Periodontal parameters of two types of 3x3 orthodontic retainer: a longitudinal study

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Introduction: bonded fixed retainers are often used to stabilize the results obtained with the orthodontic treatment. It is important that they do not prejudice dental health, as they will be used for a long period. Objective: The purpose of the present study was to compare periodontal indexes between two types of bonded fixed retainers, conventional 3x3 plain retainer (0.8-mm orthodontic wire, bonded to the canines only) and a manufactured braided retainer (0.2 x 0.7-mm stainless steel wire, bonded to all anterior teeth) after use. Methods: a test group of 15 volunteers (aged from 18 to 25 years) used both the conventional retainer and braided retainer for six months. A randomized longitudinal study design, with a two week washout interval, was applied. The dental plaque index, gingival index and dental calculus index were evaluated. Furthermore, the calculus accumulated along the retainer wire was measured and all patients answered a questionnaire about the use, acceptance and comfort of both types of retainers. Results: the scores for plaque and gingival indexes were higher for the braided retainer (p<0.05) on the lingual and proximal surfaces. The same occurred with the calculus index on the lingual surfaces (p<0.05). The calculus index along wire was higher for the braided retainer (p<0.05). All patients preferred the conventional retainer, and said that it was also more comfortable to use. Conclusion: it was concluded that the conventional retainer showed better periodontal indexes than the braided type.

Keywords: Orthodontic retainers. Gingivitis. Orthodontics, corrective. Periodontics.
INTRODUCTION

Orthodontic retainers are widely used after concluding orthodontic treatment, and are indicated to avoid crowding of the mandibular anterior teeth.¹⁻⁴

The recommendation is that orthodontic retainers should remain in place for a long period, provided that they do not compromise periodontal health.¹⁻⁵ However, the continuous presence of the retainer wires creates areas that are difficult to clean, favoring plaque formation and impaction of food debris.¹ This situation may result in the development of carious lesions and calculus formation, and induce gingival inflammation and periodontal disease.⁶ Over time, these factors may lead to the loss of adjacent soft and hard tissues.¹

Fixed retainers on mandibular anterior teeth require greater cooperation by the patient, and various designs have been proposed for this purpose, to facilitate this daily task.²⁻⁸ Nevertheless, apparently retainers bonded to mandibular anterior teeth have presented worst periodontal indexes than those observed for retainers bonded to the canines only.⁹⁻¹⁴ However, when there is excessive misalignment of the incisors before orthodontic treatment, it appears to be rational to stabilize them individually, considering the probable dissatisfaction of patients in case of short term instability.²⁻⁴,⁷⁻⁸,¹⁵,¹⁶ Another alternative is to inform the patient about the possibility of instability in the area, and adopt classical retainers bonded to the canines only, and if any alteration should occur, proceed with localized correction, followed by new stabilization.¹¹

The use of the prefabricated Ortho-FlexTech® (Reliance Orthodontic Products, USA) 3 x 3 braided retainer, bonded to all teeth, is indicated for mandibular anterior regions; and the 2 x 2 type, for maxillary regions. However, up to now, no study has been conducted demonstrating its behavior regarding the periodontal indexes.

Thus, the aim of this study was to compare the following conditions: plaque accumulation along the wire and on the gingival margin; periodontal conditions resulting from the use of conventional and Ortho-FlexTech® 3 x 3 retainers.

MATERIAL AND METHODS

Fifteen volunteers participated in this study, which were submitted to anamnesis and initial clinical oral exam. The inclusion criteria were as follows: present good alignment of the mandibular anterior teeth; age range from 18 to 25 years; submitted to previous orthodontic treatment. The exclusion criteria were: being under orthodontic treatment; or having severe crowding of the mandibular anterior teeth.

The volunteers received a Term of Free and Informed Consent, in accordance with the Guidelines and Regulatory Rules of the National Health Council (Resolution No. 196/96). The study began after being approved by the human research ethics committee of State University of Maringá (CAAE: 31435114.9.0000.0104).

The study presented the following stages in the experimental design:

1. Baseline – scaling and dental prophylaxis 15 days before starting use of the retainer. On day zero, the periodontal indexes had to be normal.  
a) Use of conventional retainer/Ortho-FlexTech – for 6 months. Readout of indexes on conclusion.

2. Washout – after removal of the first retainer used, removal of residual resin, dental polishing, and waiting period of 15 days, for normalization of the indexes.  
b) Use of Ortho-FlexTech retainer/conventional – for 6 months. Readout of indexes on conclusion.

After Baseline, the volunteers used both types of retainers during the experimental period and each retainer remained for 6 months in the oral environment, with a 15-day interval between the use of the retainers, for coronal-radicular scaling, dental prophylaxis and oral hygiene instruction (washout). During the first semester, eight patients used the conventional retainer, and seven used the Ortho-FlexTech retainer. After readout of the indexes at the end of the semester and the washout interval, the volunteers who had used the conventional retainer began to use the Ortho-FlexTech, and vice-versa (Fig 1).

At the end of each semester, the indexes were read by a single experienced examiner. After the period of 6 months of using each retainer, periodontal evaluation of the mandibular anterior teeth was performed in three areas — two proximal and one lingual —, by means of the dental plaque and dental calculus indexes. In addition, the calculus on the retention wire was measured. The same previously calibrated examiner made all the evaluations.
On conclusion of each stage of the study, the volunteers answered a questionnaire (Table 1) to evaluate the two types of retainers in terms of comfort, ease of cleaning, and acceptance by the volunteer.

The retainers were fabricated by a single orthodontist after obtaining the plaster cast of each volunteer, and were bonded to the teeth by a single experienced operator. The conventional retainers were fabricated with 0.8-mm orthodontic archwire (Morelli, Sorocaba, Brazil), and were fixed to the mandibular canines, close to the incisal middle third of the lingual surface (Fig 2). To aid bonding, a length of dental floss was folded in half and passed through the interproximal region of the central and lateral incisors on both sides. LCR composite resin (Reliance Orthodontic Products, Inc., USA) was used for bonding. The Ortho-FlexTech (Reliance Orthodontic Products, Inc., USA) retainer, prefabricated with 0.2 x 0.7mm stainless steel wire, was also fixed on all the mandibular anterior teeth, from canine to canine, close to the incisal middle third on the lingual surface (Fig 3). The bonding process was the same as that adopted for conventional retainers, with the use of the same resin (LCR, Reliance Orthodontic Products, Inc., USA).

Considering that all the variables were of the qualitative ordinal type, the Paired Wilcoxon Test was selected, at a level of significance of 5%.

Table 1 - Questionnaire to evaluate the two types of retainers in terms of comfort, ease of cleaning, and acceptance by the volunteer.

|                                      | Conventional retainer | Ortho-FlexTech retainer |
|--------------------------------------|-----------------------|-------------------------|
| Comfort in use                       |                       |                         |
| Better hygiene                       |                       |                         |
| Necessary use the dental floss       |                       |                         |
| Preference in retention type         |                       |                         |

*Respond with an X marking the preferred retainer in each case.*

Figure 1 - Research flow diagram: (a) Baseline – scaling and dental prophylaxis 15 days before starting use of the retainer. On day zero, the periodontal indexes had to be normal. (b) Use of conventional retainer / Ortho-FlexTech – for 6 months. Readout of indexes on conclusion. (c) Washout – after removal of the first retainer used, removal of residual resin, dental polishing, and waiting period of 15 days for normalization of the indexes. (d) Use of Ortho-FlexTech / conventional retainer – for 6 months. Readout of indexes on conclusion.

Figure 2 - Conventional retainer bonded to mandibular canines.

Figure 3 - Ortho-FlexTech retainer bonded to all the mandibular anterior teeth.
RESULTS

Table 2 presents the frequency and percentage of plaque scores per tooth surface, when the conventional and Ortho-FlexTech® retainers were used. There was greater plaque accumulation when the Ortho-FlexTech® retainer was used, and the results showed statistically higher values for the proximal and lingual surfaces.

Table 3 presents the frequency and percentage regarding the dental calculus index, followed by the p-value of each surface. The data were statistically higher only for the mesial, distal and lingual surfaces, and the highest indexes were found after the use of the Ortho-FlexTech® retainer.

The frequency and percentage of the gingival index and p-value for each surface are presented in Table 4. There was no difference between the retainers for the vestibular surface. Only the proximal and lingual surfaces presented statistically lower values for the conventional retainer.

The results of the calculus index along the wire are shown in Table 5. There was greater calculus accumulation along the wire in the Ortho-FlexTech retainer, and this difference was statistically significant in comparison with the conventional retainer values.

The results of the questionnaire are presented in Table 6. Of the volunteers, 40% found the Ortho-FlexTech® retainer to be more uncomfortable; 100% of the volunteers affirmed that they were better able to clean the appliance during use of the conventional retainer. Relative to the need to use dental floss, 100% affirmed this was necessary for the Ortho-FlexTech retainer, while no volunteer pointed out this need for the conventional retainer. With respect to the preferred type of retainer, all the volunteers opted for the conventional retainer.
Table 4 - Frequency and percentage of each calculus index score for each tooth surface between the conventional and Ortho-FlexTech retainers, followed by the p-value for each surface.

| Calculus index | Conventional n (%) | Ortho-FlexTech n (%) | P-value |
|----------------|---------------------|-----------------------|---------|
| **Mesial**     |                     |                       |         |
| 0              | 5 (33.3)            | 1 (6.7)               |         |
| 1              | 8 (53.3)            | 7 (46.7)              | 0.02    |
| 2              | 2 (13.3)            | 6 (40.0)              |         |
| 3              | 0 (0.0)             | 1 (6.7)               |         |
| **Distal**     |                     |                       |         |
| 0              | 5 (33.3)            | 1 (6.7)               |         |
| 1              | 9 (60.0)            | 8 (53.3)              | 0.01    |
| 2              | 1 (6.7)             | 5 (33.3)              |         |
| 3              | 0 (0.0)             | 2 (6.7)               |         |
| **Lingual**    |                     |                       |         |
| 0              | 5 (33.3)            | 0 (0.0)               | 0.001   |
| 1              | 10 (66.7)           | 5 (33.3)              |         |
| 2              | 0 (0.0)             | 10 (66.7)             |         |
| 3              | 0 (0.0)             | 0 (0.0)               |         |

Table 5 - Frequency and percentage of each calculus index score along the wire for the conventional and Ortho-FlexTech retainers, followed by the p-value.

| Calculus index along the wire | Conventional n (%) | Ortho-FlexTech n (%) | P-value |
|------------------------------|--------------------|-----------------------|---------|
| 0                            | 10 (66.7)          | 2 (13.3)              |         |
| 1                            | 5 (33.3)           | 8 (53.3)              | 0.005   |
| 2                            | 0 (0.0)            | 5 (33.3)              |         |
| 3                            | 0 (0.0)            | 0 (0.0)               |         |

Table 6 - Results of questionnaire applied to volunteers.

|                  | Conventional retainer | Ortho-FlexTech retainer |
|------------------|-----------------------|-------------------------|
| Comfort in use   | 60%                   | 40%                     |
| Better cleaning  | 100%                  | 0%                      |
| Need to use dental floss | 0%       | 100%                   |
| Preference for type of retainer | 100%   | 0%                      |

**DISCUSSION**

Fixed retainers are widely used after orthodontic treatment, due to the known instability of the mandibular anterior region.1-4 However, difficulties with cleaning these retainers may lead to calculus accumulating along the wire and in proximal areas, generating periodontal impact.1 Eventually, retainers may be removable, facilitating cleaning of the area.12 However, they will be dependent on patient’s cooperation for a long period. It has been suggested that the stability of the mandibular interincisor region may only be guaranteed if retainers are maintained throughout life.13,14 The need for maintaining the intercanine distance is emphasized, as it undergoes changes with age, irrespective of orthodontic treatment. The question remains whether the retainers should be bonded to all the incisors, or whether it would be acceptable for them to be bonded only to the canines.

The present study revealed that there was greater plaque accumulation on the Ortho-FlexTech® retainer, in comparison with that on the proximal and lingual surfaces of the flat conventional retainer. In the same way as for the plaque index, the mesial, distal and lingual surface of the gingival index presented statistically lower values for the conventional retainer, in comparison with the Ortho-FlexTech type (Table 2). Therefore, as already known, the larger the plaque accumulation, the greater the gingival inflammation.6 These results corroborate those of other studies.9,10,15,16 When the retainers are bonded to all the teeth from canine to canine, they create areas that are more difficult to clean, and deficient cleaning leads to worse consequences than slight misalignment of the area. Apart from this eventual periodontal compromise, unexpected effects have been reported with retainers bonded to all the incisors, such as root torque and gingival recessions, putting the health of the teeth at risk.17-20

The index of calculus along the gingival margin showed a statistically higher value for the Ortho-FlexTech® retainer, in comparison with the conventional retainer, both on the proximal and lingual surfaces (Table 3). This result corroborated the indexes previously evaluated, taking into consideration that...
the constant presence of dental biofilm normally undergoes a process of mineralization or calcification, forming dental calculus, which—in the same way as bacterial plaque—may be above (supragingival) or below (subgingival) the gingival margin.\textsuperscript{21,22} There was no statistically significant difference for the vestibular surfaces relative to calculus accumulation.

The index of calculus along the wire also demonstrated greater calculus accumulation for the Ortho-FlexTech\textsuperscript{®} retainer (Table 4). In addition to the difficulty of cleaning, due to the presence of resin on all the incisors, the Ortho-FlexTech is fabricated with braided wire, presenting areas that favor biofilm retention along the wire.

In spite of the increase in plaque and calculus, and the increase in local inflammatory biomarkers,\textsuperscript{16} in general, no bone loss related to fixed retainers in the mandibular anterior area was reported after 10 years.\textsuperscript{23} However, apparently this risk evaluation must be individualized.\textsuperscript{24}

As regards the questionnaire applied to all the volunteers (Table 5), 60\% declared that the conventional retainer was more comfortable, while 40\% elected the Ortho-FlexTech\textsuperscript{®} type. The volunteers reported that the roughness of the braided retainer was more perceivable by the tongue. All the volunteers affirmed the need to use dental floss in the Ortho-FlexTech retainer, demanding more time for cleaning it. However, all related that it was possible to perform complete cleaning, with dental floss reaching up to the gingival sulcus, during the use of the latter. These reports may be justified by the fact that the volunteers were Dental students, and had knowledge of the importance of complete oral hygiene. Therefore, the conventional retainer was chosen as being the one that presented better cleaning, since it was not necessary to use dental floss for interproximal cleaning and there was no resin on all the anterior teeth.

From the point of view of stabilizing orthodontic treatment, it may be imperative to use the fixed retainer on one segment of teeth. A retainer bonded to all the teeth for splinting after orthodontic treatment has been recommended for cases with accentuated bone loss, due to the loss of primary stability,\textsuperscript{3} and also for cases in which crowding of the incisors was very accentuated at the time of pretreatment.\textsuperscript{3,25-29}

In these cases, frequent supervision is recommended, both for checking bond stability, and for controlling oral hygiene in the area.

Therefore, it appears to be reasonable to recommend bonding to all the anterior teeth only when there is specific orthodontic need or splinting is necessary.

**CONCLUSION**

Based on the results obtained during the study, conventional retainers presented better periodontal results than the Ortho-FlexTech\textsuperscript{®} retainers.

**Authors’ contribution (ORCID\textsuperscript{®})**

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REFERENCES

1. Artun J. Caries and periodontal reactions associated with long-term use of different types of bonded lingual retainers. Am J Orthod. 1984;86(2):112-8.
2. Cerny R. Permanent fixed lingual retention. J Clin Orthod. 2001;35:726-32.
3. Dahl EH, Zachrisson BU. Long-term experience with direct-bonded lingual retainers. J Clin Orthod. 1991 Oct;25(10):619-30.
4. Zachrisson BU. Aspectos importantes da estabilidade a longo prazo. Rev Dental Press Ortod Ortal Facial. 1997;3(4):90-121.
5. Bearn DR. Bonded orthodontic retainers: a review. Am J Orthod Dentofacial Orthop. 1995 Aug;108(2):207-13.
6. Heier EE. Periodontal implications of bonded versus removable retainers. Am J Orthod Dentofacial Orthop. 1997 Dec;112(6):607-16.
7. Bicalho JS, Bicalho KT. Descrição do método de contenção fixa com livre acesso do fio dental. Rev Dental Press Ortod Ortal Facial. 2001;6(5):97-104.
8. Lew KK. Direct-bonded lingual retainer. J Clin Orthod. 1989 July;23(7):490-1.
9. Shirasu BK, Hayacibara RM, Ramos AL. Comparação de parâmetros periodontais após utilização de contenção convencional 3x3 plana e contenção modificada. Dental Press J Orthod. 2007;12(1):41-7.
10. Lukianchuki MA, Hayacibara RM, Ramos AL. Comparison of periodontal parameters after the use of orthodontic multi-stranded wire retainers and modified retainers. Dental Press J Orthod. 2011;16(4):44.e1-7.
11. Normando DC, Capelozza Filho LA. Method to re-treat the relapse of dental misalignment. Dental Press J Orthod. 2011 Sept-Oct;16(5):48-53.
12. O'Rourke N, Albeedh H, Sharma P, Johal A. Effectiveness of bonded and vacuum-formed retainers: a prospective randomized controlled clinical trial. Am J Orthod Dentofacial Orthop. 2016 Sept;150(3):406-15.
13. Booth FA, Edelman JM, Proffit WR. Twenty-year follow-up of patients with permanently bonded mandibular canine-to-canine retainers. Am J Orthod Dentofacial Orthop. 2008 Jan;133(1):70-6.
14. Schütz-Fransson U, Lindsten R, Bjerklin K, Bondemark L. Twelve-year follow-up of mandibular incisor stability. Comparison between two bonded lingual orthodontic retainers. Angle Orthod. 2017 Mar;87(2):200-8.
15. 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 Oct;19(5):501-9.
16. Rody WJ Jr, Elmaraghy S, McNeight AM, Chamberlain CA, Antal D, Dolce, et al. Effects of different orthodontic retention protocols on the periodontal health of mandibular incisors. Orthod Craniofac Res. 2016 Nov;19(4):198-208.
17. Katsaras C, Livas C, Renkema AM. Unexpected complications of bonded mandibular lingual retainers. Am J Orthod Dentofacial Orthop. 2007 Dec;132(6):838-41.
18. Kucera J, Marek I. Unexpected complications associated with mandibular fixed retainers: a retrospective study. Am J Orthod Dentofacial Orthop. 2016 Feb;149(2):202-11.
19. Farret MM, Farret MM, Vieira GL, Assaf LH, Lima EM. Orthodontic treatment of a mandibular incisor fenestration resulting from a broken retainer. Am J Orthod Dentofacial Orthop. 2015 Aug;148(2):332-7.
20. 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 Jan;151(1):15-27.
21. Addy M, Moran JM. Clinical indications for the use of chemical adjuncts to plaque control. Periodontol 2000. 1997 Oct;15:52-4.
22. Lang NP, Mombelli A, Attström R. Placa e cálculo dentais. In: Lindhe J, Lang NP, Karring T. Tratado de periodontia clínica e implantologia oral. Rio de Janeiro: Guanabara Koogan; 2005. p. 81-104.
23. Westerlund A, Oikonomou C, Ransjö M, Ekestubbe A, Bresin A, Lund H. Cone-beam computed tomographic evaluation of the long-term effects of orthodontic retainers on marginal bone levels. Am J Orthod Dentofacial Orthop. 2017 Jan;151(1):74-81.
24. Ramos AL. Eu penso assim. Contenções inferiores. Rev Clin Ortod Dental Press. 2016 Dez-2017 Jan;15(6):34-41.
25. Bjereng R, Sandvik L, Midtba M, Vandevska-Radunovic V. Stability of anterior tooth alignment 10 years out of retention. J Orofac Orthop. 2017 Jul;78(4):275-283.
26. Moslemzadeh SH, Sohrabi A, Rafighi A, Farshidnia S. Comparison of stability of the results of orthodontic treatment and gingival health between Hawley and vacuum-formed retainers J Contemp Dent Pract. 2018 Apr;19(4):443-9.
27. Ramazanzadeh B, Ahrari F, Hosseini ZS. The retention characteristics of Hawley and vacuum-formed retainers with different retention protocols. J Clin Exp Dent. 2018 Mar;10(3):e224-31.
28. Madurantakam P, Kumar S. Fixed and removable orthodontic retainers and periodontal health. Evid Based Dent. 2017 Dec 22;18(4):103-4.
29. Çifter M, Gümrü Çelikel AD, Çelikci A. Effects of vacuum-formed retainers on periodontal status and their retention efficiency. Am J Orthod Dentofacial Orthop. 2017 Dec;152(6):830-5.