RESEARCH ARTICLES

Recevied/ Geliş Tarihi: 13.04.2023
Accepted/ Kabul Tarihi: 18.07.2023
Published / Yayın Tarihi: 17.04.2024

Aydın Dental Journal - Volume **10** Issue **1** - April **2024** (9-21)

Aydın Dental Journal

Journal homepage: http://dergipark.ulakbim.gov.tr/adj
DOI: 10.17932/IAU.DENTAL.2015.009/dental_v010i1002

The Impact of Orthodontic Relapse on the Perception of Smile Aesthetics: An Evaluation by Patients Undergoing Orthodontic Treatment

Ortodontik Nüks Sonrası Değişikliklerin Ortodonti Hastalarinin Gülümseme Estetiği Algısına Etkisi

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ABSTRACT

Objective: To evaluate the impact of potential tooth movement following orthodontic relapse on the aesthetic perception of patients undergoing orthodontic treatment.

Materials and Methods: Frontal and lateral smiling photographs of one female and one male volunteer who had previously received orthodontic treatment and hade a regular profile with class I occlusion and class I skeletal pattern were evaluated. Variables included in the evaluation made by 200 laypeople who had undergone orthodontic treatment using photographs of male and female smiles: median diastema, overbite change, central tooth extrusion, labiolingual inclination of incisors and labiolingual translation of lateral teeth. Evaluators rated the overall attractiveness and acceptability of each photo using a scale of 0 to 10.

Results: There were statistical differences in aesthetic ratings between female and male evaluators. Median diastema and central tooth extrusion of 0.5 mm or larger affected female and male model attractiveness scores. The acceptable range for overbite, maxillary incisor inclination, and labiolingual translation of the maxillary lateral tooth varied between the female and the male models.

Conclusions: Female evaluators were more critical in aesthetic evaluation. 0.5 mm median diastema and central tooth extrusion adversely affected smile aesthetics. Although there were differences between male and female models, raters tolerated limited overbite (0 mm) less than increased overbite. Moreover, the lingual inclination of the upper incisors was more acceptable than labial movement. Perception of labiolingual translation of the upper lateral tooth varied depending on the perspective and model being evaluated.

Keywords: *Aesthetics, incisors, Perception, Relapse, Smiling*

ÖZET

Amaç: Ortodontik nüks sonrası diş hareketinin, ortodontik tedavi gören hastaların estetik algıları üzerindeki etkisini değerlendirmek.

Gereç ve Yöntemler: Daha önce ortodontik tedavi görmüş, sınıf I oklüzyon ve sınıf I iskelet yapısına sahip düzgün profilli bir kadın ve bir erkek gönüllünün frontal ve lateral gülümseme fotoğrafları değerlendirildi. Kadın ve erkek gülümseme fotoğrafları kullanılarak, ortodontik tedavi görmüş 200 kişi tarafından değerlendirilen değişkenler: median diastema, overbite değişimi, santral diş ekstruzyonu, kesici dişlerin labiolingual inklinasyonu ve lateral dişin labiolingual translasyonu. Değerlendiriciler, her fotoğrafın genel çekiciliğini ve kabul edilebilirliğini 0'dan 10'a kadar bir ölçek kullanarak derecelendirdi (0: en az çekici; 10: en çekici).

Bulgular: Kadın ve erkek değerlendiriciler arasında estetik derecelendirmelerde istatistiksel farklılıklar mevcuttu. Kadın ve erkek model çekicilik skorları, 0.5 mm veya daha büyük median diastema ve santral diş ekstrüzyonundan etkilendi. Overbite, maksiller kesici diş inklinasyonu ve maksiller lateral dişin labiolingual translasyonu için kabul edilebilir aralık, kadın ve erkek model arasında farklılık gösterdi.

Sonuç: Kadın değerlendiriciler estetik değerlendirmede daha eleştireldi. 0.5 mm median diastema ve santral diş ekstruzyonu gülümseme estetiğini olumsuz etkiledi. Erkek ve kadın modeller arasında farklılıklar olmasına rağmen, değerlendiriciler sınırlı overbite'ı (0 mm) artan overbite'a göre daha az tolere etti. Ayrıca üst kesici dişlerin lingual eğiminin labial eğime göre daha kabul edilebilir olduğu gözlendi. Üst lateral dişin labiolingual translasyon algısı, değerlendirilen perspektife ve modele bağlı olarak değişiklik gösterdi.

Anahtar kelimeler: *Estetik, Kesici Dişler, Algı, Nüks, Gülümseme*

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Giriş

Maintaining aesthetic and functional tooth positions after orthodontic treatment plays a critical role in the treatment's success. After the active treatment phase, the aim is to make the treatment results permanent by employing a suitable retention protocol. However, it is possible for unwanted changes to occur after treatment due to drawbacks such as patient cooperation issues, unsuitable retention protocols, and snapped, broken, or lost retainers.[1] Moreover, unrelated to the treatment, surrounding soft-tissue pressure and changes in the skeletal structure due to aging can also lead to deterioration in tooth position.[2] Observations reveal a strong relationship between patients' perception of post-treatment stability and current satisfaction in the event of a possible relapse.[3,4] Patients may request retreatment due to dissatisfaction resulting from tooth movement after treatment.[4,5] Therefore, it is crucial to accurately delineate the patient's awareness of relapse and the determinants that prompt the pursuit of retreatment. The anterior teeth are more likely to be noticed and considered important due to aesthetic reasons. The awareness and discomfort level of patients regarding position changes in the anterior teeth can be assessed by simulating the alterations using Photoshop software.[6,7] The null hypothesis of this study claims that the simulated post-relapse maxillary incisor movements in both female and male models do not exert any influence on the perception of smile aesthetics. Although there are studies examining the effects of tooth position changes on aesthetic perception, to the best of our knowledge, there has been no study evaluating patient awareness of possible post-relapse tooth movement simulated with Photoshop programme.[7–9] Therefore, the objective of this study was to measure patient relapse awareness by simulating possible tooth movement after orthodontic relapse in photographs of smiles. The null hypotheses were the following:

1. Patients would not recognize posttreatment changes of median diastema, overbite change, central tooth extrusion, labiolingual inclination of incisors and labiolingual translation of lateral teeth.

2. There was no difference in the aesthetic evaluation of potential tooth movements after orthodontic relapse between male and female patients undergoing orthodontic treatment.

Materials and Method

The study obtained ethical approval from the Ethics Committee of the Karadeniz Technical University Faculty of Dentistry (Decision date: 21/09/2022, Protocol no: 2022/11). The study included a male and a female volunteer who were receiving orthodontic treatment in our clinic and had not received any previous conservative or prosthetic therapy for their anterior teeth. The two individuals were selected according to the following criteria: (1) class I occlusion and class I skeletal model with normal overjet and overbite, (2) normal-range values of hard tissue according to cephalometric analysis (Nemoceph V.2022) (Supplementary Table 1), (3) proper teeth alignment, (4) symmetrical tooth form, and (5) healthy gingival structure. Both male and female individuals who satisfied the requirements were provided with details about the research and subsequently signed a consent form of their own volition. The individuals' head positions were adjusted to ensure that the Frankfort horizontal plane and the pupillary line were parallel to the ground [7] and their smiles were photographed up close from frontal and lateral perspectives.As a first step, the color, brightness, and contrast of the photographs were adjusted in Adobe Photoshop (version 23.5.1, Adobe Systems, California, USA). The photos were then retouched to remove stains and discolorations on the lips and skin and to improve the appearance of the teeth and gums. The size of the photograph was adjusted so that each millimeter measured on it was clinically equal to 1 mm (1:1 ratio) when imported into a web-based survey form. The photo was cropped to include the area between the chin and the tip of the nose. The application of tooth movements was guided by prior research and clinical expertise. [8,10–12] The following tooth movements were evaluated in the study:

1. Extrusion of the right maxillary central incisor in 0.25-mm steps (from 0.25 to 1.5 mm)

2. Labiolingual translation of the right maxillary lateral incisor in the frontal smile photograph in 0.5-mm steps (+0.5 mm, +1 mm, +1.5 mm, -0.5 mm, -1 mm, -1.5 mm) (a positive sign indicates labial movement; a negative sign indicates lingual movement)

3. Labiolingual translation of the right maxillary lateral incisor in 0.5-mm steps (+0.5 mm, +1

mm, +1.5 mm, -0.5 mm, -1 mm, -1.5 mm) in the profile smile photograph (a positive sign indicates labial movement; a negative sign indicates lingual movement)

4. Change of median diastema in 0.5-mm steps (from 0.5 to 2 mm)
5. Change of overbite in 1 mm steps (from 0 to 6 mm) (with the movement of the mandibular anterior tooth segment)
6. Labiolingual inclination of maxillary incisors in 5 steps (+5, +10, +15, -5, -10, -15o) (a positive sign indicates labial movement; a negative sign indicates lingual movement)

A decision was made to use three-dimensional (3D) digital models as a reference for the labiolingual translation of the lateral tooth and the labiolingual inclination of the incisors. 3D digital models of the teeth in the upper and lower jaws were obtained at the same time with photographic records and were created using the 3Shape® TRIOS® intraoral scanner (3Shape®, Copenhagen, Denmark). The positions of the teeth in the 3D digital model were changed with Ortho Analyzer™ software (3Shape®, Copenhagen, Denmark). To achieve this, the appropriate angle and position of the 3D models corresponding to the smile photographs were chosen. Subsequently, sequential tooth adjustments were implemented without altering the model's location, and screenshots were captured. Screenshots were used as a reference to simulate tooth movement in the smile photographs with Adobe Photoshop (version 23.5.1, Adobe Systems, California, USA). For each gender, 6 sets of photos were produced. Each set included an unaltered control photograph (except for the overbite variable). Ultimately, a total of 80 photos of both genders were produced for the survey. A survey form was created with the web-based application Google Forms (Mountain View, CA). The first section of the survey form consisted of short-answer questions regarding the evaluator's age, gender, educational status, and duration of treatment. The following 6 sections consisted of smile photographs, and under each photograph was a rating scale from 0 to 10 (0: least attractive; 10: most attractive).

Supplementary Table 1. Cephalometric measurements.

Measurements	Normal values	SD	Female Mean	Subject	Male Mean	Subject
SNA°	82	2	82		82	
SNB°	80	2	81		79	
ANB°	2	1	1		3	
U1/SN°	103	3	16		106	
U1/NA°	22	2	24		24	
UI-NA, mm	4	1	4.1		3.1	
U1-L1°	131	6	129		129	
L1/NB°	25	2	26		24	
L1-NB, mm	4	1	1.9		3.3	

§ SD: standard deviation.

Participants who evaluated the photos were selected from among those who received orthodontic treatment in our clinic and were between 18 and 50 years old. The sample size was determined by power analysis. Based on research conducted by Jiang et al.[8] the participant sample size was calculated using an alpha error of 0.05, beta error of 0.20, and effect size of 0.42, leading to the conclusion that 180 patients would be sufficient. However, with possible data loss in mind, plans were made to include at least 200 patients in total in the study.

The evaluators were briefly informed about the study and signed a voluntary consent form to participate. Two separate survey forms for male and female models created in Google Forms were presented in a computer environment monitored by a supervisor. First, the personal information of the evaluators was collected. The evaluators were then presented with the photos in random order and rated them on a scale of 0 to 10 (0: least attractive; 10: most attractive). They were given 10 seconds to rate each photo and each photograph was displayed only once. After a

period of 2 weeks, a random selection was made of 25% of the participants, consisting of 25 women and 25 men, to conduct a re-evaluation of all images.

The statistical software NCSS® (Number Cruncher Statistical System) 2020 (NCSS LLC, Kaysville, Utah, USA) was used for statistical analysis. Descriptive statistical methods such as the standard deviation and mean were used for quantitative variables, and the frequency and percentage were used for qualitative variables. A Shapiro-Wilk test and box plot graphics were used to evaluate whether the data conformed to a normal distribution. A Student's t-test was used in two-group evaluations of variables that showed normal distributions. The Mann-Whitney U test was employed to assess variables that exhibited non-normal distributions in two-group comparisons. In evaluating differences in attractiveness ratings, the Bonferroni test was used for repeated-measures post-hoc comparisons of variables that showed normal distributions. The Bonferroni Dunn test was employed for Friedman post-hoc comparisons on variables that weren't assigned to a normal distribution. The educational status was assessed by comparing gender using Pearson's chi-squared test. The results were evaluated at a 95% confidence interval and a significance level of $p<0.05$.

Results

There were no statistically significant differences between female and male participants in terms of age, duration of treatment, and educational status (Supplementary Table 2). The reliability of the ratings was tested using Intraclass Coefficient Correlation (ICC). The agreement for each photo ranged from modest (ICC = 0.40) to excellent (ICC = 0.90). There were statistical differences between male and female participants in some cases regarding the evaluation of the images ($p<0.05$, $p<0.001$); male participants gave higher scores (Tables 1 and 2). Among the diastema photos of the male and female models, the most attractive smile for both gender groups was the smile without diastema (Figure 1, a) (Tables 1 and 2). In the supplementary figure 1, the female model's overbite images with a 2-mm and 3-mm overbite received the greatest points from the participants. On the other hand, the male model's overbite photos with a 2-mm, 3-mm, 4-mm, and 5-mm overbite received the highest scores. Furthermore, the 0-mm overbite photos of the female and male models received the lowest score from both groups of participants (Tables 1 and 2). The participants rated the photos of female models at +5°, 0° (control), -5°, and -10° with the highest scores (Figure 2). Female participants rated the photos at +15° and -15° with the lowest scores, while male participants rated the +15° image with the lowest score (Table 1). For male smile photographs (Figure 2), female participants gave the highest scores to 0° (control), -5°, -10°, and -15° photos, while male participants gave the highest scores to -5°, -10°, and -15° photos. Additionally, participants gave the lowest scores to +10° and +15° images (Table 2). Figure 3 displays extrusion images of both female and male models. Among these photos, the ones with 0-mm (control) and 0.25-mm extrusion obtained the highest scores from both genders, as shown in Tables 1 and 2.

In the evaluations of the female model, the translation images in profile and frontal view (Figures 4 and Supplementary Figure 2) that were considered the most attractive by female participants were the photos having a translation of +0.5 mm, 0 mm (control), and -0.5 mm. Although there was no significant disparity in attractiveness ratings between labial and lingual translation images when viewed from the front, labial movements at a distance of 1 mm in profile view received lower scores compared to lingual movements. According to male participants, the most attractive photos in frontal view were +1 mm, +0.5 mm, 0 mm and -0.5 mm ones. Moreover, there was no significant difference in attractiveness scores between labial and lingual movements with the same distance except for 1 mm of lingual movement, which was scored lower than labial movement. In profile view, male participants rated the +0.5 mm, 0 mm, -0.5 mm, -1 mm and -1.5 mm images as the most attractive. Labial movements with a starting point of 1-mm were assigned low aesthetic values according to Table 1. When assessing the attractivemess of male smiles, both male and female participants rated frontal photos with +0.5 mm, 0 mm, -0.5 mm, -1mm, and -1.5 mm as the most attractive. The images with +0.5 mm, 0 mm, -0.5 mm, and -1 mm in profile view were likewise considered the most visually appealing. All participants rated labial movements lower than lingual movements with the same distance starting from 1 mm in both views (Table 2).

Supplementary Table 2. A comparison of demographic features based on gender

		Gender		*p*
		Female	**Male**	
Age	*Mean±SD*	20.19±3.76	19.95±2.37	† *0.646*
Treatment duration (m)	*Mean±SD*	29.13±21.68	30.73±23.24	† *0.759*
Educational status	High school	55%	61%	‡ *0.390*
	University	45%	39%	

§ SD: standard deviation, †Mann-Whitney U test, ‡ Pearson's chi-squared test

Table 1. Gender-based evaluation of scores assigned to photographs of female smiles

	Female		**Male**		
Measurements (mm/°)	**Mean†**	**SD**	**Mean‡**	**SD**	**p**
Diastema					
0 mm (control)	6.7 (a)	2.36	7.28 *(a)*	2.05	0.065
0.5 mm	4.46 (b)	2.37	5.54 *(b)*	2.20	0.001**
1 mm	3.08 (c)	2.11	3.80 *(c)*	2.15	0.018*
1.5 mm	2.43 (d)	1.91	3.20 *(d)*	2.11	0.008**
2 mm	1.89 (e)	1.77	2.23 *(e)*	2.05	0.340
Overbite					
0 mm	4.69 (e)	2.40	5.34 *(d)*	2.40	0.057
1 mm	5.64 (c,d)	2.31	6.39 *(c)*	2.09	0.017*
2 mm	6.86 (a)	2.14	7.08 *(a)*	2.02	0.438
3 mm	6.47(a,b)	2.27	6.76 *(a,b)*	2.12	0.822
4 mm	6.16 (b,c)	2,37	6.54 *(b,c)*	2.14	0.062
5 mm	5.86 (c,d)	2.31	6.55 *(b,c)*	2.35	0.038*
6 mm	5.65 (d)	2.43	6.42 *(b,c)*	2.22	0.020*
Labiolingual inclination					
15° labial	4.27 (d)	2.17	4.47 *(d)*	2.04	0.502
10° labial	5.08 (b,c)	2.09	5.28 *(c)*	1.93	0.483
5° labial	5.68 (a)	2.19	5.76 *(a)*	2.09	0.792
0 (control)	5.92 (a)	2.08	6.08 *(a)*	2.09	0.588
5° lingual	5.64 (a,b)	2.20	6.07 *(a)*	2.28	0.176
10° lingual	5.51 (a,b)	2.18	6.06 *(a)*	2.05	0.588
15° lingual	4.75 (c,d)	2.35	5.79 *(b,c)*	2.42	0.002**
Extrusion					
0 mm (control)	6.79 (a)	2.02	6.76 *(a)*	2.00	0.916
0.25 mm	6.36 (a,b)	2.19	6.75 *(a)*	1.92	0.182
0.5 mm	6.01 (b)	2.13	6.31 *(b)*	1.95	0.300
0.75 mm	5.40 (c)	2.11	5.82 *(c)*	1.96	0.146
1 mm	4.17 (d)	2.08	4.68 *(d)*	2.12	0.088
1.25 mm	3.75 (e)	2.23	4.48 *(d)*	2.20	0.021*
1.5 mm	3.53 (e)	2.13	4.31 *(d)*	2.18	0.011*
Labiolingual translation (profil)					
1.5 mm labial	3.95 (e)	1.89	4.45 *(c)*	1.90	0.064
1 mm labial	4.92 (d)	1.87	5.48 *(b)*	2.01	0.043*
0.5 mm labial	6.12 (a)	1.99	6.28 *(a)*	1.97	0.568
0 mm (control)	6.36 (a)	1.9	6.25 *(a)*	2.02	0.692

† The letters after the values indicate pairwise comparisons of females. Different letters indicate statistically significant differences.
‡ The letters after the values indicate pairwise comparisons of males. Different letters indicate statistically significant differences.
§ SD: standard deviation.
*p<0.05 **p<0.01 ***p<0.001

Table 1. Extended. Gender-based evaluation of scores assigned to photographs of female smiles

	Female		Male		
Measurements (mm/°)	**Mean†**	**SD**	**Mean‡**	**SD**	**p**
0.5 mm lingual	6.28 (a,b)	2.12	6.38 *(a)*	2.02	0.733
1 mm lingual	5.87 (b,c)	2.10	6.09 *(a)*	1.86	0.433
1.5 mm lingual	5.62 (c)	2.05	5.97 *(a)*	1.91	0.213
Labiolingual translation (frontal)					
1.5 mm labial	5.17 (d)	1.94	5.19 *(d)*	2.02	0.943
1 mm labial	6.30 (b,c)	2.03	6.77 *(a,b)*	1.89	0.092
0.5 mm labial	7.13 (a)	1.69	7.10 *(a,b)*	1.82	0.904
0 mm (control)	7.24 (a)	1.85	7.05 *(a)*	1.94	0.480
0.5 mm lingual	6.77 (a,b)	2.07	6.73 *(a,b)*	1.88	0.886
1 mm lingual	6.06 (c)	2.03	6.12 *(c)*	1.98	0.833
1.5 mm lingual	5.00 (d)	2.03	5.26 *(d)*	2.00	0.362

† The letters after the values indicate pairwise comparisons of females. Different letters indicate statistically significant differences.
‡ The letters after the values indicate pairwise comparisons of males. Different letters indicate statistically significant differences.
§ SD: standard deviation.
*p<0.05 **p<0.01 ***p<0.001

Table 2. Gender-based evaluation of scores assigned to photographs of male smiles

	Female		Male		
Measurements (mm/°)	**Mean†**	**SD**	**Mean‡**	**SD**	**p**
Diastema					
0 mm (control)	6.87 (a)	1.99	7.09 *(a)*	1.78	0.411
0.5 mm	3.57 (b)	2.09	4.23 *(b)*	2.10	0.027*
1 mm	2.91 (c)	1.96	3.16 *(c)*	2.06	0.381
1.5 mm	2.20 (d)	1.90	2.42 *(d)*	2.13	0.009*
2 mm	1.71 (e)	1.77	2.09 *(d)*	2.09	0.340
Overbite					
0 mm	4.29 (d)	2.22	4.38 *(d)*	2.25	0.776
1 mm	5.37 (c)	2.19	5.64 *(c)*	1.98	0.361
2 mm	6.86 (a,b)	2.13	7.01 *(a,b)*	1.65	0.209
3 mm	7.27 (a)	1.81	7.19 *(a,b)*	1.89	0.760
4 mm	6.93 (a,b)	2.15	7.24 *(a)*	1.95	0.287
5 mm	6.83 (a,b)	2.13	6.76 *(a,b)*	2.01	0.811
6 mm	6.64 (b)	2.20	6.66 *(b)*	2.37	0.951
Labiolingual inclination					
15° labial	3.80 (c)	1.91	4.10 *(c)*	2.16	0.300
10° labial	4.10 (c)	2.10	4.45 *(c)*	2.11	0.241
5° labial	5.07 (b)	2.02	5.42 *(b)*	2.06	0.227
0 (control)	5.39 (a,b)	2.16	5.58 *(b)*	2.04	0.524
5° lingual	5.86 (a)	2.23	5.97 *(a,b)*	2.00	0.714
10° lingual	5.78 (a)	2.24	5.93 *(a,b)*	2.03	0.620
15° lingual	5.73 (a)	2.21	6.13 *(a)*	2.00	0.182
Extrusion					
0 mm (control)	7.32 (a)	2.06	7.35 *(a)*	1.74	0.912
0.25 mm	6.95 (a)	2.09	6.97 *(a)*	1.82	0.565
0.5 mm	5.77 (b)	2.21	6.16 *(b)*	2.02	0.195
0.75 mm	5.54 (b,c)	2.03	5.71*(b,c)*	1.99	0.551
1 mm	5.26 (c)	2.06	5.56 *(c)*	1.92	0.289
1.25 mm	4.02 (d)	2.03	4.55*(d)*	2.08	0.070
1.5 mm	3.68 (e)	2.16	4.15 *(e)*	2.17	0.126
Labiolingual translation (profil)					
1.5 mm labial	3.54 (d)	1.95	3.97 *(d)*	1.97	0.122
1 mm labial	4.25 (c)	1.99	4.46 *(c)*	2.02	0.459
0.5 mm labial	5.35 (a)	2.32	5.77 *(a,b)*	2.04	0.175
0 mm (control)	5.66 (a)	2.19	5.97 *(a,b)*	2.04	0.302

† The letters after the values indicate pairwise comparisons of females. Different letters indicate statistically significant differences.
‡ The letters after the values indicate pairwise comparisons of males. Different letters indicate statistically significant differences.
§ SD: standard deviation.
*p<0.05 **p<0.01 ***p<0.001

Table 2. Extended. Gender-based evaluation of scores assigned to photographs of male smiles

	Female		Male		
Measurements (mm/°)	**Mean†**	**SD**	**Mean‡**	**SD**	**p**
0.5 mm lingual	5.63 (a)	2.12	6.04 *(a)*	2.05	0.167
1 mm lingual	5.28 (a)	2.18	5.75 *(a)*	2.00	0.114
1.5 mm lingual	4.79 (b)	2.15	5.31 *(b)*	2.29	0.099
Labiolingual translation (frontal)					
1.5 mm labial	5.11 (c)	1.96	5.38 *(c)*	2.08	0.347
1 mm labial	6.09 (b)	1.92	6.52 *(b)*	1.82	0.105
0.5 mm labial	7.15 (a)	1.93	7.10 *(a)*	1.98	0.857
0 mm (control)	7.10 (a)	1.91	7.30 *(a)*	1.70	0.435
0.5 mm lingual	7.18 (a)	1.96	7.33 *(a)*	1.73	0.566
1 mm lingual	7.10 (a)	1.83	7.02*(a,b)*	1.98	0.767
1.5 mm lingual	7.05 (a)	1.84	6.91 *(a,b)*	1.88	0.596

† The letters after the values indicate pairwise comparisons of females. Different letters indicate statistically significant differences.
‡ The letters after the values indicate pairwise comparisons of males. Different letters indicate statistically significant differences.
§ SD: standard deviation.
*p<0.05 **p<0.01 ***p<0.001

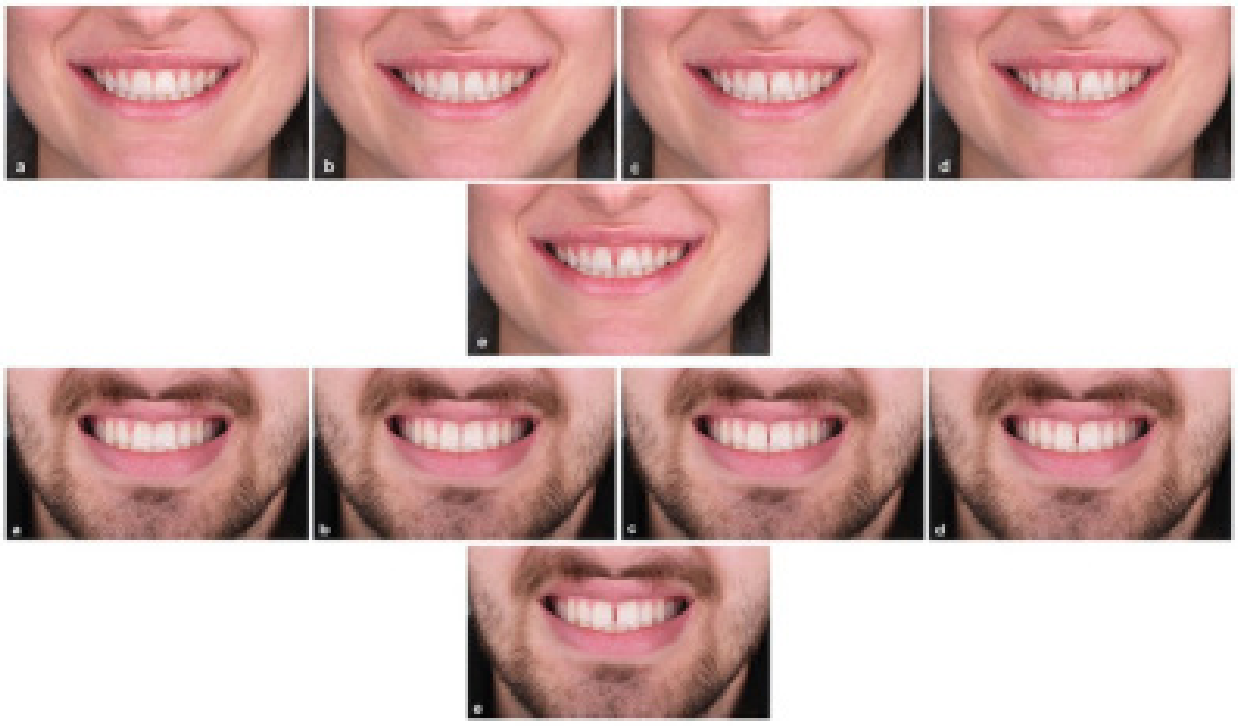

Figure 1. Female and male models showing a gradual (0.5 mm) increase in the level of midline diastema between maxillary central incisors. **a.** 0 mm, control. **b.** 0.5 mm. **c.** 1 mm. **d.** 1.5 mm. **e.** 2 mm.

Figure 2. Female and male models showing a gradual change (5°) in the level of labiolingual inclination of maxillary incisors. **a** +15°. **b** +10°. **c** +5°. **d** 0°, control. **e** -5°. **f** -10°. **g** -15°

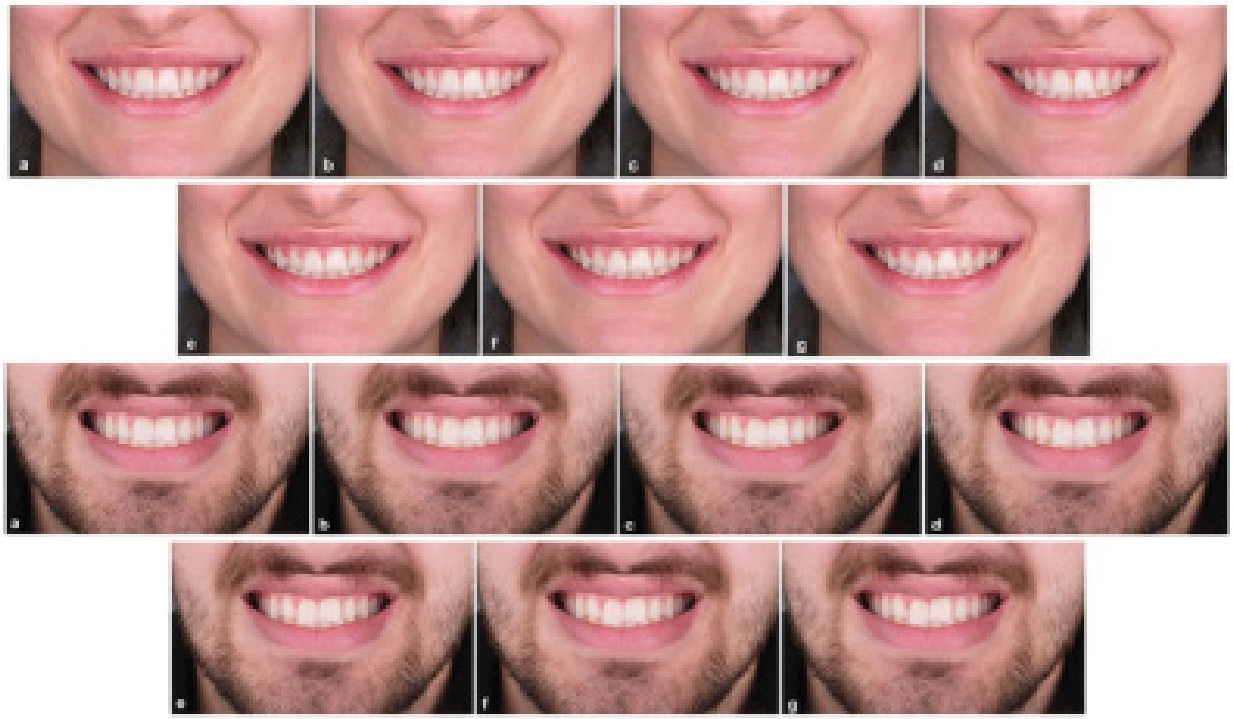

Figure 3. Female and male models showing a gradual increase (0.25 mm) in the level of extrusion of the right maxillary central tooth. **a** 0 mm, control **b** 0.25 mm. **c** 0.5 mm. **d** 0.75 mm. **e** 1 mm. **f** 1.25 mm. **g** 1.5 mm.

Figure 4. Female and male models showing a gradual change (0.5 mm) in the level of labiolingual translation of the right maxillary lateral incisor (profil wiew). **a** +1.5 mm. **b** +1 mm. **c** +0.5 mm. **d** 0 mm, control. **e** -0.5 mm. **f** -1 mm. **g** -1.5

Discussion

Several studies on patient perceptions and attitudes towards post-treatment changes state that mandibular incisor irregularity is the best indicator for awareness of change, and the main factor in discontent is recognizing the increase in maxillary irregularity.[4,13] A possible reason for patient sensitivity regarding this area is that the maxillary anterior teeth stand out aesthetically when smiling. In addition, Karslı et al.[4] found that a change in overbite ranging from 1 to 3 mm was identified as a potential factor influencing requests for retreatment. However, the researchers could not establish whether these requests were prompted by aesthetic concerns or functional issues. Therefore, this study aimed to explore the aesthetic perceptions of patients regarding possible tooth movement and overbite change after orthodontic relapse in the maxillary anterior region. Aesthetic perception of variables can be measured with smile photographs taken from an appropriate angle.[10,14–16] This study utilized smile photographs of both gender in recognition of the fact that a model's gender affects aesthetic perception.[17,18] Furthermore, the photos were cropped to include the lower third of the face to allow evaluators to focus on the smile.[19] The group of participants who evaluated the variables in the photographs consisted only of patients who had undergone orthodontic treatment. As there may be differences in the aesthetic perceptions of individuals with and without experience of orthodontic treatment, individuals without relevant experience were not included in the study.[9] There were significant differences in the aesthetic ratings between male and female participants, with male evaluators providing higher scores. This outcome was in line with research findings that suggest the evaluator's gender plays a role in assessing the attractiveness of smiles.[7,17,20,21] Previous studies on smile aesthetics had predominantly concentrated on assessments of upper anterior teeth.[6,8,12,15,22–24] Furthermore, research examining the impact of tooth wear on the level discrepancy reveals that even a minimal alteration of 0.5- mm in the central incisors might negatively impact the visual appeal of a smile.[16,24] This result

was consistent with our findings regarding change related to extrusion. Furthermore, due to the extrusion of the central tooth, changes occur at both the incisal edge level and the gingival margin level. For laypeople, however, the problem caused by asymmetry at the gingival margin level occurs only in more severe cases.[14,22] Therefore, we believe that the fact that the 0.5-mm extrusion in the study was not rated as attractive is due to the incisal edge asymmetry rather than the change in the gingival margin level. The lingual inclination of incisors is considered to be one of the factors contributing to an unattractive smile.[25] The labial inclination of incisors can lead to unfavorable aesthetic consequences as it reduces teeth appearance while smiling.[26] Furthermore, the increased labial inclination might cause the smile arch to become less curved, leading to a disruption in the alignment between the upper incisor and canine teeth and the lower lip line.[27] Upon assessing the treated cases, Işıksal et al. [28] determined that the improvement of smile aesthetics was negatively impacted by the increase of the U1-SN angle. A different study [12] investigating the impact of tooth position on the attractiveness of a smile determined that alterations in the lingual inclination of the upper incisors were more appealing than alterations in the labial inclination and the outcomes of our investigation validate these findings. In this study, it was shown that higher labial inclinations were generally not considered appealing, with the exception of the female model's 5° labial inclination. The 10° and 15° lingual inclination were found to be aesthetically acceptable in the female and male models, respectively. This variation between the models could be attributed to differences in incisor morphology.[15] In studies where the median diastema level was established at 1 mm, 1.5 mm, and 2 mm, several researchers found that changes within these specified limits were not considered aesthetically displeasing by laypeople.[10,22,23] Abu Alhaija et al.[20] found that any size of median diastema was judged unappealing, however their study did not assess diastemas smaller than 1 mm. However, our findings indicate that even a 0.5-mm diastema was not aesthetically acceptable. This can be explained by the fact that unlike other studies, the evaluation in this study was made by individuals with orthodontic treatment experience.[9] Examination of the effect of overbite change on smile aesthetics indicates that increased overbite is more aesthetically acceptable than limited overbite or open bite, and the minimum and maximum amounts of overbite that can be tolerated by laypeople have been reported as the acceptable range.[11,14,29] The findings of this study were not comparable to previous study findings in terms of the acceptable range due to overbite change amounts (1 mm each). Additionally, findings regarding the female model are not consistent with previous study findings in terms of the maximum tolerable amount of overbite.[11,14,29] Photographs with an overbite of more than 3 mm on the female model and 5 mm on the male model were not found attractive in this study. This finding also indicates that the maximum tolerable amount of overbite differs depending on the model being evaluated. Chang et al.[29] reported that the aesthetic perception of overbite change was not influenced by the gender of a model and facial attractiveness. The variation in dental aesthetics or gingival form of the models might have contributed to a disparity in the aesthetic assessment between male and female models in the present research. The position of the maxillary anterior teeth following orthodontic treatment is a crucial determinant of patient satisfaction.[4,13] Labiolingual translation of the lateral tooth with rotational movement is a tooth movement that can cause irregularities in the incisors.[8,9] A study examining the labiolingual translation of the right and left maxillary lateral teeth in frontal view reports that laypeople are sensitive to 0.5 mm of labial and lingual translation, and the labial position is more unacceptable than the lingual position.[8] However, the results of this study examining the right maxillary lateral tooth did not reveal sensitivity to a 0.5-mm position change in both frontal and profile views in both models. The aesthetic perception could vary based on whether the tooth movement creating irregularity in the upper jaw is occurring on one side or both sides.[9] Therefore, it was not surprising that our findings regarding the frontal view weren't consistent with the previous research. Furthermore, our finding regarding the frontal view of the female model, in which labial and lingual movements at the same distance were evaluated similarly, was not consistent with the findings of a previous study.[8] This study utilized frontal and profile smile images to investigate the perceptions of labiolingual translation of the lateral tooth from various perspectives.[21] The perception of lingual movements varied depending on the perspective being assessed. Considering the exception of median diastema and extrusion, there were variations in the remaining variables among the

models. Although it is reported that the perception of smile aesthetics might be affected by a model's gender,[17,18] the attractiveness of the model's smile, tooth form, gum aesthetics, etc. should not be overlooked. Additionally, as the distracting elements in the face take the focus away from the smile,[19] the beard on the male model may have affected the perception of smile aesthetics. Therefore, it would be sensible to pay attention to these details when selecting models for similar studies. Aesthetic assessments might provide valuable insights into the level of awareness and acceptability of aesthetic factors among orthodontic patients after a relapse. This method allows for a more precise orthodontic approach to be offered to patients both before and after treatment. The main limitation of our study was missing the importance of assessing the mesiodistal inclination of the central incisors and smile line criteria, both of which are crucial aspects that impact the aesthetic appearance of a smile. In the future, a comprehensive study can be undertaken to incorporate and assess these crucial factors that impact the aesthetics of a smile on a larger scale.

Conclusions

The null hypotheses were rejected. The varying genders of the evaluators had an impact on the rankings of smile attractiveness. Participants considered the protrusion of the central incisor and a median diastema of 0.5-mm or greater to be aesthetically unpleasing. Male and female models exhibited divergent participant perceptions regarding changes in overbite, labiolingual inclination of the incisors, and labiolingual translation of the lateral teeth. Participants exhibited poorer tolerance for a limited overbite (0-mm overbite) compared to an increased overbite. The upper incisors exhibited a greater tolerance for changes in lingual inclination compared to labial movement. The evaluation perspective influenced the aesthetic assessment of the labiolingual translation of the upper lateral tooth.

Conflict of interest

None of the authors of this article has any relationship, connection or financial interest in the subject matter or material discussed in the article.

Sources of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for profit sectors.

Authorship Contributions

Idea/Concept: A.H.A Design: A.H.A Control/ Supervision: G.T Literature Review: A.H.A Data Collection and/or Processing: A.H.A, G.T Analysis and/or Interpretation: A.H.A, G.T Writing the Article: A.H.A Critical Review: G.T

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