***Original article:***

# Changes in smile morphometric indices following maxillary advancement and mandibular setback surgery in skeletal Class III patients

*Fahimeh Farzanegan[1], Farzin Hearvi[1], Mandana Karrari[2], Hooman Shafaee[3*], Touraj Vaezi[4], Roozbeh Rashed[5].*

**Abstract**

***Objectives:*** The aim of this study was to evaluate the changes in smile morphometric indices following maxillary advancement and mandibular setback surgery in patients with skeletal class III malocclusion. ***Materials and Methods*:** Smile morphometric indices were measured on frontal rest and smile photographs of 15 female patients with skeletal Class III malocclusions before and three months after maxillary advancement and mandibular setback surgery. Pre- and post-surgery measurements were compared. ***Results:*** The amount of left and right commissural height, philtrum height, and maximum upper incisor show at rest did not change significantly three months after surgery ($p>0.05$). The amount of maximum upper and lower incisor show, interlabial gap, smile width and index, buccal corridor ratio, gingival display, and smile arc on the frontal smile photographs didn't showstatistically significant difference before and after surgery ($P>0.05$). **Conclusion:** Orthognathic surgery in patients with skeletal Class III malocclusion had no significant effect on rest and smile parameters from the frontal view.

**Keywords:** Smile Esthetics, Orthognathic Surgery, Angle Class IIIMalocclusion

*Bangladesh Journal of Medical Science Vol. 18 No. 02 April'19. Page : 216-221*
*DOI: https://doi.org/10.3329/bjms.v18i2.40688*

## Introduction:

In recent decades assessing and designing the smile has become a cornerstone in orthodontic diagnosis and treatment planning.[1-3]Smile esthetics is of prime importance; not only because of its contribution to the overall attractiveness but also for its role in improving self-concept and emotional well-being. [4] Individuals with dentofacial deformities and malocclusion usually have an unpleasant smile which potentially affects their social interactions.[5] Therefore, it is reasonable that orthodontic treatment and orthognathic surgery can lead to improved self-concept and decreased anxiety.

Skeletal Class III malocclusions can result in dysfunction and esthetic deformities with consequent psychological problems.[6]To resolve these challenges, orthognathic surgical procedures are used to improve function and esthetics. These esthetic changes are usually the results of variable soft tissue response to orthognathic surgery.[7-9]Therefore, it is important for orthodontists to be aware of changes in orofacial soft tissue and subsequently in smile esthetics following orthognathic surgery.

A digital frontalphotograph is a reliable tool for smile analysis. [2, 10-13]Tostandardize smile photographs, it has been suggested taking photographs in natural head position[14, 15] or using a cephalostat.[[16] Generally, the smile examination in orthodontic treatment involves a posed smile that is repeatable and reproducible. [17, 18] The aim of our study was to evaluate changes

1. Fahimeh Farzanegan,
2. Farzin Hearvi
   Dental Research center, Mashhad University of Medical Sciences, Mashhad, Iran.
2. Mandana Karrari, Private practice, Tehran, Iran.
3. Hooman Shafaee, Oral and Maxillofacial Diseases Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.
4. Touraj Vaezi, Department of Oral and Maxillofacial Surgery, school of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.
5. Roozbeh Rashed, Orthodontist, Toronto, Canada.

**Correspondence to:** Dr. Hooman ShafaeeVakilabad Blvd, Park square, Mashhad Dental School, Mashhad, Iran. E-mail: h.shafaee@gmail.com

in smile morphometric indices following maxillary advancement and mandibular setback surgery in patients with skeletal ClassIII malocclusions.

**Materials and Methods:**

Fifteen female patients with skeletal Class III malocclusions (maximum reverse overjet: 10 mm) who were candidates of maxillary advancement and mandibular set back surgery participated in this study. Patients who required impaction or down-grafting of the maxilla were excluded from the study. (n0.89978). Frontal rest and frontal posed smile photographs were taken from each patient before and three months after bilateral sagittal split osteotomy (BSSO) for mandibular setback and Lefort I maxillary advancement. The photographs were taken by digital camera (Nikon d5500, Tokyo,Japan) in natural head positionThe mean amount of maxillary advancement was 4 mm (range: 3-5 mm) and the mean amount of mandibular setback was 7 mm (range:4-9 mm). Pre- and post-surgical photographs were transferred to the smile analyzer software (Manufacture and country). [19] (Figure1) To determine the magnification of images, the upper central incisor width was measured on the patient's dentition by a digital caliper (Manufacture and country)(park tool co®, USA) and it was compared with the width of upper central incisor on images.

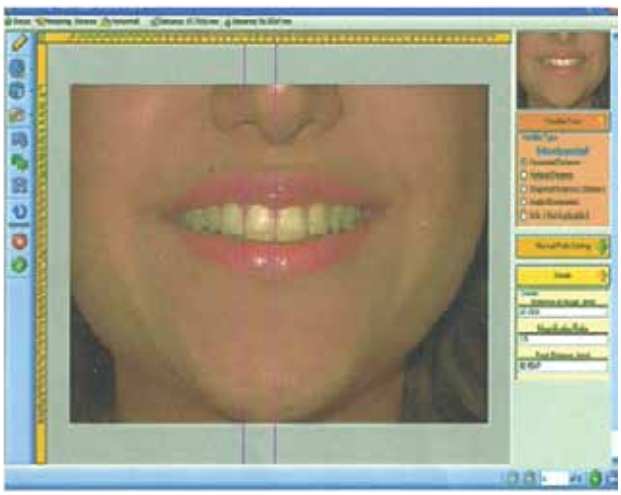

Figure 1: Smile analyzer software

The following indices were measured on the frontal rest photographs (Figure 2): the maximum upper incisor show, philtrum height, left commissural height, and right commissural height. The following indices were measured on the frontal pose smile photographs (Figures 3,4): the maximum upper incisor show, lower incisor show, gingival display of upper central incisors, interlabial gap, the width of the smile [20], smile index (which is the ratio of the

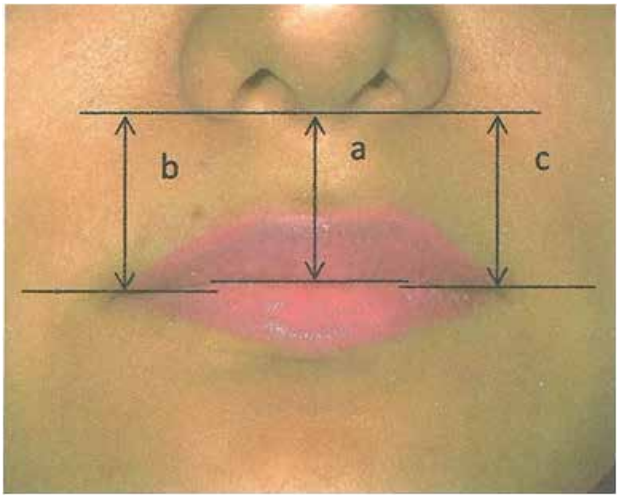


Figure 2: Morphometric indices on frontal rest photograph. (a: philtrum height; b and c: right and left commissural height)

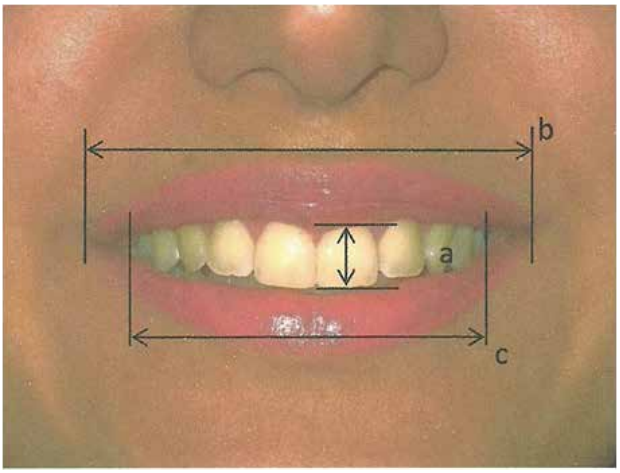


Figure 3: Morphometric indices on frontal posed smile photograph. (a: maximum upper incisor show, b: Smile width, c: the distance between internal commissures.

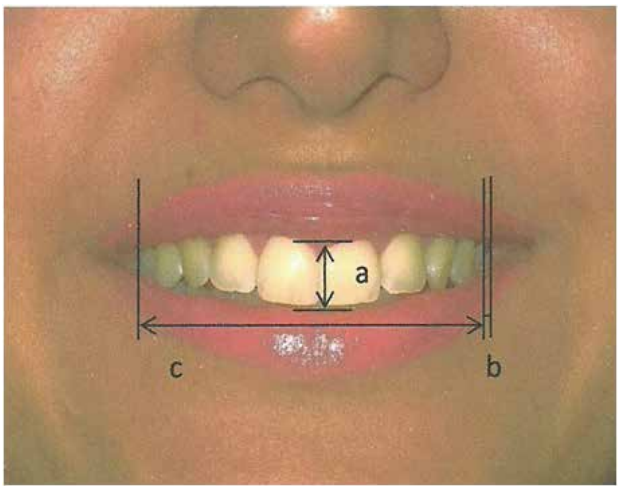


Figure 4: Morphometric indices on frontal posed smile photograph. (a: interlabial gap, b: left buccal corridor, c: visible width of upper arch dentition.

smile width to the interlabial gap) [20], the distance between inner commissures, the visible width of the upper arch dentition, buccal corridor ratio [21], smile arc (consonant or non-consonant), and the last visible tooth of the upper arch [21].

Data were analyzed using the paired t-test, Wilcoxon signed ranks and the McNemar test (α=0.05) via SPSS16 software.(SPSS Inc., Chicago, IL, USA)

**Ehtical clearance**: The research project was approved by the research ethics committee of the Mashhad University of Medical Scien, Iran.

## Results

### Rest morphometric indices before and after surgery

As in shown in Table I, the amount of maximum upper incisor show, left and right commissural height, and the philtrum height at rest did not change significantly three months after surgery (P>0.05). However, all indices, except for the maximum upper incisor show, increased after surgery. (Table I)

**Table 1: Rest morphometric indices before and after surgery**

| Variable | | Mean | SD | confidence interval | P value |
|---|---|---|---|---|---|
| Left commissural height (mm) | Before surgery | 20.5171 | 3.3318 | 18.676-22.358 | *0.656 |
| | After surgery | 20.8859 | 2.9324 | 19.266-22.506 | |
| Right commissural height (mm) | Before surgery | 19.9356 | 2.2834 | 18.674-21.197 | *0.418 |
| | After surgery | 20.6282 | 2.5026 | 19.245-22.011 | |
| Philtrum height(mm) | Before surgery | 21.0619 | 2.9151 | 19.451-22.673 | *0.953 |
| | After surgery | 21.0956 | 2.2295 | 19.864-22.328 | |
| Maximum upper incisor show (mm) | Before surgery | 0.3704 | 0.8317 | -0.089-0.830 | **0.109 |
| | After surgery | 0.0000 | 0.0000 | 0.0000 | |

*Paired t-test

**Wilcoxon test

### Smile morphometric indices before and after surgery

The amount of maximum upper and lower incisor show, interlabial gap, smile width, smile index, buccal corridor ratio, and gingival display on the frontal smile photographs show no statistically significant difference before and after surgery (P<0.05). (Table II)

The last visible maxillary tooth in most patients was the second premolar pre-and post-surgery. To determine intra-examiner and inter-examiner reliability, five patients were randomly selected and morphometric indices were re-evaluated. Strong intra-examiner and inter-examiner agreement was observed on all variables. (P<0.001, Kappa coefficient 0.82-0.93; P<0.001, Kappa coefficient 0.84-0.95 respectively.)

## Discussion

A main expectation of patients from orthodontic treatment is a beautiful appearance, which undoubtedly includes an esthetic smile. In skeletal Class III patients undergoing orthognathic surgery, major changes of soft tissue arise from the surgery, even if pre-surgical orthodontics have been performed. Evaluation of the impact of different orthodontic and surgical orthognathic procedures on the frontal view of the face is important since people see themselves in the mirror from this view.

Studies have shown higher social abilities and higher intelligence attributed to people with a pleasing smile. [22, 23] Up to now, many studies have evaluated soft tissue changes from the profile view after orthognathic surgery in Class III patients. [8, 9, 24-28] In most of them, soft tissue changes were evaluated on lateral cephalograms or laser scans. Lateral cephalograms are not the best imaging technique to evaluate soft tissues and super imposition may cause error in identification of anatomic landmarks. [28] Moreover, the lateral cephalogram requires radiation, while photographs need no radiation and are easy to take and repeatable. Claman et al. reported that an identical lens focal distance, a fixed camera position, and a constant distance from the camera to the object are required for standardized photography.[29] In the current study, the camera was fixed and the distance between the lens and the subject was maintained at 2 m.

Facial attractiveness and a beautiful smile are closely related together.[20] A smile is considered more

**Table 2: Smile morphometric indices before and after surgery**

| Variable | | Mean | Standard deviation | confidence interval | P value |
|---|---|---|---|---|---|
| Maximum upper incisorshow(mm) | Before surgery | 6.7472 | 2.5906 | 5.316-8.179 | *0.631 |
| | After surgery | 7.2573 | 3.4736 | 5.338-9.177 | |
| Maximum lower incisorshow(mm) | Before surgery | 1.0975 | 1.5485 | 0.242-1.953 | *0.177 |
| | After surgery | 1.6155 | 1.9659 | 0.529-2.702 | |
| Interlabial gap(mm) | Before surgery | 8.9877 | 2.7285 | 7.480-10.495 | *0.152 |
| | After surgery | 7.8801 | 2.5740 | 6.458-9.302 | |
| Smile width (mm) | Before surgery | 63.3322 | 7.2132 | 59.347-67.318 | *0.914 |
| | After surgery | 63.6489 | 5.1962 | 60.778-66.520 | |
| Smile index(mm) | Before surgery | 7.8210 | 3.3161 | 5.989-9.653 | *0.234 |
| | After surgery | 8.8894 | 3.0933 | 7.180-10.599 | |
| Buccal corridor ratio (mm) | Before surgery | 0.0644 | 0.0465 | 0.039-0.090 | *0.080 |
| | After surgery | 0.0432 | 0.0261 | 0.029-0.058 | |
| Gingival display (mm) | Before surgery | 0.2960 | 0.8218 | -0.158-0.750 | **0.109 |
| | After surgery | 0.0000 | 0.0000 | 0.0000 | |

*Paired t-test

**Wilcoxon test

As shown in Table III, the smile arc of six out of eight patients (75%) with non-consonant smile arcs converted to consonant smile arcs and the smile arc of six patients out of seven with consonant smile arcs, remained consonant after orthognathic surgery. The result of the McNemar test showed that there was no significant difference between the smile arc on the frontal smile photographs before and after surgery (P=0.125).

**Table 3: Distribution of consonantandnon-consonantsmile arc before and after surgery**

| | | | After surgery | | |
|---|---|---|---|---|---|
| | | | Non-consonant | Consonant | Total |
| Before surgery | Non-consonant | Number | 2 | 6 | 8 |
| | | Percent | 25.0 | 75.0 | 100.0 |
| | Consonant | Number | 1 | 6 | 7 |
| | | Percent | 14.3 | 85.7 | 100.0 |
| **Total** | | **Number** | **3** | **12** | **15** |
| | | **Percent** | **20.0** | **80.0** | **100.0** |

beautiful when it is evaluated from the profile rather than the frontal view, therefore; orthodontists should consider both views in diagnosis and treatment planning.[30] Orthognathic surgery usually causes considerable changes in function and esthetics. The response of soft tissue following mandibular set back is different among individuals. Cunningham [31] and Finlay [32] reported that skeletal and dental Class III malocclusion may cause facial asymmetry and esthetic concerns with consequent psychological stresses for the patient; therefore, success in orthognathic surgery includes achieving both proper function and excellent esthetics.

In the present study, 15 female patients with skeletal Class III malocclusion were evaluated. Frontal rest and smile morphometric indices were recorded pre-and post-surgery. The indices were measured on photographs because it has been shown that standard digital photographs are valid tools for smile analysis. [36] An obvious issue that should be noted is upper incisor show during smiling. Islam et al. showed that in the smiles of Class III patients in the frontal view, both the upper and lower lips moved to the inferior position after mandibular setback. They concluded soft tissue morphology shows a significant improvement after orthognathic surgery in Class III patients.[33] During orthodontic treatment, orthodontists should pay considerable attention to the effect of therapeutic mechanics on the smile arc because the smile arc has a definite impact on smile attractiveness.[34-35]

In our study, although the maximum upper incisor show increased and the maximum lower incisor show, gingival display and interlabial gap decreased after surgery on frontal view, these differences were not statistically significant. In addition, on frontal rest photographs the differences between measurements before and after surgery were not significant. In our study, the buccal corridor was reduced after surgery; however, this reduction was not statistically significant. Smile width and smile index were not significantly different pre- and post-surgery.

Our results show that orthognathic surgery improved the form of smile arc as the percentage of consonant smile increased and the percentage of unconsonant smile arc decreased after surgery.

Limitations:

Maybe our small sample size caused these insignificant differences and it would be easier to interpret the results if we only chose patients undergoing setback surgery or maxillary advancement not both at the same time.

Recommendations:

The measurement of smile morphometric indices could perform in other orthognathic surgeries and with greater sample size and at least six month after surgery..

**Conclusion:**

Maxillary advancement and mandibular setback surgery in patients with skeletal Class III malocclusion has no significant effect on rest and smile parameters from the frontal view.

Conflict of interest: No conflict of interest

Acknowledgement: We acknowledge and thank vice chancellor for research of Mashhad University of Medical Sciences.

Author's Contributions: Data gathering and idea owner of this study: FF and FH Study design: RR Data gathering: MK Data analysis and consultation: TV Writing and submitting manuscript: HS

## References:


1. Mackley RJ. 'Animated' orthodontic treatment planning. *JCO* 1993;**27**(7):361-5.
2. Morley J, Eubank J. Macroesthetic elements of smile design. *J Am Dent Assoc* 2001;**132**(1):39-45.
3. Peck S, Peck L, Kataja M. The gingival smile line. *Angle orthod* 1992;**62**(2):91-100; discussion 1-2.
4. Feu D, de Oliveira BH, de Oliveira Almeida MA, Kiyak HA, Miguel JA. Oral health-related quality of life and orthodontic treatment seeking. *Am J Orthod Dentofacial Orthop*2010;**138**(2):152-9.
5. Shaw WC. The influence of children's dentofacial appearance on their social attractiveness as judged by peers and lay adults. *Am J Orthod* 1981;**79**(4):399-415.
6. Cunningham SJ, Hunt NP. Quality of life and its importance in orthodontics. *J orthod* 2001;**28**(2):152-8.
7. Joss CU, Joss-Vassalli IM, Berge SJ, Kuijpers-Jagtman AM. Soft tissue profile changes after bilateral sagittal split osteotomy for mandibular setback: a systematic review. *J Oral Maxillofac Surg* 2010;**68**(11):2792-801.
8. Marsan G, Cura N, Emekli U. Soft and hard tissue changes after bimaxillary surgery in Turkish female Class III patients. *J Craniomaxillofac Surg* 2009;**37**(1):8-17.
9. Marsan G, Oztas E, Kuvat SV, Cura N, Emekli U. Changes in soft tissue profile after mandibular setback surgery in Class III subjects. *Int J Oral Maxillofac Surg* 2009;**38**(3):236-40.
10. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part I. *Am J Orthod Dentofacial Orthop* 1993;**103**(4):299-312.
11. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning--Part II. *Am J Orthod Dentofacial Orthop* 1993;**103**(5):395-411.
12. Janzen EK. A balanced smile--a most important treatment objective. *Am J Orthod* 1977;**72(**4):359-72.
13. Schabel BJ, Baccetti T, Franchi L, McNamara JA. Clinical photography vs digital video clips for the assessment of smile esthetics. *Angle orthod*2010;**80**(4):490-6.
14. Morley J. The role of cosmetic dentistry in restoring a youthful appearance. *J Am Dent Assoc* 1999;**130(**8):1166-72.
15. Weber DW, Fallis DW, Packer MD. Three-dimensional reproducibility of natural head position. *Am J Orthod Dentofacial Orthop*2013;**143**(5):738-44.
16. Ackerman MB, Ackerman JL. Smile analysis and design in the digital era. *JCO* 2002;**36**(4):221-36.
17. Hulsey CM. An esthetic evaluation of lip-teeth relationships present in the smile. *Am J Orthod* 1970;**57**(2):132-44.
18. Morley J. Smile design terminology. *Dent Today* 1996;**15**(6):70.
19. Rashed R, Heravi F, Raziee L. Smile Analyzer: a software package for analyzing the characteristics of the speech and smile. *Journal of Dental Materials and Techniques*2012;**1**(1):1-5.
20. Isiksal E, Hazar S, Akyalcin S. Smile esthetics: perception and comparison of treated and untreated smiles. *Am J Orthod Dentofacial Orthop*2006;**129**(1):8-16.
21. Maulik C, Nanda R. Dynamic smile analysis in young adults. *Am J Orthod Dentofacial Orthop*2007;**132**(3):307-15.
22. Eli I, Bar-Tal Y, Kostovetzki I. At first glance: social meanings of dental appearance. *J Public Dent Health* 2001;**61**(3):150-4.
23. Newton JT, Prabhu N, Robinson PG. The impact of dental appearance on the appraisal of personal characteristics. *Int J Prosthodont*2003;**16**(4):429-34.
24. Becker OE, Avelar RL, Dolzan Ado N, Haas OL, Jr., Scolari N, Oliveira RB. Soft and hard tissue changes in skeletal Class III patients treated with double-jaw orthognathic surgery-maxillary advancement and mandibular setback. *Int J Oral Maxillofac Surg*2014;**43**(2):204-12.
25. Chen CM, Lai S, Lee HE, Chen KK, Hsu KJ. Soft-tissue profile changes after orthognathic surgery of mandibular prognathism. *Kaohsiung J MedSci* 2012;**28**(4):216-9.
26. Gaggl A, Schultes G, Karcher H. Changes in soft tissue profile after sagittal split ramus osteotomy and retropositioning of the mandible. *J oral maxillofac surg* 1999;**57**(5):542-6; discussion 6-7.
27. Jakobsone G, Stenvik A, Espeland L. Soft tissue response after Class III bimaxillary surgery. *Angle orthod*. 2013;**83**(3):533-9.
28. Soncul M, Bamber MA. Evaluation of facial soft tissue changes with optical surface scan after surgical correction of Class III deformities. *J oral maxillofac surg*2004;**62(**11):1331-40.
29. Claman L, Patton D, Rashid R. Standardized portrait photography for dental patients. Am *J Orthod Dentofacial Orthop* 1990;**98**(3):197-205.
30. Kerns LL, Silveira AM, Kerns DG, Regennitter FJ. Esthetic preference of the frontal and profile views of the same smile. *J Esthet Dent* 1997;**9(**2):76-85.
31. Cunningham SJ, Crean SJ, Hunt NP, Harris M. Preparation, perceptions, and problems: a long-term follow-up study of orthognathic surgery. *Int J Adult OrthodonOrthognath Surg*1996;**11**(1):41-7.
32. Finlay PM, Atkinson JM, Moos KF. Orthognathic surgery: patient expectations; psychological profile and satisfaction with outcome. *Br J Oral MaxillofacSurg* 1995;**33**(1):9-14.
33. Islam R, Kitahara T, Naher L, Hara A, Nakata S. Lip morphology changes following orthognathic surgery for Class III malocclusion. *Angle orthod* 2010;**80**(2):344-53.
34. Alam, M. K., Nowrin, S., Shahid, F., Haque, S., Imran, A., Fareen, N., Sujon, M., Zaman, S., Islam, R., & Nishi, S. Treatment of Angle class I malocclusion with severe crowding by extraction of four premolars: A case report. *Bangladesh Journal of Medical Science.* 2018;17(4), 683-687. https://doi.org/10.3329/bjms.v17i4.38339
35. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. Am *J Orthod Dentofacial Orthop*2001;**120**(2):98-111.