DOI: 10.4274/TurkJOrthod.2026.2026.8

TURKISH JOURNAL OF ORTHODONTICS

Original Article

In vivo Evaluation of Gingival Thickness and Gingival Recession after Fixed Orthodontic Treatment in Patients with Normally Positioned Mandibular Incisors

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Cite this article as: Yılmaz AC, Alkan Ö. *In vivo* evaluation of gingival thickness and gingival recession after fixed orthodontic treatment in patients with normally positioned mandibular incisors. *Turk J Orthod.* 2026; 39(3): 161-168

Main Points

- No clinical gingival recession was observed in patients with normally positioned mandibular incisors during the observation period.
- Tooth- and level-specific changes in gingival thickness were detected after fixed orthodontic treatment.
- Labial gingival thickness should be considered during orthodontic treatment planning and periodontal monitoring.

ABSTRACT

Objective: This *in vivo* study evaluated clinical gingival recession and labial gingival thickness following fixed orthodontic treatment in patients with normally positioned mandibular incisors.

Methods: Twenty-six patients (18 females and 8 males; aged 11-25 years) with normally positioned mandibular incisors, defined by an initial 1-NB distance of 3-5 mm, were included. All patients received non-extraction fixed orthodontic treatment with the straight-wire technique. Gingival recession was clinically recorded at treatment onset (T0) and 20 days after appliance removal (T1). Gingival thickness was measured by transgingival probing at two labial sites on each mandibular anterior tooth: one apical to the free gingival groove and one coronal to the mucogingival junction. The T0-T1 changes were analyzed using paired samples t-tests; intergroup gingival thickness comparisons were analyzed using independent samples t-tests or Mann-Whitney U tests, with a Bonferroni correction where appropriate.

Results: The mean treatment duration was 28.26 months. The 1-NB distance increased significantly from 4.05±0.94 mm to 4.67±1.51 mm ($p=0.003$), whereas the 1-NB angle and the incisor mandibular plane angle changes were not significant. No clinical gingival recession was detected at T1. Significant tooth- and level-specific changes in gingival thickness were observed.

Conclusion: Within this sample and observation period, no clinical gingival recession was observed after treatment. However, changes in gingival thickness indicate that labial gingival thickness should be considered during orthodontic treatment planning and periodontal monitoring.

Keywords: Orthodontic appliances-fixed, incisors, gingival recession, gingival thickness

INTRODUCTION

Gingival recession is defined as the apical displacement of the gingival margin beyond the cementoenamel junction, resulting in exposure of the root surface to the oral environment.[1,2] Its clinical relevance includes dentin hypersensitivity, root caries, aesthetic concerns, plaque accumulation, and potential loss of periodontal support in advanced cases.[2-4] The etiology of gingival recession is multifactorial and involves periodontal inflammation, traumatic tooth brushing, aging,

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Received: February 06, 2026 **Accepted:** July 08, 2026 **Publication Date:** September 25, 2026

smoking, abnormal frenulum attachment, reduced width of keratinized tissue, a thin periodontal phenotype, alveolar bone dehiscence or fenestration, malocclusion, and orthodontic tooth movement.[1,4,5] The mandibular anterior region is particularly relevant in patients undergoing orthodontic treatment because gingival recession is frequently observed around the mandibular incisors, which are often positioned within a relatively narrow alveolar envelope.[2,3,6]

From an orthodontic perspective, labial displacement or proclination of mandibular incisors toward the limits of the alveolar bone may reduce labial bone support and increase the susceptibility of the marginal soft tissues to recession.[7-9] Cone-beam computed tomography studies have suggested that increases in mandibular incisor advancement and inclination may be associated with reductions in alveolar bone height and width, particularly when tooth movement exceeds periodontal limits.[8] Nevertheless, the relationship between orthodontic treatment, mandibular incisor inclination, and gingival recession remains controversial because previous studies have reported inconsistent findings.[3,7,10] Some studies have found associations between incisor proclination and gingival recession or reduced periodontal support, whereas others have reported no clinically relevant association between orthodontic tooth movement and gingival recession when periodontal conditions are properly controlled.[3,8-11] A recent prospective controlled study reported a higher incidence rate of gingival recession after fixed orthodontic treatment than in untreated controls, although most recession defects were limited in severity.[12]

Periodontal phenotype, particularly gingival thickness, is an important modifier of periodontal tissue response during orthodontic treatment.[1,5,13] A thin periodontal phenotype has been associated with greater marginal tissue instability and increased susceptibility to gingival recession, especially in the presence of inflammation, mechanical trauma, or tooth movement toward the alveolar limits.[1,2,13] Recent evidence has also shown that bleeding on probing, plaque accumulation, age, and gingival phenotype may influence gingival recession during the post-orthodontic or retention period.[5,14] In addition to soft-tissue parameters, recent radiographic studies have indicated that orthodontic treatment and gingival recession may be associated with changes in alveolar trabecular architecture, supporting the need to consider both periodontal soft tissues and alveolar bone structures in orthodontic–periodontal assessment.[14,15]

Despite this growing body of evidence, many previous studies have focused mainly on the presence or prevalence of gingival recession rather than prospectively evaluating site-specific changes in gingival thickness in the mandibular incisor region.[2,7,10] Moreover, evidence remains limited regarding patients whose mandibular incisors are within normal cephalometric limits at T0; this subgroup is clinically relevant for evaluating periodontal soft-tissue responses to routine orthodontic tooth movement.[2,3,9]

Therefore, the prospective clinical study aims to evaluate changes in gingival recession and labial gingival thickness in patients with normally positioned mandibular incisors prior to fixed orthodontic treatment and to determine whether anterior-posterior positional changes of the mandibular incisors are associated with these periodontal soft-tissue outcomes. The null hypotheses of the present study were as follows: $H0_1$: Positional changes in the mandibular incisors during fixed orthodontic treatment are not associated with development of clinical gingival recession. $H0_2$: Positional changes of the mandibular incisors during fixed orthodontic treatment are not associated with changes in labial gingival thickness measured at the apical level of the free gingival groove and at the coronal level of the mucogingival junction.

METHODS

This prospective, single-center clinical study was conducted at the Department of Orthodontics, Van Yüzüncü Yıl University Faculty of Medicine. A total of 26 patients (18 females and 8 males, aged 11-25 years) who were scheduled to receive fixed orthodontic treatment were enrolled. Prior to inclusion, all participants and the parents or legal guardians of participants aged <18 years were informed in detail about the study procedures and objectives, and written informed consent was obtained. The study was conducted in accordance with the Declaration of Helsinki and approved by the Van Yüzüncü Yıl University Faculty of Medicine Clinical Research Ethics Committee (approval no: 07, date: 23.05.2017).

Based on Cohen's conventional effect-size framework, the available sample of 26 patients was sufficient to detect moderate-to-large within-subject effects at a two-sided significance level of 0.05 with 80% statistical power. This sample size was considered adequate to detect associations of approximately r≥0.50. Accordingly, the study was primarily powered to detect moderate-to-large longitudinal changes; small effects and subgroup comparisons were interpreted with caution.[16]

Eligibility was assessed at T0. Before orthodontic treatment, all patients received standardized oral hygiene instructions and had periodontal health clinically confirmed. Individuals were included if they had clinically healthy periodontal tissues and mandibular incisors normally positioned according to Steiner's cephalometric analysis, with an initial 1-NB distance of 3-5 mm as the operational inclusion criterion.[17] Patients were also required to have complete pre- and post-treatment clinical and radiographic records, and only those whose orthodontic treatment was completed according to the American Board of Orthodontics[18] criteria were included in the final analysis. The exclusion criteria were as follows: pregnancy or lactation; smoking; periodontal pockets >4 mm; anterior crossbite or clinically evident traumatic anterior occlusion at baseline; structural defects of the teeth, crowns or large restorations that could interfere with clinical measurements; congenital anomalies, such as cleft lip and palate; systemic diseases; and the use of medications known to affect periodontal tissues, including immunosuppressive drugs, calcium channel blockers, and anticonvulsants.

Orthodontic Treatment Protocol

All patients were treated without extractions, using fixed orthodontic appliances with 0.018-inch-slot Roth-prescription brackets (Gemini Roth System, 3M Unitek, CA, USA) bonded to both maxillary and mandibular teeth. Leveling and alignment were performed sequentially with 0.012-, 0.014-, and 0.016-inch nickel-titanium archwires. Subsequently, 0.016×0.016-inch and 0.016×0.022-inch nickel-titanium archwires were used to express the prescribed bracket tip and torque values. Maxillary and mandibular elastics were used when clinically indicated. In the finishing phase, 0.016×0.016-inch and 0.016×0.022-inch stainless steel archwires were used, and vertical elastics were applied in the anterior or posterior regions when necessary.

Evaluation of Gingival Recession

Gingival recession was clinically evaluated at the beginning of orthodontic treatment (T0) and 20 days after the completion of active fixed orthodontic treatment and the removal of the fixed appliances (T1). All clinical evaluations were performed by the same examiner. Gingival recession was defined as the apical displacement of the gingival margin relative to the cementoenamel junction. Cases in which the cementoenamel junction was clinically visible due to apical migration of the gingival margin were recorded as having gingival recession. Sites without clinical exposure of the cementoenamel junction were recorded as 0.

Measurement of Gingival Thickness

Gingival thickness in the mandibular anterior region was evaluated by a single examiner at T0 and T1. Measurements were performed in the mandibular canine-to-canine region at two standardized labial points for each tooth: the apical level of the free gingival groove and the coronal level of the mucogingival junction.

After marking the measurement points with a marker pen, a topical xylocaine spray (Vemcain 10% Lidocaine, Vem İlaç Sanayi ve Ticaret Ltd Şti, Türkiye) was applied to improve patient comfort. When local anesthesia was required, a local anesthetic solution (Maxicaine, lidocaine hydrochloride) was injected slowly (Maxicaine, lidocaine hydrochloride, Vem İlaç Sanayi ve Ticaret Ltd Şti, Türkiye) in a limited volume of 0.1 mL to minimize anesthesia-related changes in mucosal volume. In these cases, gingival thickness measurements were performed 10-20 minutes after injection.

Measurements were performed using a size 10 endodontic spreader (G-Star Medical Co., Ltd., Guangdong, China) with a silicone stopper (Figure 1). The spreader was inserted perpendicular to the gingival surface at the marked points until a light contact with the alveolar bone was felt. Care was taken to apply only light pressure, because excessive force could cause the spreader to pass beyond the soft tissue and penetrate into the alveolar bone. Penetration depth was recorded as the distance between the tip of the spreader and the silicone stopper, measured using a digital caliper with a resolution of 0.01 mm (Figure 2).

To assess intra-examiner reliability, the same examiner repeated gingival thickness measurements in five patients during the same anesthetic period after a 10-minute interval. This interval was chosen to avoid additional patient discomfort and to maintain comparable local clinical conditions. Intraclass correlation coefficients were calculated to assess measurement reproducibility.

Cephalometric Evaluation of Mandibular Incisor Position

Lateral cephalometric radiographs obtained at T0 and T1 were used to evaluate the anteroposterior positional changes of the mandibular incisors. The radiographs were imported into the cephalometric analysis software (Nemoceph® NX 2005, Nemotec, Madrid, Spain), and image calibration was performed before tracing and measurement. All cephalometric measurements were performed by the same investigator using the same software and measurement protocol.

The most anterior mandibular incisor at baseline was used as the reference tooth for sagittal and angular measurements. Positional and angular changes in the mandibular incisors were calculated by comparing measurements obtained at T0 and T1. The cephalometric parameters used for this evaluation were the 1-NB distance (mm) and the 1-NB angle, both according to Steiner's analysis, and the incisor mandibular plane angle (IMPA) according to Tweed's analysis.

Statistical Analysis

Statistical analyses were performed using SPSS version 23 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean, standard deviation, median, minimum, and maximum values. Intra-examiner reliability of gingival thickness measurements was assessed using intraclass correlation coefficients based on repeated measurements obtained from five patients. The normality of continuous variables was assessed using the Shapiro-Wilk test and visual inspection of Q-Q plots. Within-subject comparisons between T0 and T1 were performed using the paired samples t-test. Comparisons between independent groups were performed using the independent samples t-test or the Mann-Whitney U test, according to the distributional characteristics of the variables. For multiple site-specific comparisons of gingival thickness, the Bonferroni correction was applied where appropriate. Because gingival recession values were recorded as 0 at both T0 and T1, no inferential statistical comparison was performed for this variable. Statistical significance was set at $p<0.05$.

RESULTS

The intra-examiner reliability of gingival thickness measurements was excellent. The intraclass correlation coefficient calculated from repeated measurements in five patients was 0.994, with a 95% confidence interval of 0.987-0.997.

A total of 26 patients were included in the study: 18 women and 8 men. The mean age at T0 was 16.32±3.67 years, and the mean age at the end of treatment was 18.68±3.71 years. The mean duration of orthodontic treatment was 28.26 months (Table 1).

Descriptive cephalometric measurements obtained at T0 and T1 are presented in Table 2. The mean 1-NB distance increased from 4.05±0.94 mm at T0 to 4.67±1.51 mm at T1. The mean 1-NB angle remained almost unchanged, changing from 24.90°±3.84° at T0 to 24.92°±5.04° at T1. The mean IMPA angle decreased slightly from 92.77°±5.66° at T0 to 92.37°±7.13° at T1. Because changes were calculated as T0 minus T1, the mean changes were -0.62 mm for 1-NB distance, -0.03° for 1-NB angle, and 0.39° for IMPA.

Clinical gingival recession was not detected in any mandibular anterior tooth at either T0 or T1. Therefore, all gingival recession values were recorded as 0 at both time points, and no inferential statistical comparison was performed for this variable.

Gingival thickness values by tooth region, measurement level, and direction of mandibular incisor positional change are presented in Table 3. Patients were categorized as having proclined (n=14) or retroclined (n=12) mandibular incisors, based on the direction of positional change during treatment. At the apical level of the free gingival groove, the retroclined group showed statistically significant changes from T0 to T1 for teeth 33, 31, and 41. At this level, an intergroup difference at T1 was observed for tooth 32, with lower gingival thickness in the proclined group than in the retroclined group.

At the coronal level of the mucogingival junction, gingival thickness for tooth 32 in the proclined group decreased significantly from T0 to T1. In the retroclined group, significant decreases were observed for teeth 32 and 42. In addition, baseline gingival thickness at the mucogingival junction differed significantly between the proclined and retroclined groups for tooth 32. No other site-specific comparisons showed statistically significant differences after the applied statistical testing.

DISCUSSION

This prospective clinical study evaluated changes in clinical gingival recession and labial gingival thickness in patients with normally positioned mandibular incisors prior to fixed orthodontic treatment. The main findings were that no clinical gingival recession was detected in the mandibular anterior region at the end of active treatment, whereas site-specific changes in gingival thickness were observed at both the apical level of the free gingival groove and the coronal level of the mucogingival junction. In addition, the mean 1-NB distance increased significantly during treatment, whereas changes in the 1-NB angle and IMPA were limited. Based on these findings, the first null hypothesis was accepted, whereas the second was partially rejected.

The absence of clinical gingival recession in the mandibular anterior region at the end of active fixed orthodontic treatment indicates that no apical displacement of the gingival margin

Table 1. Demographic characteristics and treatment duration of the study sample

		Mean	SD	Min	Max
Female (n=18)	Age at T0 (y)	17.01	4.04	10.92	23.00
	Age at T1 (y)	19.39	4.08	13.11	26.06
	Treatment duration (mo)	28.46	6.17	15.18	37.72
Male (n=8)	Age at T0 (y)	14.77	2.14	12.42	18.25
	Age at T1 (y)	17.09	2.11	14.63	20.16
	Treatment duration (mo)	27.81	3.17	22.90	33.25
Total (n=26)	Age at T0 (y)	16.32	3.67	10.92	23.00
	Age at T1(y)	18.68	3.71	13.11	26.06
	Treatment duration (mo)	28.26	5.65	15.18	37.72

T0, beginning of orthodontic treatment; T1, end of active fixed orthodontic treatment; y, years; mo, months; SD, standard deviation; Min, minimum; Max, maximum.

Table 2. Cephalometric measurements of mandibular incisor position at T0 and T1

Variable	T0 Mean ± SD	T1 Mean ± SD	Change Mean ± SD	t	p
1-NB distance, mm	4.05±0.94	4.67±1.51	-0.62±0.95	-3.33	**0.003**
1-NB angle, °	24.90±3.84	24.92±5.04	-0.03±4.45	-0.03	0.973
IMPA, °	92.77±5.66	92.37±7.13	0.39±4.28	0.46	0.646

All p-values were calculated using the paired samples t-test. Change was calculated as T0-T1; therefore, negative values indicate an increase from T0 to T1. Statistical significance was set at (p<0.05).
T0, beginning of orthodontic treatment; T1, end of active fixed orthodontic treatment; SD, standard deviation; IMPA, incisor mandibular plane angle.

Table 3. Gingival thickness changes according to mandibular incisor movement direction

Measurement level	Tooth	Proclined group T0	Proclined group T1	Retroclined group T0	Retroclined group T1	Significant comparison
Apical to the free gingival groove	33	0.62±0.21 (0.36-1.00)	0.66±0.18 (0.50-1.15)	0.59±0.15 (0.40-0.94)	0.78±0.19 (0.48-1.04)	†
	32	0.69±0.16 (0.40-1.00)	0.68±0.16 (0.43-0.89)	0.70±0.20 (0.46-1.08)	0.81±0.17 (0.43-0.99)	§
	31	0.74±0.16 (0.50-0.99)	0.70±0.15 (0.50-1.00)	0.67±0.13 (0.46-0.94)	0.77±0.19 (0.38-1.12)	†
	41	0.73±0.23 (0.37-1.07)	0.74±0.21 (0.46-1.12)	0.72±0.16 (0.40-0.92)	0.83±0.18 (0.63-1.14)	†
	42	0.79±0.21 (0.49-1.04)	0.71±0.13 (0.46-0.92)	0.77±0.21 (0.48-1.07)	0.84±0.17 (0.45-1.05)	-
	43	0.63±0.22 (0.33-1.10)	0.67±0.18 (0.46-1.05)	0.65±0.25 (0.30-1.35)	0.71±0.20 (0.35-1.05)	-
Coronal to the mucogingival junction	33	0.66±0.27 (0.35-1.30)	0.61±0.16 (0.44-0.96)	0.63±0.20 (0.35-1.01)	0.67±0.22 (0.37-1.04)	-
	32	0.67±0.19 (0.45–1.04)	0.55±0.09 (0.45-0.78)	0.86±0.20 (0.60-1.26)	0.61±0.25 (0.38-1.35)	*†‡
	31	0.69±0.23 (0.27-1.04)	0.68±0.12 (0.42-0.84)	0.78±0.18 (0.44-1.07)	0.64±0.20 (0.38-1.14)	-
	41	0.71±0.24 (0.31-1.04)	0.68±0.17 (0.25-0.88)	0.81±0.20 (0.48-1.08)	0.70±0.31 (0.37-1.47)	-
	42	0.75±0.29 (0.25-1.20)	0.68±0.26 (0.35-1.11)	0.89±0.23 (0.52-1.30)	0.66±0.23 (0.28-1.21)	†
	43	0.58±0.20 (0.30-1.04)	0.63±0.17 (0.26-0.91)	0.67±0.30 (0.33-1.51)	0.67±0.19 (0.41-1.15)	-

Values are presented as mean ± standard deviation (minimum-maximum).
*A significant difference was observed between T0 and T1 in the proclined group.
†Significant difference between T0 and T1 in the retroclined group.
‡Significant difference between the proclined and retroclined groups at T0.
§Significant difference between the proclined and retroclined groups at T1.
Statistical significance was set at $p<0.05$ after the Bonferroni correction, where appropriate.
T0, beginning of orthodontic treatment; T1, end of active fixed orthodontic treatment.

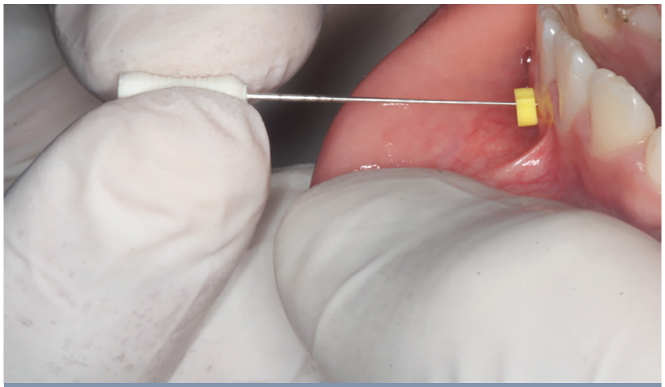

Figure 1. Transgingival probing using a 10-gauge endodontic spreader.

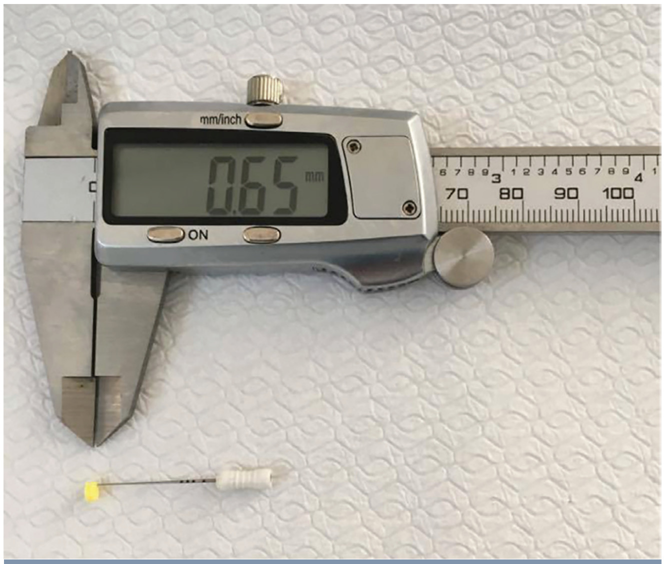

Figure 2. Digital caliper with 0.01 mm precision and endodontic spreader of 10- gauge.

was clinically detectable in this specific group of patients who had healthy periodontal tissues and normally positioned mandibular incisors at baseline. However, this finding should not be interpreted as evidence that fixed orthodontic treatment has no effect on gingival recession risk in general. Gingival recession is a multifactorial condition influenced by periodontal phenotype, baseline periodontal status, oral hygiene, inflammation, age, traumatic tooth brushing, alveolar bone support, and the length of the observation period.[2,5] Recent systematic reviews and controlled studies have shown that the relationship between orthodontic treatment and gingival recession remains controversial, with some studies reporting an increased risk after treatment and others finding no clinically relevant association, particularly when periodontal conditions are controlled.[3,10,12] Therefore, the absence of gingival recession in the present study should be interpreted within the limitations of the sample size, the baseline periodontal health of the patients, the normally positioned mandibular incisors at treatment onset, and the fact that periodontal evaluation was performed at the end of active treatment rather than after long-term retention.

One of the clinically relevant findings of the present study was that site-specific changes in gingival thickness were observed in the mandibular anterior region despite the absence of clinical gingival recession. This finding suggests that evaluating periodontal soft-tissue response only by the presence or absence of gingival recession may not fully reflect the tissue alterations occurring during fixed orthodontic treatment. Gingival thickness is an important component of the periodontal phenotype; a thin phenotype has been associated with increased susceptibility to marginal tissue instability, particularly in the presence of inflammation, mechanical trauma, or tooth movement toward the limits of the alveolar bone.[1,2,13] Therefore, reductions in gingival thickness may not necessarily result in short-term clinical gingival recession; however, they should be considered during periodontal risk assessment, especially when labial movement of the mandibular incisors is planned. The site-specific changes observed in the present study indicate that the periodontal soft-tissue response to mandibular incisor movement may vary according to tooth region and measurement level.

Although the 1-NB distance increased significantly during treatment, the limited changes observed in the 1-NB angle and IMPA suggest that mandibular incisor movement was characterized mainly by mild sagittal positional change rather than by marked proclination. Therefore, the present findings should be interpreted primarily in patients whose mandibular incisors were normally positioned at baseline and who did not undergo substantial protrusion or retrusion during treatment. This does not reduce the clinical relevance of the study, but it limits the direct generalizability of the findings to cases in which the periodontal boundaries are challenged by marked labial displacement of the mandibular incisors. Previous studies have suggested that mandibular incisor advancement or proclination toward the anatomical limits of the alveolar bone may be associated with reduced alveolar bone height and width, dehiscence formation, or increased risk of gingival recession in susceptible patients Matsumoto et al.;[8] Lee et al.;[11] Kalina et al.[9] Accordingly, the absence of gingival recession in the present sample should not eliminate the need for careful evaluation of periodontal phenotype and alveolar bone limits, particularly when greater mandibular incisor protrusion is planned.

The site-specific changes in gingival thickness observed in the present study are partly consistent with previous evidence that gingival thickness may change after fixed orthodontic treatment. Alkan et al.[19] reported decreases in gingival thickness in maxillary and mandibular anterior teeth after fixed orthodontic treatment but found no consistent significant association between sagittal tooth movement and gingival thickness changes. This finding suggests that changes in gingival thickness may not be explained solely by the amount or direction of sagittal incisor movement. Similarly, in the present study, changes in gingival thickness were not uniformly distributed across all mandibular anterior teeth but were more evident at specific teeth and measurement levels. This site-specific pattern may reflect the influence of baseline gingival thickness, local alveolar bone morphology, tooth position, and regional soft-tissue characteristics on the periodontal response to orthodontic tooth movement.

That the observed changes in gingival thickness did not progress to clinical gingival recession may suggest a degree of short-term adaptation of the periodontal soft tissues during active orthodontic treatment. Nevertheless, in individuals with a thin periodontal phenotype, limited labial bone support may reduce the stability of the marginal tissues, particularly when additional factors such as inflammation, plaque accumulation, or traumatic tooth brushing are present.[1,5,13] Therefore, when labial movement of mandibular incisors is planned, treatment planning should not rely solely on cephalometric incisor position but should also include assessment of gingival thickness, keratinized tissue dimensions, plaque control, bleeding on probing, and the anatomical limits of the alveolar bone.[2,12,20] The present findings suggest that clinical gingival recession may not occur by the end of active treatment in patients with normally positioned mandibular incisors and healthy periodontal tissues at baseline; however, site-specific reductions in gingival thickness should still be considered relevant in periodontal risk assessment.

A strength of the present study is its prospective clinical design, which allowed periodontal soft-tissue changes to be evaluated before and after fixed orthodontic treatment in the same patients. The inclusion of patients with normally positioned mandibular incisors at baseline provided a well-defined clinical sample that allowed assessment of the periodontal response to limited positional changes of the mandibular incisors. Another methodological strength was that gingival thickness was quantitatively assessed by transgingival probing rather than by visual inspection or probe transparency alone, since direct measurement methods provide a more objective evaluation of soft-tissue thickness.[19,21] In addition, measurements were performed at two standardized levels in the mandibular canine-to-canine region, allowing changes in gingival thickness to be evaluated by both tooth region and measurement level. The excellent intra-examiner reliability observed in the present study further supports the reproducibility of the gingival thickness measurements.

Study Limitations

Several limitations should be acknowledged. First, the sample size was relatively small, and no untreated control group was included. Therefore, the observed soft-tissue changes cannot be attributed solely to orthodontic treatment or distinguished from growth-related changes, age-related tissue alterations, or individual variability in periodontal response. Second, periodontal evaluation was performed at the end of active orthodontic treatment, and the long-term retention period was not included in the evaluation. Although patients with anterior crossbite or clinically evident traumatic anterior occlusion at baseline were excluded, detailed quantitative measurements of overjet and overbite were not systematically analyzed. Therefore, the possible influence of anterior occlusal relationships on periodontal outcomes should be considered when interpreting the results. Because gingival recession may develop or progress over time, longer follow-up studies are required to clarify the post-treatment periodontal response Morris et al.;[3] Gebistorf et al.;[4] Pernet et al.[6] Third, although all patients received standardized oral hygiene instructions and periodontal health was clinically confirmed before treatment, detailed periodontal variables, such as plaque index, bleeding on probing, clinical attachment level, and toothbrushing habits, were not systematically analyzed. In addition, frenulum tension in the mandibular anterior region and Pg-NB measurements were not evaluated. Mandibular incisor position was assessed on lateral cephalometric radiographs using the most anterior mandibular incisor as the reference tooth, which precluded analysis of individual three-dimensional positional changes of all mandibular incisors. Accordingly, the present findings should be interpreted primarily for periodontally healthy patients with normally positioned mandibular incisors at baseline.

Future studies should include larger samples, untreated or matched control groups, and long-term follow-up throughout the retention period to clarify the relationship between mandibular incisor movement and periodontal soft-tissue changes. In addition, systematic assessment of periodontal variables such as plaque index, bleeding on probing, clinical attachment level, keratinized tissue width, toothbrushing habits, and frenulum tension would help identify patient- and site-related factors associated with gingival recession risk.[2,5,12] Three-dimensional evaluation of alveolar bone boundaries may also strengthen periodontal risk assessment, particularly in patients for whom mandibular incisor protrusion is planned.[8,11] Overall, the present findings suggest that clinical gingival recession may not be observed at the end of fixed orthodontic treatment in periodontally healthy patients with normally positioned mandibular incisors; however, site-specific changes in gingival thickness may still occur and should be considered during orthodontic treatment planning and periodontal monitoring.

CONCLUSION

Within the limitations of this prospective clinical study, no clinical gingival recession was observed in the mandibular anterior region at the end of active fixed orthodontic treatment in patients whose mandibular incisors were normally positioned at baseline. However, site-specific changes in gingival thickness were detected at different teeth and at different measurement levels, suggesting that periodontal soft-tissue alterations may occur even in the absence of clinically detectable gingival recession. These findings indicate that labial gingival thickness should be considered during orthodontic treatment planning and periodontal monitoring, particularly when mandibular incisor positional changes are expected. Further controlled studies with larger sample sizes and long-term follow-up of retention period are needed to determine the clinical relevance of changes in gingival thickness and their potential association with future gingival recession.

Ethics

Ethics Committee Approval: The study procedures were approved by the Van Yüzüncü Yıl University Faculty of Medicine Clinical Research Ethics Committee (approval no: 07, date: 23.05.2017).

Informed Consent: Signed informed consent forms were obtained.

Footnotes

Author Contributions: Concept - A.C.Y., Ö.A.; Design - Ö.A.; Data Collection and/or Processing - A.C.Y.; Analysis and/or Interpretation - A.C.Y., Ö.A.; Literature Search - A.C.Y.; Writing - A.C.Y., Ö.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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

REFERENCES

1. Rasperini G, Acunzo R, Cannalire P, Farronato G. Influence of periodontal biotype on root surface exposure during orthodontic treatment: a preliminary study. *Int J Periodontics Restorative Dent.* 2015;35(5):665-675. [CrossRef]
2. Cadenas de Llano-Pérula M, Castro AB, Danneels M, Schelfhout A, Teughels W, Willems G. Risk factors for gingival recessions after orthodontic treatment: a systematic review. *Eur J Orthod.* 2023;45(5):528-544. [CrossRef]
3. Morris JW, Campbell PM, Tadlock LP, Boley J, Buschang PH. Prevalence of gingival recession after orthodontic tooth movements. *Am J Orthod Dentofacial Orthop.* 2017;151(5):851-859. [CrossRef]
4. Gebistorf M, Mijuskovic M, Pandis N, Fudalej PS, Katsaros C. Gingival recession in orthodontic patients 10 to 15 years posttreatment: a retrospective cohort study. *Am J Orthod Dentofacial Orthop.* 2018;153(5):645-655. [CrossRef]
5. Gül İ, Çolak R, Cicek O. Evaluation of the effect of periodontal health and orthodontic treatment on gingival recession: a cross-sectional study. *BMC Oral Health.* 2025;25(1):1069. [CrossRef]
6. Pernet F, Vento C, Pandis N, Kiliaridis S. Long-term evaluation of lower incisors gingival recessions after orthodontic treatment. *Eur J Orthod.* 2019;41(6):559-564. [CrossRef]
7. Tepedino M, Franchi L, Fabbro O, Chimenti C. Post-orthodontic lower incisor inclination and gingival recession-a systematic review. *Prog Orthod.* 2018;19(1):17. [CrossRef]
8. Matsumoto K, Sherrill-Mix S, Boucher N, Tanna N. A cone-beam computed tomographic evaluation of alveolar bone dimensional changes and the periodontal limits of mandibular incisor advancement in skeletal class II patients. *Angle Orthod.* 2020;90(3):330-338. [CrossRef]
9. Kalina E, Zadurska M, Górski B. Postorthodontic lower incisor and canine inclination and labial gingival recession in adult patients : a prospective study. *J Orofac Orthop.* 2021;82(4):246-256. [CrossRef]
10. Bin Bahar BSK, Alkhalidy SR, Kaklamanos EG, Athanasiou AE. Do orthodontic patients develop more gingival recession in anterior teeth compared to untreated individuals? A systematic review of controlled studies. *Int Orthod.* 2020;18(1):1-9. [CrossRef]
11. Lee JB, Baek SJ, Kim M, Pang EK. Correlation analysis of gingival recession after orthodontic treatment in the anterior region: an evaluation of soft and hard tissues. *J Periodontal Implant Sci.* 2020;50(3):146-158. [CrossRef]
12. Kloukos D, Koukos G, Pandis N, Doulis I, Stavropoulos A, Katsaros C. Effect of orthodontic treatment with fixed appliances on the

development of gingival recession. A prospective controlled study. *Eur J Orthod*. 2025;47(3):cjaf022. [CrossRef]

13. Amid R, Kadkhodazadeh M, Moscowchi A, et al. Effect of gingival biotype on orthodontic treatment-inducedperiodontal complications: a systematic review. *J Adv Periodontol Implant Dent*. 2020;12(1):3-10. [CrossRef]
14. Küçükoğlu Çolak M, Çolak R, Cicek O. Fractal dimension analysis of mandibular trabecular architecture in gingival recession during orthodontic retention: a cross-sectional study. *Diagnostics*. 2025;15(8):1013. [CrossRef]
15. Çiçek O, Yılmaz H, Melayim H. Evaluation of changes in alveolar bone remodeling after orthodontic treatment using fractal analysis: a retrospective study. *Int Dent Res*. 2024;14(1):19-26. [CrossRef]
16. Cohen J. Statistical power analysis for the behavioral sciences. *(2nd ed.). Routledge; New York. 1988*. [CrossRef]
17. Steiner CC. Cephalometrics for you and me. *American Journal of Orthodontics*. 1953;39(10):729-755. [CrossRef]
18. Casko JS, Vaden JL, Kokich VG, et al. Objective grading system for dental casts and panoramic radiographs. American Board of Orthodontics. *Am J Orthod Dentofacial Orthop*. 1998;114(5):589-599. [CrossRef]
19. Alkan Ö, Kaya Y, Tunca M, Keskin S. Changes in the gingival thickness and keratinized gingival width of maxillary and mandibular anterior teeth after orthodontic treatment. *Angle Orthod*. 2021;91(4):459-467. [CrossRef]
20. Allais D, Melsen B. Does labial movement of lower incisors influence the level of the gingival margin? A case-control study of adult orthodontic patients. *Eur J Orthod*. 2003;25(4):343-352. [CrossRef]
21. Frost NA, Mealey BL, Jones AA, Huynh-Ba G. Periodontal biotype: gingival thickness as it relates to probe visibility and buccal plate thickness. *J Periodontol*. 2015;86(10):1141-1149. [CrossRef]