TURKISH JOURNAL of ORTHODONTICS

DOI: 10.5152/TurkJOrthod.2018.17056

ORIGINAL ARTICLE

Upper Lip Asymmetry During Smiling: An Analysis Using Three-Dimensional Images

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Cite this article as: Mathis A, Laskin DM, Tüfekçi E, Caricco C, Lindauer S. Upper Lip Asymmetry During Smiling: An Analysis Using Three-Dimensional Images. Turk J Orthod 2018; 31: 32-6.

ABSTRACT

Objective: The aim of this study was to use three-dimensional images to determine the presence of upper lip asymmetry at rest and during smiling in a group of individuals with no history of orthodontics or facial cosmetic surgery.

Methods: Standardized three-dimensional frontal resting and smiling images of 54 volunteers were analyzed using the 3dMDvultus software (3dMD, Atlanta, GA). Measurements were made from the soft tissue nasion, ipsilateral ala, subnasale, and menton to the right and left commissures of the lip. A 2.5 mm or greater difference between the right and left sides was defined as an asymmetry. The agreement on the presence or absence of asymmetry between the subjects' states of rest and smiling was determined by the McNemar's chi-squared test. Statistical significance was defined as $p<0.05$.

Results: Menton was the most stable facial landmark to evaluate the upper lip symmetry at rest and during smiling ($p=0.002$). Using menton as a landmark, only one of the 54 subjects showed asymmetry while resting, but 12 (22%) showed asymmetry when smiling.

Conclusion: As part of treatment planning for orthodontics or orthognathic surgery, patients should be evaluated for the upper lip symmetry during resting and smiling. The presence of asymmetry during smiling is a significant clinical problem that needs to be recognized so that patients can be informed about the effect it can have on the final esthetic result.

Keywords: Esthetics, three-dimensional images, smiling, orthodontics, orthognathic surgery

INTRODUCTION

Facial attractiveness and dental esthetics have been shown to have a significant impact on the social status and quality of life (1, 2). Several studies have reported that attractive individuals are perceived to be more intelligent, talented, and successful (3-5). One important component of facial attractiveness is smile esthetics (6-8). Although, teeth color has been reported to be the most important factor in smile attractiveness, the vertical thickness and the symmetry of the lips have been also ranked as important variables (6, 9-11).

Facial and smile asymmetries can arise not only from the hard tissue, but also from the soft tissue imbalances. Furthermore, lip asymmetry can affect the amount of tooth and gingival display, which could also contribute to an unesthetic smile. The effect of hard tissue cants on facial esthetics has also received much attention in the literature; however, soft tissue asymmetry should also be analyzed as a patient's smile can have a dramatic impact on the esthetic results of both orthodontic and surgical cases. This is especially important considering that individuals pursuing orthodontics or orthognathic surgery may have heightened awareness of their preoperative and postoperative facial esthetics. Achieving an esthetic smile has been shown to be one of

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Received: 28 November 2017
Accepted: 30 March 2018

the most important reasons why patients request orthodontic treatment (12).

The lip position at rest and during smiling can have an important effect on facial appearance following orthognathic surgery. In the case of mandibular advancement and setback, patients often place greater emphasis on changes in the lip position than on the chin position when considering their profile changes (13). However, favorable results in correcting smile asymmetry are relatively unpredictable (14, 15). Smiling is not a static phenomenon; it is influenced by many muscle groups that are not always involved in the different types of orthognathic surgery (16). In fact, smile asymmetry may be the result of asymmetry of the perioral musculature itself (15).

Because of the importance of lip symmetry in facial appearance, it is essential to adequately determine deviations from the ideal symmetry prior to orthognathic surgery to avoid unfulfilled patient expectations postoperatively (17). Previously, soft tissue asymmetry has generally been studied using photographs at rest and during smiling; however, to the best of our knowledge, there have been only two studies that have evaluated lip asymmetry using a three-dimensional technique (18, 19). One of these used soft tissue landmarks unlike those used in this study, and the other focused on the laterality of the corners of the mouth during a portrait smile. The aim of this study was to determine the presence of resting and smiling upper lip asymmetry in a group of individuals with no facial skeletal asymmetry and no history of orthodontics or facial cosmetic surgery, using three-dimensional imaging software.

METHODS

The ethical approval for this investigation was obtained from the Virginia Commonwealth University Institutional Review Board. The study included 54 volunteers (24 males, 30 females) between 20 and 35 years of age with a balanced and symmetric face, who were not currently receiving orthodontic treatment, who had no history of orthodontic treatment, or who were not pursuing orthognathic surgery. Standardized resting and smiling frontal view images were obtained with a 3dMDface stereophotogrammetry camera (3dMD, Atlanta, GA). The subjects were seated ensuring that their head was in the focal field of the camera and were instructed to look at a fixed point directly in front of their eyes to obtain a natural head position. Instructions prior to capturing the resting image included, "Say 'Emma', relax your lips, and try not to blink." To obtain a relatively normal smiling picture, instructions included, "Smile as big as you would for a picture and try not to blink." Using the 3dMDvultus software (3dMD, Atlanta, GA, US), the two images were superimposed by the best fit method described by the software manufacturer following selection of surfaces that were predicted to remain unchanged between the two images: the forehead and the upper one-third of the nasal bridge. A root mean squared value (RMS) was recorded from each image that assessed the accuracy of the surface superimposition. The RMS values of 0.5 mm or less were deemed acceptable, as recommended by the manufacturer. Following successful registration, landmarks were plotted on each image. Measurements (mm) were then made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the lip, respectively, using the caliper setting (Figure 1). A ≥2.5 mm difference between the right and left commissure of the lip defined an asymmetry.

Statistical Analysis

To evaluate consistency of the measurements, 40 measurements were independently reevaluated by the data collector (AM). Based on this independent sample of rechecked measures, the intraclass correlation coefficient was >0.7 for all landmarks, indicating a good measurement reliability. Normality of the study measures was assessed using the Shapiro-Wilk test and visual test. All measures demonstrated sufficient normality. The agreement on the presence or absence of asymmetry between the subjects' states of rest and during smiling was determined by McNemar's chi-squared test. Statistical significance was defined as $p<0.05$. SAS EG v.6.1 (SAS Institute, Cay, NC, USA) was used for all analyses.

RESULTS

Although the use of all four landmarks revealed that some patients had an asymmetrical smile, menton appeared to be the

Table 1. The number of subjects with an asymmetry of ≥2.5 mm at rest and while smiling using various landmarks as a reference point; only menton was determined to be statistically significant as the point of reference to evaluate the differences in the distance to the left and right commissure, respectively

	Resting Asymmetry	Smiling Asymmetry	Both	p*
Ala	7	5	1	0.5271
Menton	1	12	0	0.0023
Nasion	2	4	1	0.3173
Subnasale	4	11	1	0.0522
Overall	11	23	3	0.0233

*p from the McNemar's chi-squared test of agreement between the resting and smiling asymmetry

Table 2. Differences in the distance from menton to the left and right commissure in individuals with an asymmetry >2.5 mm when smiling. The asterisk sign indicates the right-side asymmetry.

Subject	Smiling Asymmetry (in mm)
Subject 1	4.11
Subject 2	3.46
Subject 3	2.74
Subject 4	3.01
Subject 5	2.63
Subject 6	4.06*
Subject 7	4.15*
Subject 8	7.76
Subject 9	2.69
Subject 10	4.32*
Subject 11	2.58
Subject 12	3.62

most stable facial landmark to evaluate lip symmetry at rest and during smiling because it was able to show the greatest change in asymmetry from resting to smiling (p=0.0023) (Table 1). Using menton as a landmark, only one of the 54 subjects showed asymmetry at rest, but 12 (22%) showed asymmetry while smiling (Table 2). Of these 12 subjects, nine had asymmetry on the left side. This is demonstrated in the Bland-Altman Plots in Figures 2A and 2B. Table 3 provides the average absolute difference (absolute value of difference from left to right to eliminate negatives) for each of the landmarks along with the minimum and maximum for both resting and smiling.

DISCUSSION

The findings of this study indicate that a relatively significant number of people who have lip symmetry at rest showed asymmetry during smiling. Since the study participants were 20 to 35-year-old healthy individuals who could be candidates for orthodontics or orthognatic surgery, it indicates that the presence of asymmetry during smiling should be considered when developing a diagnosis and treatment plan. A soft tissue asymmetry absent at rest but noticeable while smiling is generally not correctable by orthognathic surgery. Therefore, patients need to be made aware of the situation prior to treatment so that they do not consider it a result of the treatment and are displeased with the results. This is particularly true in light of the fact that many patients with an asymmetrical smile may be unaware of the situation (14).

A difference in the position of the commissures of ≥2.5 mm was chosen as an indicator of the upper lip asymmetry based on studies involving the recognition of a maxillary cant and the study of Batwa et al. (11) who showed that such a lip asymmetry had a relative impact on smile esthetics (20). Although clinically soft tissue menton is generally not considered to be a reliable reference point to determine facial skeletal asymmetry, in this 3dMD study, it proved to be most reliable for measuring the upper lip symmetry because the subjects had no bony facial asymmetry, and soft tissue menton is not subject to simultaneous movement when the facial muscles activate during smiling. The asymmetry was most frequently on the left side. This type of laterality has also been shown by Okamoto et al. (18) using three-dimensional facial images (1).

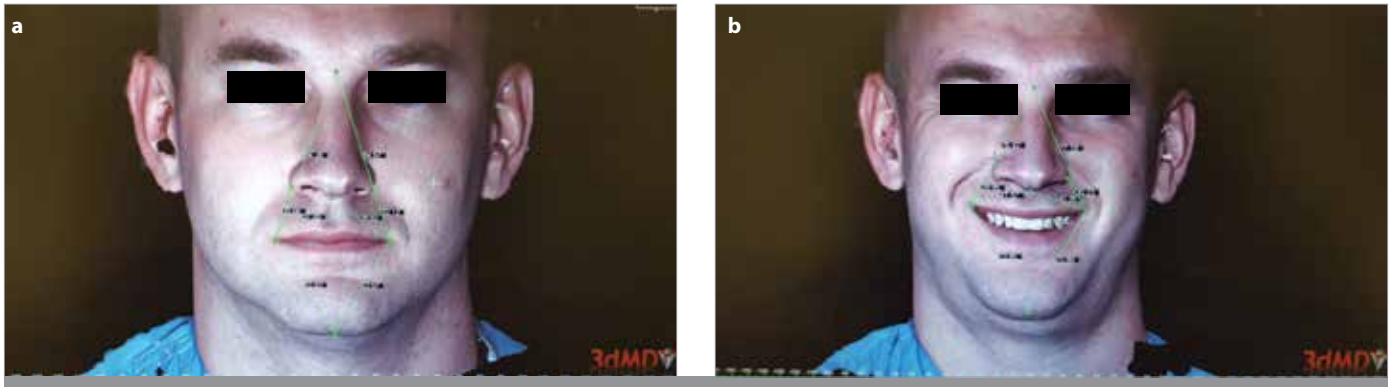

Figure 1. a, b. Measurements (mm) made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the lip with the patient at rest (a); measurements (mm) made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the patient's lip while smiling; note the lip asymmetry (b)

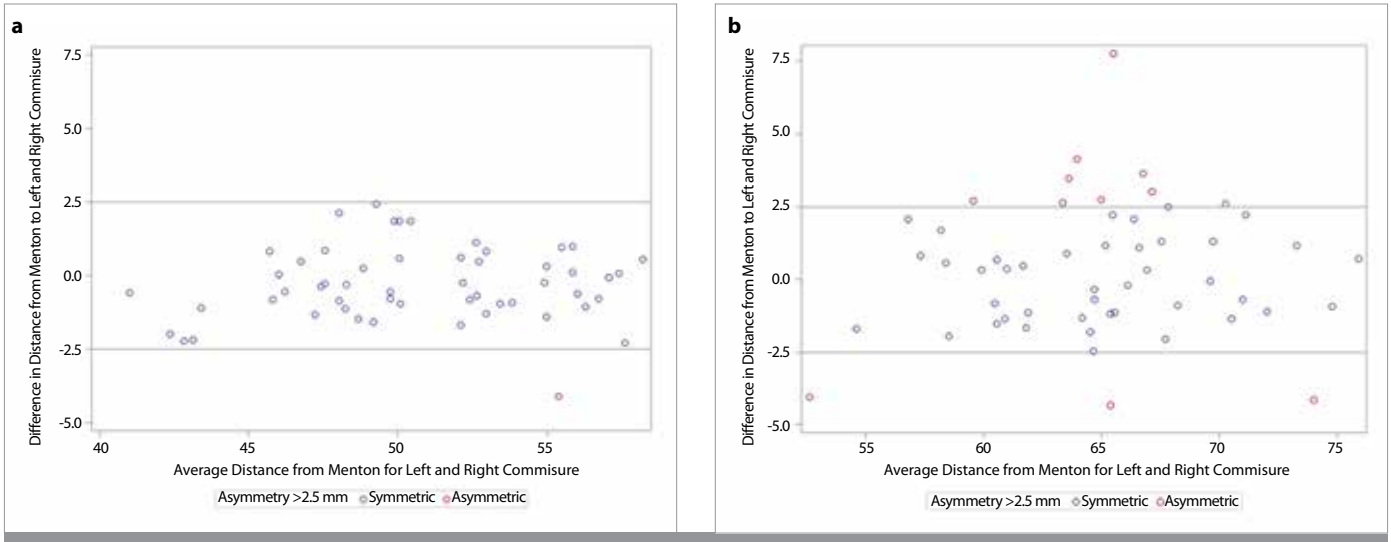

Figure 2. a, b. Bland-Altman plot of comparison of the distance to the left and right commissure from menton at rest (a); Bland-Altman plot of comparison of the distance to the left and right commissure from menton when smiling (b)

Table 3. Summary of the absolute difference between the left and right commissure from each landmark

	Resting			Smiling		
Landmark	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
Menton	1.02	0.03	4.11	1.77	0.06	7.76
Nasion	0.98	0.05	2.67	1.08	0.00	5.07
Subnasale	1.30	0.04	6.21	1.46	0.07	4.45
Ipsilateral ala	1.30	0.04	3.68	1.10	0.03	4.34

Although it was assumed that the measurement from menton to the labial commissure was a vertical measurement, it also has a horizontal component. However, because a natural smile cannot anatomically be purely horizontal, any vertical difference between the two sides is still reflective of an upper lip asymmetry. A malpositioned nose potentially introduced the largest source of error in this study because it can result in the ala, philtrum, and nasion being shifted off the midline.

It has been claimed that there is a difference between a spontaneous and posed smile and that the posed smile may be more asymmetrical; however, later studies have shown no difference (3, 7, 8). Moreover, even if there is a difference, one needs to consider that patients generally evaluate their smile in a posed position and are, therefore, more likely to detect asymmetry.

This study did not have the power to accurately determine the true prevalence of the upper lip asymmetry because of the small number of subjects. There was also a considerable variation in the findings depending on the landmark used. However, it still shows that the presence of the upper lip asymmetry when smiling is a significant clinical problem and that the two-dimensional studies used in the past have underestimated the magnitude of this condition.

CONCLUSION

A significant number of individuals have an upper lip asymmetry when smiling. This problem needs to be recognized in patients considering orthodontics or orthognathic surgery so that they can be informed that the condition is not correctable and that it can affect the final esthetic result.

Ethics Committee Approval: Ethics committee approval was received for this study from the Institutional Review Board of Virginia Commonwealth University.

Informed Consent: Written informed consent was obtained from the volunteers who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - D.M.L., E.T.; Design - D.M.L., A.M.; Supervision - D.M.L., E.T.; Resources - S.J.L.; Materials - S.J.L.; Data Collection and/or Processing - A.M., E.T.; Analysis and/or Interpretation - C.C., A.M.; Literature Search - A.M.; Writing Manuscript - A.M., D.M.L.; Critical Review - D.M.L., S.J.L.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. 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: 399-415. [CrossRef]
2. Kiyak HA. Does orthodontic treatment affect patients' quality of life? J Dent Educ 2008; 72: 886-94.
3. Langlois JH, Kalakanis L, Rubenstein AJ, Larson A, Hallam M, Smooth M. Maxims or myths of beauty? A meta-analytic and theoretical review. Pscychol Bull 2000; 126: 390-423. [CrossRef]
4. Henson ST, Lindauer SJ, Gardner WG, Shroff B, Tufekci E, Best AM. Influence of dental esthetics on social perceptions of adolescents judged by peers. Am J Orthod Dentofacial Orthop 2011; 140: 389-95. [CrossRef]
5. Pithon MM, Nascimento CC, Barbosa GC, Coqueiro Rds S. Do dental esthetics have any influence on finding a job? Am J Orthod Dentofacial Orthop 2014; 146: 423-9. [CrossRef]
6. Havens DC, McNamara JA Jr, Sigler LM, Baccetti T. The role of the posed smile in overall facial esthetics. Angle Orthod 2010; 80: 322-8. [CrossRef]
7. Parekh SM, Fields HW, Beck M, Rosenstiel S. Attractiveness of variations in the smile arc and buccal corridor space as judged by orthodontists and laymen. Angle Orthod 2006; 76: 557-63.
8. Ker AJ, Chan R, Fields HW, Beck M, Rosenstiel S. Esthetics and smile characteristics from the layperson's perspective: a computer-based survey study. J Am Dent Assoc 2008; 139: 1318-27. [CrossRef]
9. McNamara L, McNamara JA Jr, Ackerman MB, Baccetti T. Hard- and soft-tissue contributions to the esthetics of the posed smile in growing patients seeking orthodontic treatment. Am J Orthod Dentofacial Orthop 2008; 133: 491-9. [CrossRef]
10. 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. [CrossRef]
11. Batwa W, McDonald F, Cash A. Lip asymmetry and smile aesthetics. Cleft Palate Craniofac J 2013; 50: e111-44. [CrossRef]
12. Springer NC, Chang C, Fields, HW, et al. Smile esthetics from the layperson's perspective. Am J Orthod Dentofacial Orthop 2011; 1391: 91-101. [CrossRef]
13. Burcal RG, Laskin DM, Sperry TP. Recognition of profile change after simulated orthognathic surgery. J Oral Maxillofac Surg 1987; 45: 666-70. [CrossRef]
14. Al-Hiyali A, Ayoub A, Ju X, Almuzian M, Al-Anezi T. The impact of orthognathic surgery on facial expressions. J Oral Maxillofac Surg 2015; 73: 2380-90. [CrossRef]

15. Benson KJ, Laskin DM. Upper lip asymmetry in adults during smiling. J Oral Maxillofac Surg 2001; 59: 396-8. [CrossRef]
16. Kang SH, Kim MK, An SI, Lee JY. The effect of orthognathic surgery on the lip lines while smiling in skeletal class III with facial asymmetry. Maxillofac Plast Reconstr Surg 2016; 38: 18. [CrossRef]
17. Van Steenbergen E, Litt MD, Nanda R. Presurgical satisfaction with facial appearance in orthognathic surgery patients. AJODO 1996; 109: 653-9. [CrossRef]
18. Okamoto H, Haraguchi D, Takada K. Laterality of asymmetry in movements of the corners of the mouth during voluntary smile. Angle Orthod 2010; 80: 223-9. [CrossRef]
19. Duran GS, Dindaroğlu F, Görgülü S. Three-dimensional evaluation of social smile symmetry. Angle Orthod 2017; 87: 96-103. [CrossRef]
20. Padwa BL, Kaiser MO, Kaban LB. Occlusal cant in the frontal plane as a reflection of facial asymmetry. J Oral Maxillofac Surg 1997; 55: 811-6. [CrossRef]