewise (0.018 inch). The inclusion criteria were having 18–28 years of age, demanding nonextraction orthodontic treatment, no need for surgical correction, recently finished course of treatment, available pre- and post-treatment one-view frontal facial photographs, and the patient's agreement to participate in the study. The exclusion criteria were a history of trauma to the face or jaws, previous course of orthodontic treatment, orthognathic or facial esthetic surgery, visible asymmetry in the frontal view, missing or peg-shaped lateral incisors, severe skeletal malocclusion, and no tooth display while smiling.

Only patients with typical angle classification were included in the study. Each patient's Angle class was confirmed through clinical and cephalometric assessments. Those with an ANB angle of 1–3°, an overjet of 1–3 mm, and a canine or molar Class I relationship were confirmed as Class I malocclusion; having 3–5° ANB, 3–5 mm overjet, and a convex profile were considered as Class II; and 1 to −1° ANB, an overjet of 0 to −1 mm, and a straight profile were classified as Class III patients.

Variables measured

A professional photographer used a digital SLR camera to photograph all the patients at a standardized position. The patient sat on a chair with headrest. One-view frontal photographs were taken with the patients' Frankfort plane horizontal and the head midsagittal plane at the center of the camera lens.

All the pre- and post-treatment smiling photos were cropped to create a rectangular grid (smile mesh). The subnasale was the upper margin of the rectangular grid. The lower margin was 10 mm below the inferior border of lower lip, and the lateral margins were 10 mm outside the right and left lip commissures.

The patients were clinically assessed to calibrate their photographs magnification ratio. The width of the upper right incisor was measured by a digital caliper, so as to set all the photographs to a magnification of 1:1. This process ensured that all the smile characteristics would be comparable. The height of the upper right central incisor was measured to evaluate the amount of maxillary gingival display when smiling.

The vertical and horizontal lines were marked on each calibrated smile photograph to form the smile mesh grid. The horizontal reference lines were placed at the inferior margin of the upper lip, the central incisor gingival margin, the incisal edge of the upper incisors, and the superior margin of the lower lip. The vertical reference lines were placed at the outer left and right lip commissures, the inner left and right commissures, and the left and right uppermost posterior visible tooth.

The interlabial gap, upper incisor exposure, smile width, smile index, buccal corridor right, buccal corridor left, and gingival display were assessed. Table 1 represents a brief definition of each parameter. The ruler tool in Photoshop 7 was used to measure all the smile characteristics.

Statistical analysis

The output data were transferred to SPSS software version 20 (Chicago, Illinois, USA) for statistical analysis. Paired t-test was employed to evaluate the differences between the values of smile characteristics of each group after the orthodontic treatment. One-way analysis of variance (ANOVA) was performed to compare the three malocclusion types before the treatment; Kruskal–Wallis test was used for the

Table 1: Brief definition of the studied smile characteristic

Variable	Brief definition
Interlabial gap	The distance between the inferior border of the upper lip and superior border of the lower lip on smile
Upper incisor exposure	The amount of upper incisors exposure on smile
Smile width	The distance between the commissures
Smile index	The result of smile width divided by the interlabial gap
Buccal corridor-right	The distance between the most distal upper right canine or first premolar and the right commissure
Buccal corridor-left	The distance between the most distal upper left canine or first premolar and the left commissure
Gingival display	The amount of gingival display of the upper central incisor from the gingival margin to the inferior border of the upper lip on smile

posttreatment comparison. Tukey's *post hoc* test was used whenever the ANOVA result showed significant difference among the three groups before the treatment. Mann–Whitney test was used when Kruskal–Wallis test showed the three groups to be significantly different.

Results

The three groups were not statistically different in terms of age and sex. There were 30 participants in each study group: 14 men and 16 women with the mean ± standard deviation (SD) age of 25.54 ± 1.6 in the Class I group, 17 men and 13 women with the mean ± SD age of 24.68 ± 2.1 in the Class II group, and 16 men and 14 women with the mean ± SD age of 25.098 ± 1.5 in the Class III group.

Having compared the study groups regarding the pretreatment smile characteristics, significant difference was only noted between Class II and III groups in the pretreatment mean value of upper incisor exposure ($P = 0.021$)

Table 2 demonstrates the pre- and post-treatment mean value of smile characteristics and also the results of paired *t*-test in the study groups. Considering the pre- to post-treatment changes among the three groups, the following results were found:

1. Interlabial gap: No significant difference existed between the patients with Class I and II malocclusion; whereas, Class III was significantly different from Class I and II in this regard ($P < 0.05$)
2. Upper incisor exposure: Class II was significantly different from Class I and III ($P < 0.05$)
3. Smile width: The differences among the three groups were statistically significant ($P < 0.05$)
4. Smile index: No significant difference was observed
5. Right and left buccal corridors: Class II was significantly different from Class I and III.
6. Gingival display: Class II was significantly different from Class I and III groups.

Discussion

This retrospective study was designed to evaluate and compare the orthodontically induced changes in seven smile characteristics in the three Angle's classification malocclusion. Pre- and post-treatment changes of seven smile characteristics were compared within each group, and then, the three study groups were compared to find out any different between the pre- and post-treatment changes. The main question was whether any correlation exists between the initial type of malocclusion and the final smile esthetics. To the best of our knowledge, no study had compared the three malocclusion classes in terms of the effects of orthodontic therapy on smile features as carried out in the present study. Thus, there are few previous reports for comparison.

Our results showed that the mean pretreatment value of the upper incisor exposure was significantly higher in patients with Class II malocclusions than in those with Class III type. This was not surprising since the maxillary dentoalveolar protrusion is a common feature in Class II malocclusion.

Although the smile characteristics improved after the treatment in the study groups, the three groups were not significantly different in most of the pre- and post-treatment smile characteristics. One explanation is that most of the included patients in this study had dental and/or mild skeletal malocclusions and those with severe skeletal malocclusions were excluded from the study.

The three groups were compared regarding the pre- and post-treatment changes in all smile characteristics except the smile index and interlabial gap; and it was found that the changes were significantly higher in Class II patients than the other two groups. Changes of the interlabial gap in Class II and Class I patients were significantly more than that in Class III patients. It indicated that Class II patients may benefit more from the orthodontic treatment in terms of smile esthetics.

The orthodontic treatment improved all the smile measures in each group. This was in agreement with what was found by Maganzini *et al*., in 2014, expressing that the treatment improved the smile characteristics in both severe and mild malocclusion groups, regardless of the initial severity of malocclusion.[14]

Although increase of the upper incisor exposure and gingival display was significant only in the Class II group, the treatment also increased these measures in Class I and III malocclusions, representing an improvement in the patients' smiles. Maganzini *et al*.[14] reported similar findings about these two smile characteristics following the orthodontic treatment. This was in line with the studies

Table 2: Comparison of the pre- and post-treatment measurements among the three groups*

Variable	Class I malocclusion group (*n*=30)				Class II malocclusion group (*n*=30)				Class III malocclusion group (*n*=30)			
	Mean±SD		*P**	95% CI	Mean±SD		*P**	95% CI	Mean±SD		*P**	95% CI
	Pretreatment	Posttreatment			Pretreatment	Posttreatment			Pretreatment	Posttreatment		
Interlabial gap	8.603±3.05	10.677±4.82	0.053	−0.01-4.23	8.165±3.36	10.303±4.21	0.033	0.16-4.32	8.087±3.26	9.107±2.49	0.178	−0.43-2.46
Upper incisor exposure	7.823±4.53	8.607±4.27	0.493	−1.34-3.05	8.503±3.19	10.369±3.88	0.046	0.03-3.74	7.103±2.06	8.370±3.43	0.155	−0.18-2.63
Smile width	56.690±7.01	57.045±6.88	0.843	−3.32-3.65	55.107±4.31	57.783±5.86	0.048	0.03-5.23	54.871±6.14	55.561±6.89	0.683	−2.65-4.03
Smile index	6.099±3.95	7.093±4.22	0.079	−1.11-3.21	5.253±2.24	6.150±2.96	0.191	−0.48-2.34	6.368±5.12	5.668±3.31	0.531	−1.53-2.92
Buccal corridor- right	5.657±1.94	5.060±1.94	0.200	−0.42-1.76	5.333±2.26	4.873±2.17	0.424	−0.64-1.63	4.634±2.15	4.617±2.74	0.978	−1.25-1.29
Buccal corridor-left	6.097±1.97	5.832±1.28	0.539	−0. 52-1.31	5.577±2.22	5.584±2.12	0.081	−1.31-1.27	5.686±3.11	5.445±2.43	0.739	−1.20-1.68
Gingival display	−0.657±0.15	−0.592±0.28	0.267	−0.05-0.17	−0.729±0.32	−0.543±0.27	0.018	0.02-0.33	−0.639±0.34	−0.497±0.28	0.088	−0.02-0.30

*: $P<0.05$ All measures are presented in mm. CI: Confidence interval; SD: Standard deviation

which demonstrated that the most attractive and young smile displays 100% of the upper incisor and even 2 mm gingival exposure.[20,21] However, in some cases, gingival margin discrepancy or increased gingival display is manageable using noninvasive gingivectomy by means of diode laser. Diode laser provide benefit of minimal to no interaction with healthy dental hard tissue, making them suitable for soft-tissue procedures.[22]

Interlabial gap increased in patients with each of the three malocclusions after the treatment, although the changes were significant only in Class II patients. Maganzini *et al*. also reported the same results in both studied groups of malocclusion.[14] As stated by Desai *et al*., the more the interlabial gap, the more youthful the smile.[21]

In all the three groups, the smile width increased and the buccal corridors decreased, creating broader smile with less negative space. It might be due to the nonextraction treatment performed on all cases. In all the study groups, increase in the smile width was relatively less than the interlabial gap. Accordingly, orthodontic treatment increased the smile index in all the three malocclusion groups and created a younger smile. Many previous studies reported that aging decreases the tissue elasticity and increases the dental attrition, which consequently results in vertically narrower and transversely wider smile.

The current study employed a relatively precise digital method for studying the smile. Reliable and accurate measurements were made to the three decimal places in this analysis. All patients were treated by a single orthodontist with the same method. Moreover, the sample size was relatively large compared with the previous studies. In the literature, there was no such a study comparing the smile of all malocclusion types.

A limitation of this study and all similar ones is the evaluation of a fake or posed smile, which could be different from the real-life gestures. Moreover, despite being the best view for assessment of smile, one-view frontal photograph is not sufficiently adequate to judge a smile.[13] Therefore, a three-dimensional analysis is worth working on in the future.

Conclusion

Smile esthetics improves following the orthodontic treatment, regardless of the initial malocclusion type. This study demonstrated that in equal conditions, the orthodontically induced changes are higher in patients with Class II malocclusion than in those with Class I or III malocclusions. Patients with different types of malocclusions were not significantly different in terms of the studied smile characteristics, except for the upper incisor exposure, which was higher in Class II malocclusion before the treatment and significantly higher in both Class I and II patients after the treatment.

Acknowledgment

The authors would like to thank the Vice-Chancellery of Shiraz University of Medical Science for supporting this research. The authors would also thank Dr. Vosough from Dental Research Development Center, for the statistical analysis and Dr. Hamedani for help with the English in the manuscript.

Financial support and sponsorship

The authors would like to thank the Vice-Chancellery of Shiraz University of Medical Science for supporting this research.

Conflicts of interest

There are no conflicts of interest.

References

1. Ackerman JL, Ackerman MB, Brensinger CM, Landis JR. A morphometric analysis of the posed smile. Clin Orthod Res 1998;1:2-11.
2. Matoula S, Pancherz H. Skeletofacial morphology of attractive and nonattractive faces. Angle Orthod 2006;76:204-10.
3. Pahel BT, Rozier RG, Slade GD. Parental perceptions of children's oral health: The early childhood oral health impact scale (ECOHIS). Health Qual Life Outcomes 2007;5:6.
4. Shaw WC, Rees G, Dawe M, Charles CR. The influence of dentofacial appearance on the social attractiveness of young adults. Am J Orthod 1985;87:21-6.
5. François G. Orthodontics and cosmetic composite for treatment ending: ultra conservative approach of the smile restoring. Orthod Fr 2013;84:361-6.
6. Yorita FK. Integrating orthodontics for the optimal smile. J Calif Dent Assoc 2008;36:587-96.
7. Ghafari J. More on "Definition and scope of orthodontics". Am J Orthod Dentofacial Orthop 1987;91:513.
8. Ackerman JL, Proffit WR. Soft tissue limitations in orthodontics: Treatment planning guidelines. Angle Orthod 1997;67:327-36.
9. Margolis MJ. Esthetic considerations in orthodontic treatment of adults. Dent Clin North Am 1997;41:29-48.
10. Islam R, Kitahara T, Naher L, Hara A, Nakasima A. Lip morphological changes in orthodontic treatment. Class II division 1: Malocclusion and normal occlusion at rest and on smiling. Angle Orthod 2009;79:256-64.
11. Wylie WL. The mandibular incisor – Its role in facial esthetics. Angle Orthod 1955;25:32-41.
12. Işiksal E, Hazar S, Akyalçin S. Smile esthetics: Perception and comparison of treated and untreated smiles. Am J Orthod Dentofacial Orthop 2006;129:8-16.
13. Mackley RJ. An evaluation of smiles before and after orthodontic treatment. Angle Orthod 1993;63:183-9.
14. Maganzini AL, Schroetter SB, Freeman K. Improvement in smile esthetics following orthodontic treatment: A retrospective study utilizing standardized smile analysis. Angle Orthod 2014;84:492-9.
15. Matthews TG, Blatterfein L, Morrow RM, Payne SH. The anatomy of a smile. J Prosthet Dent 1978;39:128-34.
16. Haggiag-Grimbert D. Creating a younger smile through orthodontic treatment*. J Dentofac Anom Orthod 2009;12:S5.
17. Janson G, Branco NC, Fernandes TM, Sathler R, Garib D, Lauris JR, *et al.* Influence of orthodontic treatment, midline position, buccal corridor and smile arc on smile attractiveness. Angle Orthod 2011;81:153-61.
18. Janson G, Branco NC, Morais JF, Freitas MR. Smile attractiveness in patients with class II division 1 subdivision malocclusions treated with different tooth extraction protocols. Eur J Orthod 2014;36:1-8.
19. Borzabadi-Farahani A, Borzabadi-Farahani A, Eslamipour F. Malocclusion and occlusal traits in an urban Iranian population. An epidemiological study of 11- to 14-year-old children. Eur J Orthod 2009;31:477-84.
20. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: Part 2. Smile analysis and treatment strategies. Am J Orthod Dentofacial Orthop 2003;124:116-27.
21. Desai S, Upadhyay M, Nanda R. Dynamic smile analysis: Changes with age. Am J Orthod Dentofacial Orthop 2009;136:310.e1-10.
22. Borzabadi-Farahani A. The adjunctive soft-tissue diode laser in orthodontics. Compend Contin Educ Dent 2017;38:e18-31.