

Original research article

# A prospective clinical evaluation of fixed retainer failures

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## ABSTRACT

**OBJECTIVE:** The aim of this prospective study was to evaluate the failure rate of fixed lingual retainers and to determine the distribution of these failures over a 6-month period.

**MATERIALS AND METHOD:** One hundred and fifty consecutively treated patients (92 females and 58 males, mean age of  $14.89 \pm 1.08$  years) who received canine-to-canine fixed lingual retainers after active orthodontic treatment were followed up for 6 months. A 0.0215-inch five-stranded wire (PentaOne, Maseel Orthodontics) was bonded to the teeth using Transbond LR (3M Unitek) adhesive. The patients were examined in the 1st, 3rd, and 6th months after retention. The retainer failures during the 6-month observation period were registered, and statistically analyzed using a Cochran's Q test at a significance level of  $p < 0.05$ .

**RESULTS:** Retainer failures were seen in 14 patients, and the total failure rate was 9.3%. The highest failure rate was seen in the first month ( $p < 0.05$ ). The female patients exhibited a higher failure rate than the male patients ( $p < 0.05$ ), and three patients had repeated failures. The failure rate was higher in the mandible when compared with the maxilla ( $p < 0.05$ ), and in the right quadrant for both the maxilla and the mandible. The total survival rate was 90.7%.

**CONCLUSION:** The result of this study revealed that higher number of failures occurred in the first month of fixed retention. Therefore, regular clinical controls are necessary to determine bonding failures.

**KEYWORDS:** Orthodontic retainers; relapse; survival rate

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## INTRODUCTION

Post-orthodontic retention is one of the most difficult challenges faced by an orthodontist. Retention is often necessary after active orthodontic tooth movement to maintain the teeth in their corrected positions<sup>1</sup> and prevent the tendency of the teeth to return to their initial positions.<sup>2</sup> The origin of relapse relates to a number of factors, including the periodontal and gingival forces, occlusal factors, orofacial soft tissue forces, and post-treatment facial growth and development.<sup>3</sup> However, there is no consensus about a uniform system of retention in the literature, and a patient-specific retention regime should be determined by the orthodontist.<sup>4</sup>

Post-orthodontic retention can be achieved using various types of removable or fixed retainers. One of the most commonly used methods of retention is the bonded lingual retainer,<sup>5</sup> which has been in popular use since the late 1970s.<sup>6</sup> In the construction of bonded lingual retainers, many different wire types and composites have been used. They are typically made of a thick (usually 0.032-inch) round plain blue Elgiloy wire with a loop at each end bonded only to the canines, a thick (0.032-inch) round spiral wire bonded only to the canines, or a thin (usually 0.0195-inch or 0.0215-inch) flexible spiral wire bonded to each tooth at the anterior segments, rather than only to the two terminal dental units.<sup>7,8</sup> Those retainers bonded to six teeth have been thought to be more effective in preventing relapse.<sup>9</sup> This type of bonded lingual retainer is used to prevent the spaces from reopening and rotational relapse. The flexibility of the wire allows the physiological movement of the teeth; therefore, any stress concentration in the composite, and subsequent fracture, is eliminated.<sup>10</sup>

The major advantage of bonded lingual retainers is that they are patient compliance free. Additionally, they are invisible and more acceptable to the patient for long-term wear. One major disadvantage is that the placement procedure is time-consuming, and the technique is sensitive.<sup>7,11,12</sup> One of the technique-related

problems is frequent bond failure. It is believed that these failures are due to some degree of distortion during the setting of the adhesive, leading to a decrease in the bond strength, the use of too little adhesive, or direct trauma to the retainer.<sup>7</sup>

Several studies have investigated the survival rates of bonded lingual retainers,<sup>7,12-16</sup> with previously reported overall failure rates ranging from 10.3%<sup>12</sup> to 50%.<sup>14</sup> The failure rates differ in those studies according to the materials used to construct the retainer, the type of retainer, and the follow-up period. It has been reported that the failure rate is the highest within the first 6 months after bonding.<sup>13,15</sup> However, the number of prospective studies investigating the survival of bonded lingual retainers in both the lower and upper jaws is limited.<sup>17,18</sup>

Thus, the aim of the present study was to evaluate the failure rate of bonded lingual retainers in both the lower and upper jaws prospectively, and to determine the distribution of those failures over a 6-month period.

## MATERIALS AND METHOD

Ethical approval for this study was obtained from the Ethical Committee of the Faculty of Dentistry of Selçuk University in Turkey (document no: 2012/09), and written informed consent was obtained from the patients or their parents. This prospective study was conducted between December 2012 and November 2013 at the Department of Orthodontics, Selçuk University, with 150 consecutively treated patients (92 females and 58 males, mean age of 14.89±1.08 years) who received canine-to-canine lingual retainers bonded to the lingual surfaces of both the maxillary and mandibular anterior teeth after active orthodontic treatment. These patients had various types of malocclusions and were treated by different orthodontists. The patient selection criteria were the presence of all maxillary and mandibular incisor and canine teeth, adequate oral hygiene, the absence of premature contact with the upper retainer, and no active caries, restorations, fractures, or periodontal disease.

### Bonding procedure

After the removal of the orthodontic appliances, maxillary and mandibular alginate impressions were taken, and plaster models were fabricated. The lingual retainers, consisting of 0.0215-inch five-stranded stainless steel wire (PentaOne, Masel Orthodontics, Carlsbad, CA, USA) were bent initially on the plaster models by the same orthodontic dental technician. The lingual retainers were bonded to the anterior 6 teeth of both the maxilla and mandible according to the following sequences:

1. The lingual surfaces of the teeth were cleaned and polished using oil-free powder pumice, then rinsed with water and dried with compressed air.
2. A cheek and lip retractor was placed. The teeth were isolated with a saliva ejector and cotton rolls.

3. The lingual surfaces of the teeth were etched with 37% orthophosphoric acid (Etch Royale; Pulpdent Corporation, Watertown, MA, USA) for 30 sec, rinsed thoroughly, and dried.

4. After obtaining a chalky white appearance, Transbond XT primer (3M Unitek, Monrovia, CA, USA) was applied and light-cured with an Elipar-S10 light emitting diode curing light (3M Unitek) for 20 sec.

5. Small amounts of Transbond LR adhesive (3M Unitek) were applied to the lingual surfaces of the six anterior teeth, and the lingual retainer was fitted in place. The adhesive was light-cured.

6. A little more adhesive was added on the lingual retainer to cover the wire surface and its ends, resulting in a smooth surface. It was light-cured on incisal surface for 40 sec per tooth.

7. The surface of the lingual retainer was checked for smoothness, while the contacts and gingival areas were checked for excess primer and adhesive.

8. All of the upper retainers were checked using articulation paper to avoid premature contact.

### Follow-up procedure

The patients were re-evaluated during the first, third, and sixth months after the fixed retainer bonding. Retainer failures during the 6-month observation period were registered as wire fractures, bond failures, or both by one author (Z.M.B.). Any retainer loss was also noted. When a bond failure occurred, the retainer was re-bonded. When the retainer was lost or broken, it was replaced with a new retainer. In the case of retainer loss or breakage, the patient was instructed to come to the orthodontic clinic immediately.

### Statistical analysis

The statistical analysis was carried out using SPSS software (version 17.0; SPSS Inc., Chicago, IL, USA), and descriptive statistics were performed. The distribution of the failure rates over time, the number of repeated failures, and the distribution of the failure rates between the genders, jaws, and quadrants were calculated. The retainer failures were compared and statistically analyzed with a Cochran's Q test. The level of statistical significance for all of the analyses was set at 0.05.

## RESULTS

Retainer failures were seen in 14 of the 150 patients during the 6-month retention period. However, no retainer breakage or loss was found during this period. The total failure rate was 9.3%, and the total survival rate was 90.7%. In total, 18 retainers had bond failures (6% of 300 retainers) without any repeated failures.

Figure 1 shows the distribution of the failure rates over time. The highest failure rate was seen in the first month, with a total of 9 failures observed in 9 patients ( $p < 0.05$ ). The lowest failure rate was seen in the sixth month, in which a total of 4 failures were observed in 3

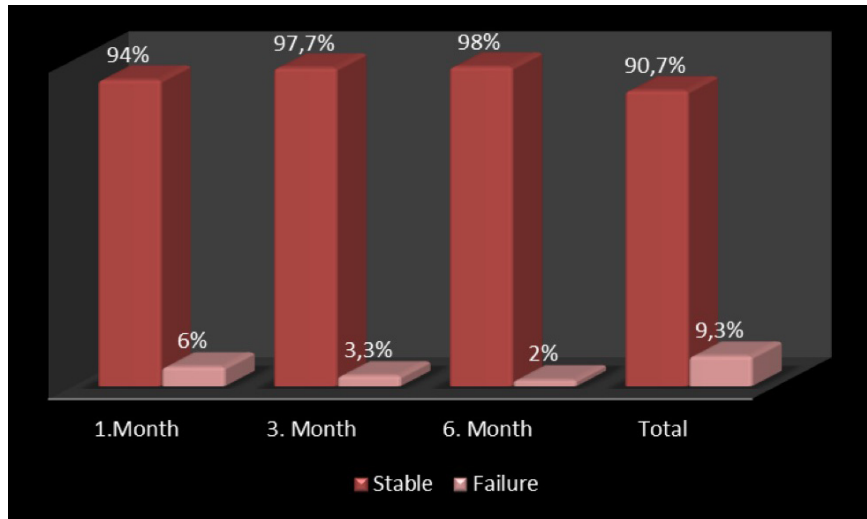


Figure 1. Failure distribution (%) over time

patients. Female patients exhibited a higher failure rate than the male patients ( $p < 0.05$ ; Table 1). Among the 14 patients with bond failures, 3 patients (21.4%) had repeated failures; two of the patients had single failures at different appointments, and one patient had multiple failures at the same appointment (Table 2). Table 3 shows the distribution of the failures on the maxillary and mandibular anterior teeth at the first, third, and sixth months. The failure rate was higher in the right quadrant for both the maxilla (60%) and the mandible (61.5%). The bond failures were more common in the mandibular central incisors than in the mandibular lateral and canine teeth (Table 3). In total, more bond failures occurred in the mandible (8.7% of 150 retainers) than in the maxilla (3.3% of 150 retainers) ( $p < 0.05$ ; Table 4).

Table 1. Comparison of fixed retainer failures between females and males

	N	Age (mean±SD)	Failure	%	Sig.
Female	92	14.82±1.12	12	13.0	$p < 0.05$
Male	58	15.03±1.04	2	3.4	
Total	150	14.89±1.08	14	9.3	

SD: standard deviation; Sig.: statistical significance (p value)

Table 2. The distribution of repeated failures in three patients

Patient's initials	1. month	3. month	6. month
A.D.	UR2	LR2	-
Z.S.A.	LR1	LL1	UR1
B.S.	-	-	LR2 and LR1

UR1: upper right central, UR2: upper right lateral, LR1: lower right central, LR2: lower right lateral, LL1: lower left central.

## DISCUSSION

Fixed lingual retainers are used extensively after orthodontic treatment for the purpose of preventing relapse. These retainers can be constructed from different wires and bonded using different techniques and materials. One of the disadvantages of these retainers is bond failure.<sup>6</sup> Therefore, in this prospective study, we evaluated the survival rate of bonded lingual retainers in both the lower and upper jaws during a 6-month period.

It has been reported that the failure rate is the highest within the first 6 months after bonding.<sup>13,15</sup> Thus, it is essential to be wary of the fact that relapse that may occur in the early stages of retention.<sup>2</sup> The patients in our study were carefully monitored at the first, third, and sixth months after the bonding of the lingual retainers. In addition, the patients were instructed to come to the clinic immediately if they noticed a problem with their retainers, so that any breakage, loss, or bond failure could be detected and recorded.

Many wire and composite combinations have been used in the construction of fixed lingual retainers.<sup>6</sup> For this research, we used 0.0215-inch five-stranded stainless steel wire and Transbond LR composite resin. The total survival rate was 90.7%. Similar to our study, Lee and Mills<sup>19</sup> reported a survival rate at 6 months of 87.6% with 0.0175-inch five-stranded stainless steel wire and Transbond LR composite resin. Taner and Aksu<sup>16</sup> reported a lower survival rate at 6 months of 62% with 0.016×0.022-inch, eight-braided stainless steel wire and Transbond LR composite resin. Unlike our study, they only evaluated the mandibular lingual retainers by using a rectangular wire and both direct and indirect bonding methods. In the study by Bovali *et al.*<sup>20</sup> the 6-month survival rate of the mandibular bonded lingual retainers was 76% with 0.0215-inch five-stranded stainless steel wire and Transbond LR composite resin. In another study, Lie Sam Foek *et al.*<sup>15</sup> retrospectively evaluated the survival of 0.016×0.022-inch three-stranded stainless steel lingual retainers bonded

**Table 3.** The distribution of failures occurring on the anterior teeth at 1, 3, and 6 months

		N	R canine	R lateral	R central	L central	L lateral	L canine	Total
Maxilla	1. month	150	-	2	-	-	2	-	5 (%3.3)
	3. month	150	-	-	-	-	-	-	
	6. month	150	-	-	1	-	-	-	
<b>Total</b>			3 (%60)		2 (%40)				
Mandible	1. month	150	-	-	2	3	-	-	13 (%8.7)
	3. month	150	-	1	2	2	-	-	
	6. month	150	1	1	1	-	-	-	
<b>Total</b>			8 (%61.5)		5 (%38.5)				

R: right, L: left.

**Table 4.** Comparison of fixed retainer failures between the maxilla and the mandible

	N	Maxilla	Mandible	p value
1. month	150	2.7%	3.3%	0.500
3. month	150	0.0%	3.3%	0.030
6. month	150	0.7%	2.0%	0.311
<b>Total</b>	150	3.3%	8.7%	0.043

with Tetric Flow composite resin over 41.7 months, and reported a survival rate of 78% at 6 months. The total survival rate decreased to 63% over an observation period of 41.7 months. Artun *et al.*<sup>21</sup> reported a survival rate of 72.7% for mandibular bonded lingual retainers made of 0.0205-inch spiral wire over a 3-year retention period. Tang *et al.*<sup>22</sup> reported a survival rate of 86.4% with 0.0215-inch five-stranded stainless steel wire and Transbond LR composite resin after a retention period of 43 months. Overall, the survival rate in this study was generally higher when compared with the results of the other studies.

Our lower failure rate could have been due to several factors. First, our follow-up time was 6 months. Although the failure rate has been reported to be the highest within the first 6 months after bonding,<sup>13,15</sup> we expect more bond failures when the follow-up time lengthens, as supported by the study of Lie Sam Foek *et al.*<sup>15</sup> Second, we evaluated both the maxillary and mandibular lingual retainers. The maxillary lingual retainers showed fewer bond failures (3.3% of 150 retainers) than the mandibular lingual retainers (8.7% of 150 retainers) in our study. However, the maxillary lingual retainers were generally reported to show more bond failures. Salehi *et al.*<sup>17</sup> stated that flexible spiral retainers showed no statistically significant difference between the failure rates of the maxillary (36.5%) and mandibular (37.8%) arches. Lee and Mills<sup>19</sup> reported more bond failures in the maxilla (15.1% of 132 retainers) than in the mandible (10.8% of 185 retainers). In a clinical study by Dahl

and Zachrisson,<sup>12</sup> there was a higher failure rate in the maxilla when compared to the mandible. The lower failure rate of the maxillary lingual retainers in our study may be due to better moisture control and meticulous avoidance of occlusal contact. In those studies in which only the mandibular lingual retainers were evaluated, the bond failures were associated with the lack of moisture control during bonding.<sup>16,20,21,23</sup>

Previous studies have reported that the use of different types of retainers results in a difference in the failure rates.<sup>12,21,24</sup> For example, Störmann and Ehmer<sup>24</sup> found that over a 2-year retention period, 0.0195-inch and 0.0215-inch wires showed 71% and 47% survival rates, respectively. Dahl and Zachrisson<sup>12</sup> reported that 0.0215-inch five-stranded wires (7.8% for the maxilla and 5.9% for the mandible) showed a lower failure rate than 0.0195-inch or 0.0215-inch three-stranded wires (25% for the maxilla and 10.3% for the mandible) after 3 and 6 years, respectively. The use of a wire with five strands rather than three, as in our study, may increase the success rate because of the increased flexibility of the multistranded wires occupying the same diameter.

Gender and age have been previously reported to have no significant effects on the survival rate.<sup>15,25</sup> Contrarily, the female patients exhibited a significantly higher failure rate than the male patients in our study. Moreover, the mean age of our patient population was 14.9 years old. Despite this adolescent population, a high success rate was seen, supporting the studies that indicate no age effect on the survival rate.

In our study, the failures occurred only at the adhesive-enamel interface, and no breakage or loss of the retainer was recorded, in accordance with the findings of Taner and Aksu,<sup>16</sup> Lumsden *et al.*,<sup>25</sup> and Bovali *et al.*<sup>20</sup> The failure rate was the highest in the first month and gradually decreased towards the sixth month. The bond failures were more common in the left and right mandibular central incisors, which is in agreement with the study by Taner and Aksu,<sup>16</sup> according to whom the concave form of the lingual surface of the central incisor can lead to inadequate tooth-wire contact. Interest-

ingly, failure was observed on only one canine tooth, suggesting a lower risk of failure for the canines when compared with the incisors. Moreover, the failure rate was higher in the right quadrant for both the maxilla and mandible, in accordance with the findings of Taner and Aksu.<sup>16</sup> This result may be related to biting forces; therefore, the biting patterns of the patients should be taken into consideration.

The results of this prospective study confirmed that fixed lingual retainer failure may occur in the early periods of retention. Therefore, regular clinical controls after orthodontic treatment are important and necessary. The different types of retainers, adhesive systems, and bonding methods were not evaluated in this research; however, these factors should also be taken into account.

The adaptation of the retainer wire to the teeth, strict moisture control, placement of adequate adhesive, and inhibition of abrasion-induced adhesive loss are all key factors for the success of fixed lingual retainers. In addition, monthly controls for the first 6 months are required to prevent any tooth movement that may cause relapse.

## CONCLUSION

The results of this study showed that the total failure rate of fixed lingual retainers was 9.3% during the 6-month retention period. Moreover, the highest failure rate was seen in the first month (6%). Regular clinical controls are necessary to determine bonding failures in these patients.

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## REFERENCES

1. Joondeph DR, Riedel RA. Retention and relapse. Graber TM, Vanarsdall RL, editors. Orthodontics: current principles and techniques. St. Louis: Mosby-Year Book; 1994. p. 908-50.
2. Reitan K. Tissue rearrangement during retention of orthodontically rotated teeth. Angle Orthod 1959;29:105-13.
3. Melrose C, Millett DT. Toward a perspective on orthodontic retention? Am J Orthod Dentofacial Orthop 1998;113:507-14.
4. Zachrisson BU. JCO/interviews Dr. Bjorn U. Zachrisson on excellence in finishing. Part 1. J Clin Orthod 1986;20:460-82.
5. Renkema AM, Sips ETH, Bronkhorst E, Kuijpers-Jagtman AM. A survey on orthodontic retention procedures in The Netherlands. Eur J Orthod 2009;31:432-7.
6. Bearn DR. Bonded orthodontic retainers: a review. Am J Orthod Dentofacial Orthop 1995;108:207-13.
7. Zachrisson BU. Clinical experience with direct bonded orthodontic retainers. Am J Orthod 1977;71:440-8.
8. Zachrisson BU. The bonded lingual retainer and multiple spacing of anterior teeth. Swed Dent J Suppl 1982;15:247-55.
9. Zachrisson BJ. Third-generation mandibular bonded lingual 3-3 retainer. J Clin Orthod 1995;29:39-48.
10. Artun J. Caries and periodontal reactions associated with long-term use of different types of bonded lingual retainers. Am J Orthod 1984;86:112-8.
11. Becker A. Periodontal splinting with multistrand wire following orthodontic realignment of migrated teeth: report of 38 cases. Int J Adult Orthodon Orthognath Surg 1987;2:99-109.
12. Dahl EH, Zachrisson BU. Long-term experience with direct-bonded lingual retainers. J Clin Orthod 1991;25:619-30.
13. Segner D, Heinrici B. Bonded retainers—clinical reliability J Orofac Orthop 2000;61:352-8.
14. Booth FA, Edelman JM, Proffit WR. Twenty-year follow-up of patients with permanently bonded canine-to-canine retainers Am J Orthod Dentofacial Orthop 2008;133:70-6.
15. Lie Sam Foek DJ, Ozcan M, Verkerke GJ, Sandham A, Dijkstra PU. Survival of flexible, braided, bonded, stainless steel lingual retainers: a historic cohort study. Eur J Orthod 2008;30:199-204.
16. Taner T, Aksu M. A prospective clinical evaluation of mandibular lingual retainer survival. Eur J Orthod 2012;34:470-4.
17. Salehi P, Zarif Najafi H, Roeinpekar SM. Comparison of survival time between two types of orthodontic fixed retainer: a prospective randomized clinical trial. Prog Orthod 2013;11:14-25.
18. Tacken MP, Cosyn J, De Wilde P, Aerts J, Govaerts E, Vannet BV. Glass fibre reinforced versus multistranded bonded orthodontic retainers: a 2 year prospective multi-centre study. Eur J Orthod 2010;32:117-23.
19. Lee KD, Mills CM. Bond failure rates for V-loop vs straight wire lingual retainers. Am J Orthod Dentofacial Orthop 2009;135:502-6.
20. Bovali E, Kiliaridis S, Cornelis MA. Indirect vs direct bonding of mandibular fixed retainers in orthodontic patients: a single-center randomized controlled trial comparing placement time and failure over a 6-month period. Am J Orthod Dentofacial Orthop 2014;146:701-8.
21. Artun J, Spadafora AT, Shapiro PA. A 3-year follow-up study of various types of orthodontic canine-to-canine retainers. Eur J Orthod 1997;19:501-9.
22. Tang AT, Forsberg CM, Andlin-Sobocki A, Ekstrand J, Hägg U. Lingual retainers bonded without liquid resin: a 5-year follow-up study. Am J Orthod Dentofacial Orthop 2013;143:101-4.
23. Egli F, Bovali E, Kiliaridis S, Cornelis MA. Indirect vs direct bonding of mandibular fixed retainers in orthodontic patients: Comparison of retainer failures and posttreatment stability. A 2-year follow-up of a single-center randomized controlled trial. Am J Orthod Dentofacial Orthop 2017;151:15-27.
24. Störmann I, Ehmer U. A prospective randomized study of different retainer types. J Orofac Orthop 2002;63:42-50.
25. Lumsden KW, Saidler G, McColl JH. Breakage incidence with direct-bonded lingual retainers. Br J Orthod 1999;26:191-4.

## Sabit pekiştirme apareyi başarısızlığının prospektif klinik değerlendirmesi

### ÖZET

**AMAÇ:** Bu çalışmanın amacı, sabit pekiştirme apareylerinin başarısızlık oranlarını prospektif olarak değerlendirmek ve başarısızlıkların dağılımını 6 aylık süre boyunca belirlemektir.

**GEREÇ VE YÖNTEM:** Sabit ortodontik tedavisi tamamlanmış, ortalama yaşları 14.89±1.08 yıl olan, 92 kız ve 58 erkek toplam 150 hastaya her iki çenede kanin kanin arası sabit pekiştirme apareyleri uygulandı. Bu amaçla, 0.0215 inçlik beş sarmallı tel (PentaOne, Masel Orthodontics), dişlere

Transbond LR (3M Unitek) kullanılarak yapıştırıldı. Hastalar, sabitleyicinin yapıştırılmasından sonra 1., 3. ve 6. aylarda klinikte kontrol edildi. Altı aylık gözlem periyodu boyunca sabitleyici başarısızlığı kaydedildi ve  $p<0.05$  anlamlılık düzeyinde Cochran Q testiyle istatistiksel olarak analiz edildi.

**BULGULAR:** Sabit pekiştirme aapareyleri 14 hastada başarısızlık gösterdi. Toplam başarısızlık oranı %9.3'tü. En yüksek başarısızlık oranı ilk ayda görüldü ( $p<0.05$ ). Kadın hastalarda başarısızlık oranı erkek hastalara göre daha yüksekti ( $p<0.05$ ). Üç hastada başarısızlık tekrarlandı. Ba-

şarısızlık oranı mandibulada maksillaya göre daha yüksek olup ( $p<0.05$ ), hem maksilla hem de mandibulada sağ tarafta daha yüksekti. Toplam başarı oranı %90.7 idi.

**SONUÇ:** Bu çalışmanın sonuçları, sabit pekiştirme aapareyindeki başarısızlık oranının, retansiyon döneminin ilk ayında daha sık görüldüğünü ortaya koydu. Bu nedenle, bağlanma başarısızlıklarını belirlemek için düzenli klinik kontroller gereklidir.

**ANAHTAR KELİMELER:** Ortodontik sabitleyici; relaps; sağkalım oranı