

COMPARISON OF FACIAL PROFILE CHANGES BEFORE AND AFTER ANTERIOR TEETH RETRACTION FOLLOWING ACTIVE PLATE REMOVABLE ORTHODONTIC TREATMENT: A RETROSPECTIVE PRE-POST PHOTOGRAPHIC ANALYSIS

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ABSTRACT

Introduction: Orthodontic treatment using removable active plates can improve teeth alignment, facial balance, mastication, and speech. Anterior teeth retraction may influence lip position, nasolabial angle, and overall facial harmony, but evidence remains inconsistent. **Aim:** This study compared facial profile changes before and after anterior teeth retraction following active plate removable orthodontic treatment. **Methods:** This retrospective paired pre-post observational study included 22 patients treated at the Dental Hospital of Universitas Muhammadiyah Yogyakarta during 2021–2022. All subjects followed a standardised protocol, using active plates for at least 20 hours daily. Pre- and post-treatment lateral photographs were superimposed in Adobe Photoshop to measure the facial convexity angle (landmarks: soft tissue glabella, upper lip, lower lip, and pogonion). A change greater than 2° was deemed clinically relevant. Data were analysed using the Wilcoxon signed-rank test. **Results:** Of those 22 patients, 59.1% exhibited a reduction in the facial profile convexity angle, and 40.9% showed an increase; however, the difference before and after treatment was not statistically significant (Wilcoxon signed-rank test, $p=0.733$). **Conclusion:** These findings suggest that anterior teeth retraction with removable active plates does not significantly affect the overall facial profile in this cohort. Further research with larger samples, three-dimensional imaging, and longitudinal follow-up is recommended to confirm these results and to explore patient-specific factors influencing soft-tissue response.

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INTRODUCTION

Aesthetics plays an essential role in orthodontic treatment, because the success of this treatment not only affects dental health, but also

the psychosocial aspects of the patient. One of the positive impacts of orthodontic treatment is increased self-confidence through improvements in the aesthetic components of the teeth.¹ A harmonious face is usually achieved if the dental occlusion is in a normal position, namely in the Angle class I relationship between the maxilla and mandible.² For individuals who have facial

disharmony, changes in the soft tissue profile during orthodontic treatment can be important in evaluating treatment outcomes.³ Orthodontists are responsible for achieving optimal occlusion and facial harmony for each individual.⁴

Orthodontic treatment is a procedure that aims to improve the arrangement of teeth, which in turn can improve masticatory, phonetic, and aesthetic functions.⁵ This treatment can be performed using fixed or removable orthodontic appliances, each of which has its own advantages and disadvantages.⁶ Removable orthodontic appliances, which can be installed and removed by the patient, consist of passive and active components, such as acrylic plates, springs, expansion screws, adam clasps, and labial arches.^{7,8,9}

Problems of irregular dental arrangement and poor facial proportions can cause psychosocial disorders, which often worsen an individual's self-image.² In addition, orthodontic treatment can contribute to improving facial and dental aesthetics, which provides significant benefits for patients who experience dental and facial aesthetic problems. Maintaining dental health is also seen as a form of gratitude for the blessings given by God.¹⁰ As stated in QS. Yunus: 57, "Every disease has a cure," and Islam highly respects medicine as a way to improve health.¹⁰

Knowledge about facial malformations caused by disharmonious jaw and tooth relationships is growing. Assessment of the soft tissue facial profile is essential in orthodontic treatment.⁴ In clinical practice, soft tissue examination is an important part of assessing the results of orthodontic treatment, because soft

tissue morphology greatly influences the overall facial profile.¹¹ Changes in the facial profile, especially due to growth and changes in bone tissue, are not always accompanied by comparable changes in the soft tissue.¹²

Orthodontic treatment often involves analysis of the patient's facial profile, which is determined through the use of patient photographs and sagittal plane analysis.¹³ Based on profile analysis, there are three main types, namely orthogonal (straight) profile, convex profile, and concave profile.¹⁴ Changes in teeth relationships, such as anterior teeth retraction, can cause changes in the facial profile, which is often used to plan orthodontic treatment.¹⁵

Meanwhile, some malocclusion conditions, such as Angle's class I, although meeting the criteria for normal dental occlusion, can still cause facial disharmony.¹⁶ For example, Angle's class I malocclusion type, which consists of five subtypes, can affect the facial profile depending on the position of the anterior and posterior teeth.⁷ Similarly, class II and class III malocclusions have certain characteristics that affect the patient's dental occlusion and facial profile.¹⁷

Retraction of anterior teeth in patients with class II division 1 malocclusion can reduce facial convexity, which significantly affects soft tissue and lip profile.² The use of active orthodontic appliances such as labial bows can help in retracting anterior teeth and improving occlusal relationships.¹⁸ Previous studies have shown that retraction of anterior teeth can change the facial profile by pulling the upper lip back, which in turn results in changes in the chin profile.¹² Removable appliances are generally not the first

choice for anterior retraction in adult patients due to their limited ability to achieve complex tooth movements. They may be considered in select cases where minor corrections are needed. Removable appliances can sometimes solve dental problems in a shorter period, especially when patient selection and appliance design are appropriate. Removable appliances allow for easier oral hygiene maintenance, which is particularly important for adults concerned about periodontal health. The relationship between anterior tooth retraction and changes in the soft-tissue facial profile has been extensively studied, including through cephalometric, photogrammetric, and three-dimensional imaging approaches; however, the majority of cases treated with fixed orthodontic appliances involve tooth extraction or bimaxillary protrusion. However, specific evidence on the use of active plates in cases without tooth extraction remains limited. Given the limitations on tooth movement with the removable orthodontic appliances mentioned above, the soft-tissue response may differ from that seen with fixed appliances or with tooth extraction. This gap is the focus of this study, which aims to provide preliminary clinical evidence rather than definitive conclusions.

Based on the description, this study aims to analyze the facial profile changes before and after anterior teeth retraction following active plate removable orthodontic treatment. This study is intended to provide preliminary clinical evidence on the effect of hard-tissue changes on the soft-tissue facial profile. Therefore, the formulation of the problem that arises is whether there are differences in facial profile changes

before and after anterior teeth retraction following active plate removable orthodontic treatment.

METHODS

This study is an analytical observational study with a retrospective paired (pre-post) observational approach to compare the facial profile before and after anterior teeth retraction in removable appliance orthodontic treatment using the Graber method. The study was conducted on patients of the Dental Hospital Education Polyclinic, Universitas Muhammadiyah Yogyakarta (RSGM UMY) who had completed active plate orthodontic treatment with anterior teeth retraction in 2021-2022. This research has received ethical clearance Number: 038/EC-EXEM-KEPK FKIK UMY/III/2024 from the ethics commission of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta.

The population in this study were all initial and final reports in the form of lateral photographs of patients who had undergone active plate orthodontic treatment with maxillary anterior teeth retraction at RSGM UMY. The sampling technique used total sampling, with inclusion criteria, namely patients with Angle class I malocclusion (spacing or malposition of individual teeth), age ≥ 17 years, and patients with active plate orthodontic treatment in 2021-2022. This study is an analytical observational study with a retrospective paired (pre-post) observational approach to compare the facial profile before and after anterior teeth retraction in removable appliance orthodontic treatment using the Graber method. The study was conducted on

patients of the Dental Hospital Education Polyclinic, Universitas Muhammadiyah Yogyakarta (RSGM UMY) who had completed active plate orthodontic treatment with anterior teeth retraction in 2021-2022. This research has received ethical clearance Number: 038/EC. Exclusion criteria included patients with extraction cases and unclear lateral photographs of the facial profile. Based on the Slovin formula with an error rate of 20%, the minimum number of samples required is 19, plus 10% to reduce research errors, so that a minimum sample of 22 pairs of lateral photographs was obtained that met the inclusion and exclusion criteria.

The study was conducted at RSGM UMY located on Jalan HOS Cokroaminoto, Yogyakarta, from January to February 2024. Data collection for this study has obtained permission from the Dental Hospital of the Universitas Muhammadiyah Yogyakarta with No. 359/RSGM-UMY/V/2024, patient data in this study which is the patient's identity will be kept confidential by the researcher to maintain patient privacy and confidentiality of patient identity data.

The facial profile is analyzed using lateral photos that have been given anatomical points (glabella, upper lip, lower lip, and pogonion) to measure the angle of the facial profile degree. Measurements are made using the Adobe Photoshop application through two methods, namely digital superimposition and measurement of the facial profile angle, digital superimposition is by stacking lateral photos before and after treatment and adjusting the reference points on the porion and orbita. All lateral facial photographs were taken using a smartphone

camera. The patient's face is facing straight ahead and aligned with the Frankfurt Horizontal Plane under adequate lighting. The angle measurement method is carried out by comparing the numbers from the results of measuring the degree of the facial profile angle before and after to see how much change occurs. Prior to angle measurement, the measurement scale in Adobe Photoshop was calibrated, and anatomical reference points were identified under the supervision of an orthodontist and a dental radiologist to enhance measurement accuracy and consistency. Lateral photos were analyzed using the ruler tool in Adobe Photoshop by drawing lines from anatomical points to calculate the angle of the facial profile. Furthermore, the superimposition method was carried out to assess changes in the facial profile visually and quantitatively.

Data analysis was performed using the Shapiro-Wilk normality test to determine the distribution of data. Data with normal distribution were analyzed using descriptive statistics in the form of frequency distribution and crosstabulation to see data categories such as changes in convexity angle based on patient gender. For non-normally distributed data, the Wilcoxon test was used to analyze significant changes in facial profiles before and after active plate orthodontic treatment. All analyses were performed using SPSS software, and the results were processed to produce conclusions.

RESULTS

This study compared the facial profile before and after anterior teeth retraction in active plate orthodontic treatment, using secondary data

from the initial and final reports of dental profession patients at the Dental and Oral Hospital of Muhammadiyah University of Yogyakarta. The measurement of the patient's facial profile was carried out using two methods: superimposition and angle measurement using the Adobe Photoshop application. Both methods were used to obtain accurate data. The study sample consisted of 22 pairs of lateral facial profile photos, which were analyzed using SPSS. The results of the data analysis are presented below.

Table 1. Frequency distribution of facial profile disappearance angles

Category	n	%
Decrease of Angle Convexity	13	59,1
Increase in Angle Convexity	9	40,9
Total	22	100,0

Based on Table 1, the results of active plate orthodontic treatment with anterior teeth retraction showed that most subjects experienced a decrease in facial profile convexity, namely 13 subjects (59.1%), while 9 subjects (40.9%) experienced an increase in facial profile convexity.

Table 2. Gender frequency distribution

Category	n	%
Man	5	22,7
Woman	17	77,3
Total	22	100,0

Based on Table 2, the characteristics of the respondents show that the majority of respondents were female, with a total of 17 respondents (77.3%), while there were 5 male respondents (22.7%).

Table 3 illustrates the distribution of changes in the convexity angle based on gender, from a total of 5 male respondents, 3 respondents (60.0%) experienced an increase in the convexity

angle, while 2 respondents (40.0%) experienced a decrease in the convexity angle. In the 17 female respondents, 6 respondents (35.3%) experienced an increase in the convexity angle, while 11 respondents (64.7%) experienced a decrease in the convexity angle.

Table 3. Distribution of changes in convexity angle by gender

Gender	Change of Convexity Angle			Total
		Increase in Convexity Angle	Decrease in Convexity Angle	
Man	n	3	2	5
	%	60,0	40,0	100,0
Woman	n	6	11	17
	%	35,3	64,7	100,0
Total	N	9	13	22
	%	40,9	59,1	100,0

Based on Table 4, the results of the normality test using the Shapiro-Wilk Test show that the active plate treatment data before anterior teeth retraction has a p value = 0.046 ($p < 0.05$), which indicates that the data is not normally distributed. Meanwhile, the active plate treatment data after anterior teeth which indicates that the data is normally distributed. The conclusion of this normality test is that the facial profile comparison data before and after anterior teeth retraction is not normally distributed, so further data analysis uses the Wilcoxon test.

Table 4. Test of normality

Group	Sig.	Information
Before	0.733	No difference
After		

Table 5. Wilcoxon test

Variable	Sig	Limit	Information
Before	0,046	< 0,05	Abnormal
After	0,333	> 0,05	Normal

Table 5 shows that the Wilcoxon test results produce a p value = 0.733 ($p > 0.05$). Based on these results, it can be concluded that

there is no significant difference in the soft tissue facial profile before and after anterior teeth retraction in active plate orthodontic treatment.

DISCUSSION

Based on the frequency distribution data in Table 1, it can be seen that 13 subjects (59.1%) experienced a decrease in the convexity angle of the facial profile after active plate orthodontic treatment with anterior teeth retraction, while 9 subjects (40.9%) experienced an increase in the convexity angle. This indicates that a decrease in the convexity angle occurs more often than an increase.

The results of Table 3 show that most female respondents experienced a decrease in the soft tissue convexity angle of the facial profile (64.7%), while the majority of male respondents experienced an increase in the soft tissue convexity angle of the facial profile (40.9%). This can be explained by the thickness of the soft tissue in men which tends to be thicker than in women. In general, the male facial profile has less convexity than women, because the growth of the male jaw forms a larger angle, causing the male facial profile to be generally straight or concave, while the female facial profile tends to be more convex.¹⁹ Research by Kummer et al. (2024) showed a significant difference in the degree of soft tissue convexity between the sexes, with an average of 159.05 degrees for men and 162.77 degrees for women ($p < 0.05$). This confirms that women tend to have a more convex facial profile than men, which can affect how anterior tooth retraction impacts the overall facial aesthetics.²⁰ Similarly, the gender-related differences described above are drawn from the

existing literature, rather than from direct measurements of the sample in this study; they should therefore be treated with caution.

This study used the Shapiro-Wilk test to test the normality of the data. The results of the normality test presented in Table 4 show that for the facial profile before active plate orthodontic treatment with anterior teeth retraction, the p value = 0.046 ($p < 0.05$), which indicates that the data are not normally distributed. While for the facial profile after treatment, the p value = 0.333 ($p > 0.05$), which indicates that the data are normally distributed. In conclusion, because the data before treatment were not normally distributed, the next statistical test used was the Wilcoxon test.

In Table 5, the results of the analysis using the Wilcoxon test show a P value = 0.733 ($P > 0.05$), which indicates no significant difference in the soft tissue facial profile of the subjects before and after anterior teeth retraction. These results are in line with research conducted by Lu et al. (2020), which showed that incisor retraction in cases of protrusive bimaxillary teeth did not cause significant changes in the soft tissue morphology area, especially around the chin.²¹ Another study by Pudyani & Hanimastuti (2013) also found that there were no significant changes in the nose, upper lip, lower lip, and chin after orthodontic treatment without extraction.²²

These insignificant changes can be caused by several factors. One of them is removable orthodontic appliances that only function optimally if used regularly. Patient compliance in using these appliances greatly affects the treatment results, including achieving the desired facial aesthetics.²³ Patients often experience

discomfort when wearing removable orthodontic appliances, which can reduce compliance and lead to less than optimal treatment results.²⁴ In addition, removable orthodontic appliances can only move teeth in limited movements, such as tipping, which does not allow for extrusion or bodily movements, so that changes in facial profile are more minimal.²³

Nofrizal's (2024) study showed that in cases of bimaxillary dental protrusive, a fairly large anterior teeth retraction is needed to obtain a good facial profile, and additional anchorage is needed to minimize the movement of posterior teeth anteriorly. Orthodontic appliance design with inadequate anchorage can affect the effectiveness of anterior teeth retraction and result in minimal changes in the facial profile.²⁵ Al-Shakhs & Hashim's (2021) study also showed that anterior teeth retraction of 2-3 mm can affect the soft tissue of the facial profile, with a significant ratio between upper incisor retraction and changes in certain points in the soft tissue, such as the superior sulcus, superior labrale, and subnasale.²⁶ Overall, as the removable active plates used in this study primarily produce tilting movements with minimal retraction (less than 4 mm) and are highly dependent on patient compliance, the anterior teeth are likely to undergo much smaller movements compared to treatment with fixed or extraction-based appliances, where greater tooth retraction can be achieved; therefore, the resulting changes in soft-tissue profile are expected to be smaller and often clinically negligible, in line with meta-analysis evidence that the extent of soft-tissue changes is highly dependent on the magnitude of the underlying incisor movement.²⁷

Several other studies have shown that soft tissue responses vary depending on the individual and the design of the orthodontic appliance used. Almrayati et al. (2024) noted that although some designs of removable orthodontic appliances resulted in improvements in facial profiles, such as decreased facial convexity and better lip relationships, many studies did not show significant changes in specific facial tissue morphology, indicating uncertainty in the soft tissue response to removable orthodontic treatment.²⁸

In terms of facial shape analysis, this study used the photogrammetry method, which allows soft tissue facial analysis using 2D photos. One of its advantages is patient comfort, affordable cost, and ease of digital analysis.²⁹ However, the accuracy of this technique is highly dependent on the quality of the images taken. Blurry photos or improper photo taking can affect the measurement results.³⁰ The individual's body position when taking the photo can also affect the dimensions of the facial soft tissue, leading to differences in facial reference points that can cause distortion and inaccuracy in the measurement results.³¹ The latest evidence increasingly suggests that three-dimensional imaging offers greater accuracy and reliability than two-dimensional photography in the assessment of facial soft tissues, thereby supporting its use in future research.³²

It must be acknowledged that cephalometric and 3D analyses of the effects of anterior tooth retraction on the soft-tissue facial profile have been extensively investigated in previous studies, particularly regarding fixed orthodontic appliances. Therefore, the

contribution of this study can be regarded as preliminary, specific clinical evidence on the use of removable active plates in cases without tooth extraction.

CONCLUSION

No statistically significant changes were detected in the soft tissue profile of the face before and after anterior tooth retraction using removable active plates, as assessed by two-dimensional photographic measurements in this small retrospective sample. These findings should be interpreted in light of several limitations, including the small sample size and the use of two-dimensional photographs rather than cephalometric or three-dimensional imaging. Therefore, these results should not be generalised as evidence that anterior tooth retraction with removable active plates does not affect the facial profile. It is recommended that further research be conducted with a larger sample size, three-dimensional imaging, and longitudinal follow-up to confirm these preliminary findings and clarify their clinical implications.

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