Title: Analysis of gingival display during static and dynamic smiles in a Turkish sample: a clinical study*

Running title: Gingival display and the smile line

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Abstract

Purpose: The aim of this study is to determine the prevalence of smile types in spontaneous smiles among a Turkish population aged 18–23 and to compare it with the prevalence of static smiles.

Materials and methods: This study was carried out with 150 undergraduate students at Başkent University Faculty of Dentistry (75 females, 75 males). For this purpose, photo recordings for static smiles and 20-second video recordings for dynamic smiles were taken 40 cm from the participant's nose. Measurements were made with an electronic ruler.

Results: High smile line was found to be the highest prevalence in both static and dynamic smiles ($p < 0.001$). The average soft tissue display is higher in dynamic smiles ($p < 0.05$). In both static and dynamic smiles, the average amount of gingival display was higher in females than in males ($p < 0.05$).

Conclusion: When the smile line was evaluated on the photograph recordings while the patient was posing, it was found to be lower than the natural spontaneous smile line obtained from the video recordings. Since the gingival display increases when patients smile naturally instead of posing, clinical evaluations and restorative considerations should be planned according to the dynamic smile.

Key words: smile line, dynamic smile, static smile, gingiva, esthetic

TÜRK POPÜLASYONUNDA STATİK VE DİNAMİK GÜLÜŞ SIRASINDA GİNGİVAL GÖRÜNÜM ANALİZİ: KLİNİK ÇALIŞMA

ÖZ

Amaç: Gülüş tipi en çok hasta statik durumda iken, fotoğraflarda poz verirken sınıflandırılır ve buna göre popülasyondaki gülüş tiplerinin yaygınlığı belirlenir. Ancak spontane gülümsemede prevalansın farklılık gösterebileceği düşünülmektedir. Bu çalışmanın amacı, 18-23 yaş arasındaki Türk popülasyonunda spontan gülüşte gülme hattı tiplerinin yaygınlığını belirlemek ve statik gülüş prevalansı ile karşılaştırmaktır.

Gereç ve Yöntem: Bu çalışma Başkent Üniversitesi Diş Hekimliği Fakültesi'nden 150 lisans öğrencisi (75 kız, 75 erkek) dahil edilerek yapıldı. Bu amaçla katılımcının burun ucundan 40 cm mesafede, statik gülüş için fotoğraf kayıtları, dinamik gülüş için ise 20 saniyelik video kayıtları alındı. Ölçümler elektronik cetvelle yapıldı.

Bulgular: Hem pozlanmış hem de spontan gülüşte yüksek gülme hattı prevalansı en fazla bulunmuştur. ($p<0.001$). Ortalama dişeti yüksekliği dinamik gülüşte daha fazladır ($p<0.05$). Kadınlarda hem statik hem de dinamik gülmede erkeklere göre ortalama dişeti görünme miktarı daha fazladır ($p<0.05$).

Sonuç: Gülme hattı, hastanın poz vererek fotoğraflandığı kayıtlar üzerinde değerlendirildiğinde, video kayıtlar yoluyla elde edilen doğal gülme hattına göre daha düşük bulunmuştur. Hastalar poz vermek yerine doğal şekilde güldüklerinde gingival görünüm arttığından, klinik değerlendirmeler ve restoratif düşünceler dinamik gülüşe göre planlanmalıdır.

Anahtar kelimeler: Gülme hattı, statik gülüş, dinamik gülüş, dişeti, estetik.

Introduction

Evaluating dental esthetic parameters has become a routine procedure for patients who need esthetic dental treatment. Performing a detailed esthetic evaluation, by integrating it with biological and functional parameters, will allow the clinician to accurately diagnose and select the most appropriate treatment plan for the patient (1).

The smile is an important facial expression and communication parameter (2). An esthetic smile is related to the color, shape, and size of the teeth as well as the amount of gingival display (3). Gingival display is defined as the amount of gingival visibility during a smile or the distance between the gingiva and upper lip (4). The amount of soft tissue displayed is related to the position of the smile line (5). During the smile, the relationship between the lower border of the upper lip and the upper teeth and/or gingival display forms the smile line. In previous years, smile line types were categorized in three groups. According to this classification, cases with enamel-cement junction visibility and gingival display above this junction were described as Class 1 (gummy smile), cases where only gingival embrasures were seen as Class 2, and cases where less than 75% of the anterior teeth were visible were Class 3 (6). In 2004, Liebart et al. (7) expanded the types of smile lines into four groups: Class 1, with a very high smile line (more than 2 mm gingival display); Class 2, with a high smile line (0–2 mm gingival display); Class 3, with an average smile line (display of gingival embrasures only); and Class 4, with a low smile line (gingival embrasures and enamel-cement junction not visible) (Figure 1).

Clinicians often base their diagnosis, treatment planning, and research on patients' static smiles at a single moment of a posed smile. For all those purposes, this static analysis can lead to misdiagnosis and non-ideal treatment because patients' natural smiles may be significantly different from their posed smiles, displaying more teeth and/or gingiva. Dynamic smile assessments should be used to determine the entire range of a spontaneous smile (8).

In addition, the prevalence of a smile line is determined according to a static (posed) smile. It is thought that obtaining dynamic smile records spontaneously can change the prevalence of smiling lines and give more accurate results.

The aim of this study was to determine the prevalence of smile types in dynamic (spontaneous) smiles in a young Turkish population between the ages of 18 and 23 and to compare it with the prevalence in static smiles. The first null hypothesis was that gingival display would not change between static and dynamic smiles. The second null hypothesis was that the smile line types would not be different between males and females.

Materials and methods

Ethical statement

This study was approved by the Başkent University Institutional Review Board (project no.: D-KA20/10) and Ethics Committee with support from Başkent University Research Fund. Informed consent was obtained from all participants by asking them to sign a consent form containing details about the study.

Sample size estimation

This study was carried out with 150 students (75 females, 75 males). The sample size was calculated for the chi-square test, which was used to test the primary hypothesis of our study. As a result of the sample size analysis performed using Cohen's effect size value of 0.29, a minimum of 150 individuals should be included in the study ($1 - \beta = 0.80$) to reveal significant differences between the groups with 80% power and $\alpha = 0.05$ error (95% confidence interval).

Study protocol

Exclusion criteria were orthodontic treatment in process, a missing anterior tooth, restoration in the anterior region, and periodontal disease. For static and dynamic recordings, photographs and video recordings were taken at a distance of 40 cm between the lens and the

tip of the nose by using a camera (Canon EOS 750D, Canon Inc., Japan), a lens (100 mm, Canon Inc., Japan), a ring flash (MR-14EX II, Canon Inc., Japan), and a tripod (HAMA HM.4605 FlexProS, China). All photographs were taken under the same conditions by the same photographer. Participants were positioned standing in front of a white background. Before the recordings were taken, 13.1 cm wide archless flat glasses were fitted to each participant to calibrate the gingival distance measurement in the photos (Figure 2). For the static recording, the participants were asked to look across and smile with their mouths open while the photo was taken. In order to record the dynamic smile correctly, the participants were engaged in relaxed conversations and asked to laugh more comfortably, and the video of these moments was recorded for 20 seconds while maintaining the same distance. Then, the video recordings were evaluated, and the screenshot taken of the moment when the participant smiled most comfortably. Thus, the highest smile line was recorded. This moment was determined as a dynamic smile line. Gingival display in the static and dynamic records was measured with an electronic ruler by using the Keynote (v6.6.1; Apple Inc., USA) program (Figure 2). All photographs were adjusted, and black bars were placed on the eyes of the participants' photographs by using Adobe Photoshop (version 21.2, USA). Measurements were made between the enamel-cement junction of the maxillary central teeth and the lower border of the upper lip. In cases of asymmetry, the amount of gingival display of both central teeth was measured, and the arithmetic mean was calculated. Then, smile lines were classified according to the classification of Liebart et al. (7).

Statistical analysis

Post hoc power analysis was conducted to determine the power of the study, with a type-1 error value of 0.05 for the primary hypotheses that were found to be statistically significant. The G*power software (version 3.1.9.7, Heinrich Heine University Düsseldorf, Germany) was used for sample size estimation and post hoc power analysis. Statistical analysis of the data

collected in our study was performed using the SPSS package program (Version 22.0, SPSS Inc., USA). Frequency distributions of categorical variables were presented as number and percentage (%). Descriptive statistics of continuous variables were reported with mean ± standard deviation, in accordance with the data normality distribution. The normal distribution of the data was tested with the Shapiro–Wilks test. Relationships and ratio comparisons between categorical variables were evaluated using the chi-square test. Gingival display measurements were compared by Student's *t*-test between two independent groups. The statistical significance level was considered as $p < 0.05$.

Results

A statistically significant difference was found between the ratios of smile line types in static and dynamic smiles in young individuals between the ages of 18 and 23 ($chi\ square^2(3) = 47.87$, $p < 0.001$). The statistical post hoc power for this comparison was calculated to be 100%. Class 2 was found to be most prevalent in both static and dynamic smiles at 36% and 44%, respectively. The prevalence of Class 2 in dynamic smiles is higher than in static smiles ($p < 0.001$). While the least common type in static smiles is a very high smile line, it was the second most frequent type in dynamic smiles ($p < 0.001$). Average smile line was the second most frequent smile type in posed smiles, while it was the second least frequent in spontaneous smiles ($p < 0.001$) (Table 1).

Figure 3 shows the change in smile types of individuals from static smile to dynamic smile. As a descriptive analysis, none of the participants with a low smile line in the static smile showed a very high smile line in the dynamic smile (Figure 3). All of the participants with an average smile line in a static smile showed high or very high smile lines in a dynamic smile. There was no decrease in the amount of gingival display in any of the participants from static smile to dynamic smile.

The ratios of the smile line types in static and dynamic smile by gender are given in Table 2. The ratios of smile line types were statistically different between males and females in both static and dynamic smiles among young individuals aged 18–23 (*chi square*(3) = 17.33, $p = 0.001$; *chi square*(3) = 22.12, $p < 0.001$, respectively). For this comparison performed by gender, statistical post hoc power was calculated to be 100% for static smiles and 100% for dynamic smiles. While the prevalence of high smile lines in static smiles and very high smile lines in dynamic smiles is highest in females, the prevalence of average smile lines in static smiles and high smile lines in dynamic smiles was highest in males ($p = 0.001$ and $p < 0.001$, respectively).

The arithmetic mean gingival display was 0.35 ± SD mm in static smiles and 1.44 ± SD mm in dynamic smiles. The average soft tissue display is higher in dynamic smiles ($p < 0.05$). The arithmetic mean gingival display of females and males in static smiles was 0.47 ± SD mm and 0.20 ± SD mm, respectively; in dynamic smiles, it was 1.92 ± SD mm and 0.87 ± SD mm, respectively. In both static and dynamic smiles, the average amount of gingival display was higher in females than in males ($p < 0.05$ and $p < 0.05$, respectively).

The average gingival display in participants with a Class 1 smile line is 2.41 ± SD mm in static smiles and 3.34 ± SD mm in dynamic smiles. On the other hand, the average gingival display in static and dynamic smiles was 0.52 ± SD mm and 0.62 ± SD mm, respectively.

Figure 1. Smile line types *(Liebart et al., 2004) (A: Class 1; B: Class 2; C: Class 3; D: Class 4)*

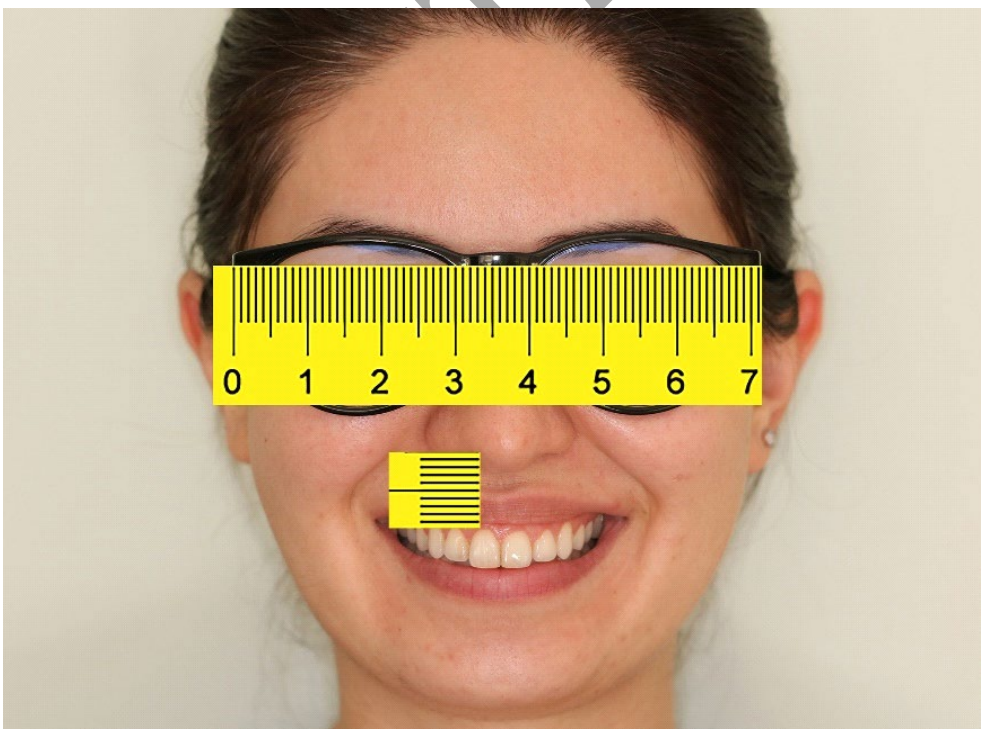

Figure 2: Gingival display measurement and calibration

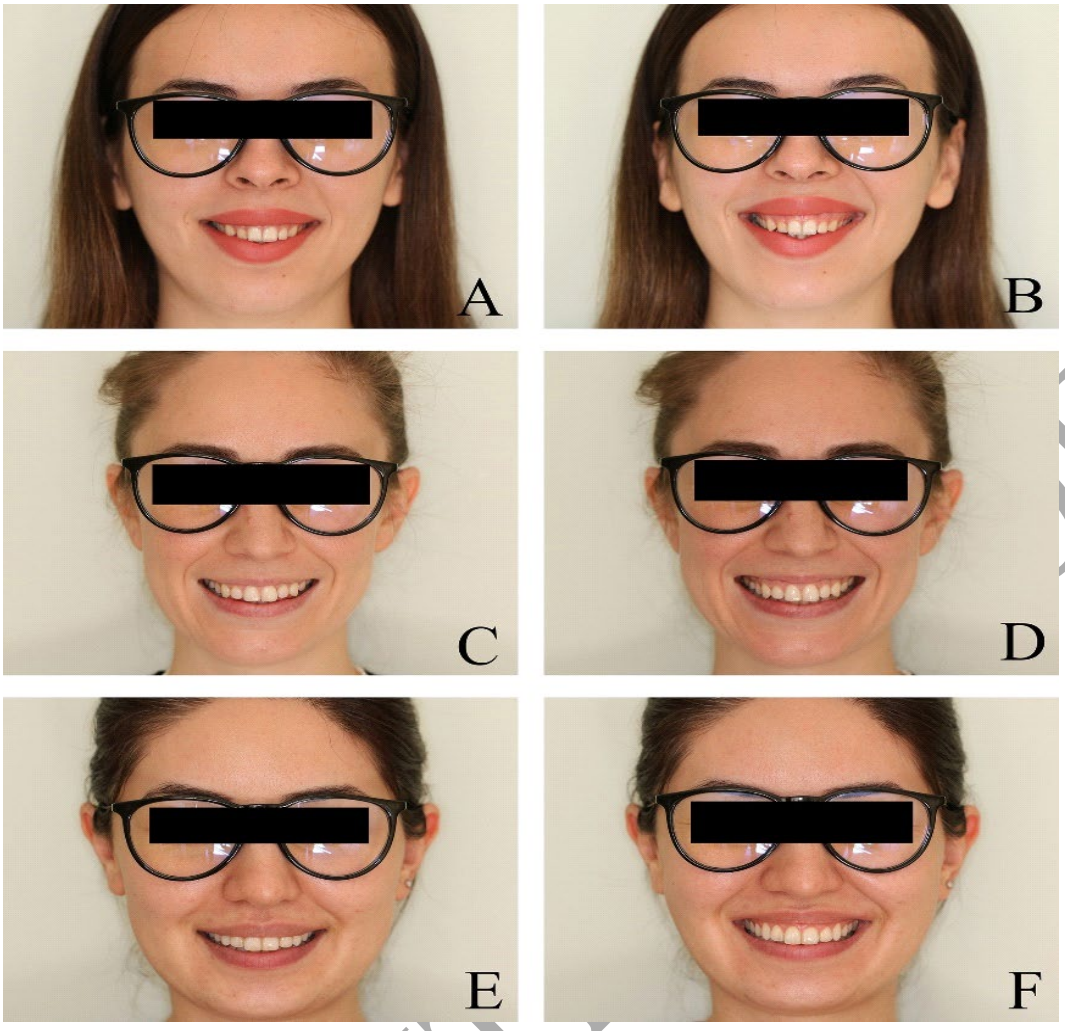

Figure 3. Change in smile types from static to dynamic smile. A, C, E show posed (static) smiles, B, D, F show spontaneous (dynamic) smiles. *(A: High smile line; B: Very high smile line; C: Average smile line; D: High smile line; E: Low smile line; F: High smile line.)*

Table 1. Prevalence of smile line types in static and dynamic smile (*Statistically significant with Chi-square test).

Smile Line Types	Static Smile n (%)	Dynamic Smile n (%)	*P* value	Power
Class 1 (Very high smile line)	12 (8)	51 (34)	**<0.001***	**100%**
Class 2 (High smile line)	54 (36)	66 (44)		
Class 3 (Average smile line)	51 (34)	18 (12)		
Class 4 (Low smile line)	33 (22)	15 (10)		

Table 2. The prevalence of static and dynamic smile lines by gender (*Statistically significant with Chi-square test).

Smile Line Types	Smile Types							
	Static (Posed)				Dynamic (Spontaneous)			
	Female (%)	Male (%)	*P* value	Power	Female (%)	Male (%)	*P* value	Power
Very high	8	8			48	20		
High	48	24			40	48		
			0.001*	**100%**			**<0.001***	**100%**
Average	32	36			8	16		
Low	12	32			4	16		
Total	100	100			100	100		

Discussion

Regardless of gender and age, there are parameters for the evaluation of smile esthetics, such as midline, incisor width/height ratio, buccal corridor, incisor crown inclination, and smile arch appearance. Among these parameters, the amount of gingival display is one of the most important keys to smile beauty (9–12). Both null hypotheses of the presented study were rejected; gingival display changed during static and dynamic smiles within both male and female populations.

In this research, static photographs were evaluated to measure gingival display. Capturing dynamic smiles using a video camera recording can change the display of soft tissues and teeth compared to static images produced by a camera (13–15). Recording a video for dynamic smiles can allow a proper analysis of esthetics and function. Usually, when the patient is asked to smile broadly during the clinical evaluation, the patient poses with a lower smile than usual (16, 17). In this study, the frequency of smile types in static and dynamic smiles in a young Turkish population aged 18–23 was compared. This age range was preferred because the gingival display changes as the age increases (14, 18).

Maxillary central incisors are the key determinant in the evaluation of smile type and esthetics. Therefore, in this study, the smile type was evaluated by measuring the gingival display of the maxillary central teeth (19–21).

There are a few studies from different ethnic communities that show that the smile line may be found to be different in a patient's comfortable position, since the smile line assessment is mostly based on the patient's photographs and the patient is asked to pose (8, 22). Also in this study, the prevalence of the smile line types changed between the posed smile and the spontaneous smile.

In a study performed by Mahn et al. (8), while the prevalence of the smile line changed in dynamic smiles, the most common smile line was the low smile line in static smiles, while the average smile line was found in dynamic smiles. However, in this study, although the most common smile line type is the high smile line in both static and dynamic smiles, the rate of high smile lines is higher in dynamic smiles. This is thought to be related to the conduct of studies in different ethnic communities.

The prevalence order of smile types in static smiles and dynamic smiles in both females and males has changed. While the most common smile line in females in static smiles is Class 2, it is Class 1 in dynamic smiles. The rate of very high smiles line in dynamic smiles is six times higher (48%) than in static smiles (8%) in the female population. While the lowest two smile lines (Class 3 and Class 4) are most prevalent in static smiles in males, the highest two smile lines (Class 1 and Class 2) are most prevalent in dynamic smiles. Based on these findings, it can be said that the posed smiles of the majority of the Turkish population do not reflect their natural smiles.

In a study by Jensen et al. (23), it was reported that the average amount of gingival display of females was higher than that of males in posed smiles. Similarly, in this study, the amount of gingival display is higher in both posed and spontaneous smiles of females compared to males.

This study obtains specific frames for the desired purpose, using videographic imaging technology. The fact that video recordings are as easy, reproducible and reliable as photographic recordings makes them valuable in clinical practice. With the help of a software program, the desired analyses and measurements can be performed on the images obtained from video recordings.

This study showed that the use of digital photography alone is insufficient for evaluating gingival display and planning the esthetic restorations to be decided accordingly, because most

of the participants showed a change in the type of smile between posed and spontaneous records. Moreover, treatments should be planned individually, as females usually present higher gingival display than males in both posed and spontaneous smiles.

The reason for the limitation of this study to the young age group is the decrease in gingival display due to age. Further studies should be investigated on types of smiles and changes in gingival display during static and dynamic smiles in different age ranges.

Considering that the amount of gingival display is an important parameter that directly affects esthetics, it is critical to accurately determine the amount of gingival display in the planning and performing stages of certain clinical applications, such as esthetic restorations, prosthetic material decision, orthognathic surgeries, philtrum and lip repositioning operations, and periodontal crown lengthening.

Conclusion

The smile line is usually found lower than its natural position since the smile line assessment is based on the patient's photographs and the patient is asked to pose. The smile line in spontaneous smiles is higher than in static evaluations. Clinical evaluations and restorative thoughts should be planned according to the dynamic smile, as the gingival appearance increases when patients are smiling naturally rather than posing.

Ethics Committee Approval: This study was approved by Baskent University Institutional Review Board (Project no: D-KA20/10).

Informed Consent: The informed consents were provided by the participants.

Peer-review: Externally peer-reviewed.

Author contributions: OA and UY participated in designing the study. OA participated in generating the data for the study. UY participated in gathering the data for the study. OA, UY participated in the analysis of the data. OA wrote the majority of the original draft of the paper.

UY participated in writing the paper. OA, UY have had access to all of the raw data of the study. OA and UY have reviewed the pertinent raw data on which the results and conclusions of this study are based. OA and UY have approved the final version of this paper. OA and UY guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors had no conflict of interest to declare.

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