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Choice of the retention method after an orthodontic treatment: A narrative review

Jeleskovic, Azra; Redzepagic-Vrazalica, Lejla*; Dzemidzic, Vildana*; Tiro, Alisa*; Nakas, Enita**** Department of Orthodontics, School of Dental Medicine, University of Sarajevo*

ABSTRACT

Introduction: There are three main characteristics that each ideal retainer is required to have: to keep the teeth in the correct position after orthodontic therapy, to be long-lasting and resistant to mechanical damage, and to have no adverse long-term effects on periodontal tissue.

Aim: This research paper aims to evaluate the effectiveness of different retention appliances based on the results of randomized clinical studies that outlines an evidence-based choice of the retention procedure for different cases.

Materials and methods: PubMed and Google Scholar were screened for articles. A different search strategy was used to construct algorithms mainly based on the following keywords: orthodontics, retention, stability, impact. Inclusion criteria were as follows: randomized clinical trials evaluating the effectiveness of at least a removable/fixed retention device, availability of a research paper, articles in English, research papers published in the period 2007-2019, human studies. Articles with incomplete data or partial description of the sample/procedures were excluded. No limitations were set as to the presence of an untreated control group, length of follow-up, sample size, number of examined groups.

Conclusion: This research paper concludes that bonded retainers prove to be most effective in stabilizing the incisors' position, particularly the lower ones, but their disadvantages include the reopening of the extraction space and the retention of plaque due to difficulties in maintaining oral hygiene. Vacuum-formed Essix retainers appear to be more effective than Hawley retainers in retaining the incisors' position, and patients have indicated that they are more acceptable to wear. Hawley retainers prove to be most effective in preserving a closed extraction space; however, when it comes to maintaining the incisor position, they do not show reliable results.

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INTRODUCTION

Retention is a phase of orthodontic treatment devised to keep the teeth in a correct position once the orthodontic treatment has been completed. Without the retention phase, there is a tendency of the teeth to return to their initial position (relapse).¹

It is assumed that after orthodontic treatment, relapse occurs in about 70% of cases.^{2,3} Binda et al.⁴ have found that changes in teeth position after treatment were more common in females than in males, and in children than adults.⁴

Factors most commonly associated with the relapse after the

active phase of orthodontic therapy are related to supragingival and transseptal fibers, as well as occlusal factors, soft tissue pressures, and further growth.²

The retention phase is essential in order to ensure the reorganization of the periodontal ligament and gingival tissue. Reorganization of the periodontal ligament takes about 3-4 months; reorganization of gingival elastic fiber networks of collagen fiber takes about 4-6 months. However, the supracrestal elastic fiber are reshaped at a much slower rate, so that even after one year after the treatment, they can act by forces that are capable of displacing back teeth.⁵ There are three main characteristics that each ideal retainer should have: to keep the teeth in the correct position after orthodontic therapy, to be long-lasting and resistant to mechanical damage, and to have no adverse long-term effects on periodontal tissue.

Retention appliances can be divided into fixed and removable retainers. The most commonly described removable retainers

Corresponding Author:

*Azra Jeleskovic**Department of Orthodontics,**School of Dental Medicine,**University of Sarajevo**e-mail: azra.jeleskovic@gmail.com*

are vacuum-formed (VFRs) Essix and Hawley retainers.⁶ A major disadvantage of removable retainers is that their successful outcome heavily depends on patient's compliance.⁷ Fixed orthodontic retainers are used in situations where relapse is expected to be noteworthy and where prolonged retention is necessary.⁵

Recent evidence has shown that there is no high-quality evidence that would favor some of the specific retention methods 1, so the choice is often the result of individual orthodontist preferences.⁸

There is no consensus among orthodontists about the need for retention, the choice of retention type, and the time during which the retainer should be worn after orthodontic treatment. A vast number of variants in the retention protocol, different materials used for retainers, and different patients' factors make the choice of the proper retention procedure a challenging task to the orthodontist.⁹ Besides, current data on clinical trial-based retention is still scarce.¹⁰

The aim of this research paper is to evaluate the effectiveness of different retention appliances based on the results of randomized clinical studies that outlines an evidence-based choice of the retention procedure for different cases.

MATERIALS AND METHODS

PubMed and Google Scholar were screened for articles. A different search strategy was used to construct algorithms mainly based on the following keywords: orthodontics, retention, stability, impact.

Inclusion criteria were as follows: 1) randomized clinical trials evaluating the effectiveness of at least a removable/fixed retention device; 2) availability of a research paper, 3) articles in English, 4) research papers published in the period 2007-2019; 5) human studies. Articles with incomplete data or partial description of the sample/procedures were excluded. No limitations were set as to the presence of an untreated control group, length of follow-up, sample size, number of examined groups.

RESULTS

According to the automatic database search, a total of 165 relevant articles were retrieved. A complete set of the inclusion criteria were met 8 published research papers, but 7 articles^{11,12,17,18,22-24} were finally included (Figure 1). The selected articles have compared different types of fixed and mobile retainers, different times of wearing the retainers, the impact that the retainers had on the periodontium, and the patients' compliance.

Three studies^{11,12,17} have compared the effectiveness of vacuum-formed and Hawley retainers, two studies^{18,23} have compared vacuum-formed retainers and bonded retainers, and one²⁴ has compared three different retention protocols:

- 1) vacuum-formed in the upper jaw and bonded retainer in the lower jaw²⁴,
- 2) vacuum-formed in the upper jaw and stripping in the lower jaw without retainer²⁴, and
- 3) prefabricated positioners in the upper and lower jaws.²⁴

Table 1 . The total number of 790 patients were evaluated in all studies, including both children and adults.

Hawley retainer vs. vacuum-formed Essex retainers	Bonded retainers vs. Removable retainers	Three retention protocols: Tynelius GE, Petren S, Bondemark, Ljilja-Karlander E Five-year postretention outcomes of three retention methods-a randomized controlled trial. Eur J of Orthod,2014
Rowland H, Hichens L, Williams A, Hills D, Killingback N, Ewings P, Clark S, Ireland JA and Sandyi J. The effectiveness of Hawley and vacuumformed retainers: a single center randomized controlled trial. Am J Orthod Dentofac Orthop 2007; 132:730-7	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 Dentofac Orthop 2016; 150:3	Vacuum-formed Essex retainers in the upper jaw and bonded retainers in the lower jaw
Ramazanadeh B, Ahrari F, Hosseini ZS. The retention characteristics of Hawley and vacuum-formed retainers with different retention protocols. J Clin Exp Dent. 2018;10(3):224-31	Storey M, Forde K, Littlewood S J, Scott P, Luther F, Kang J. Bonded versus vacuum-formed retainers: a randomized controlled trial. Part 2: periodontal health outcomes after 12 months. Eur J of Orthod, 2017, 1-10	Vacuum-formed Essex retainers in the upper jaw and stripping in the lower jaw without retainers
Saleh M, Hajeer MY , Muessig D. Acceptability comparison between Hawley retainers and vacuum-formed retainers in orthodontic adult patients: a single-centre, randomized controlled trial. Eur J of Orthod, 2017, 1-9	Forde K, Storey M, Littlewood S J, Scott P, Luther K and Kang J. Bonded versus vacuum-formed retainers: a randomized controlled trial. Part 1: stability, retainer survival, and patient satisfaction outcomes after 12 months. Eur J of Orthod,2017, 1-12	Prefabricated positioners in the upper and lower jaws

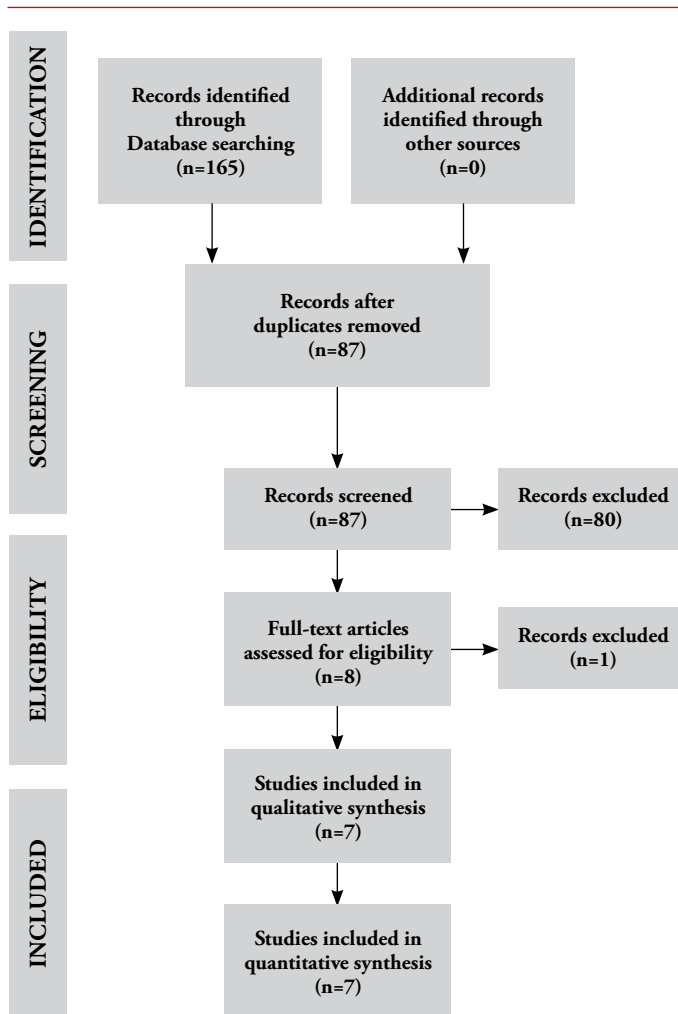


Figure 1. The flow of records through the reviewing process

DISCUSSION

Hawley retainers vs. vacuum-formed retainers

Among the three studies that compared the effectiveness of vacuum-formed retainers and Hawley retainers, the most extensive one was conducted by Rowland et al.¹¹ Their sample included 397 patients randomized in two groups received either a Hawley retainer (n=196 cases) or a vacuum-formed retainer (n=201). Retainers were given to the patients 7 days after the fixed orthodontic appliances were removed. The group receiving Hawley retainer was instructed to wear it for 24 hours per day (except when brushing their teeth) over three months. And also at night (or about 12 hours a day) thereafter.

Patients receiving a vacuum-formed retainer were instructed to wear them 24 hours per day (except when eating and brushing their teeth) during the first week, and at night (or about 12 hours a day).

The patients were recalled 3 and 6 months after debonding. The monitored parameters were: the presence of tooth rotation, Little's irregularity index or LII (the sum of distances between the contact points of the mandibular incisors), intercanine

and intermolar width, the distance between mesiopalatal and mesiolingual cusps of the first molars, overbite and overjet.

This study¹¹ showed that there is no statistically significant difference in the preservation of the overbite between these two retainers, or any significant difference in the effectiveness of both retainers to prevent tooth rotation and maintain the intercanine and intermolar widths. However, study¹¹ also shows a statistically significant difference between the retainers in stabilizing the incisor position, particularly the mandibular ones, with the vacuum-formed Essix retainers having a better outcome.

Accordingly, the authors concluded that vacuum-formed Essix retainers are more effective than Hawley retainers, although the difference seems to be of relevance only for the labial segment of the mandibular arch.¹¹ As a limitation, this study¹¹ had a short follow-up limited to 6 months.

Another study¹² compared the effectiveness of Hawley retainers and vacuum-formed Essix retainers in 90 patients between the ages of 14 and 25 years. Those patients were randomly divided into three groups the first receiving Hawley retainers, the second and third groups wearing vacuum-formed Essix retainers. The first and second groups were instructed to wear the retainers 24 hours per day for the period of the first four months (except when eating and brushing their teeth) and after that to wear them only at night (12 hours per day). The third group was instructed to wear the retainers 24 hours per day for one week (except when eating and brushing their teeth) and thereafter for 12 hours per day.

An evaluation of the effectiveness of these retainers was made 4 and 8 months after the fixed orthodontic appliance was removed, by measuring the intercanine width, intermolar width arc length, the modified Little's irregularity index.

The results of study¹² show insignificant differences in intercanine and intermolar widths among the groups, which means that both retainers deliver a solid level of performance in maintaining the anterior and posterior width after removal of the orthodontic appliance. These results are consistent with the previously described study by Rowland et al.¹¹, followed by Barlin et al.¹³, Demir et al.¹⁴, Ledvinka et al.¹⁵ and Kalha.¹⁶

As far as the arch length is concerned, it has been reduced in all groups during eight months of retention, but the only statistically significant difference is observed in the upper arch length, which was significantly shorter in the group of patients wearing the Hawley retainer than in the other two groups.

Irregularities in the position of the incisors were greater in the patients wearing Hawley retainers in comparison with the patients wearing vacuum-formed Essix retainers. This is attributed to the relationship that vacuum-formed Essix retainers have with the teeth (they have full coverage of the teeth), as opposed to Hawley retainers, which contact the teeth at reduced size points.¹⁶

This study¹² concluded that there is no significant difference in the maintenance of intercanine and intermolar width between Hawley retainers and vacuum-formed Essix retainers; however, the length of the upper arch was reduced in the group of patients wearing the Hawley retainer. As far as the retention of the position of the incisors is concerned, patients with vacuum-formed retainers show better results, particularly the group wearing the retainers for 24 hours per day for four months. In the other segments, the two groups of patients wearing vacuum-formed retainers also show similar results.¹²

The limitation of this study¹² was the small sample size. Since relapse occurs over a long time after treatment, studies with a larger sample size and longer follow-ups should be performed to compare the retention characteristics of Hawley and VFRs.

The third analyzed study¹⁷ was aimed at comparing the potential differences in the levels of acceptability between two different mobile retainers – vacuum-formed Essix retainers and Hawley retainers.¹⁷ This segment is important as the success of retention in mobile retainers depends on the level of cooperation and interaction with the patient.

Two randomized groups of respondents were made for this study. One group of patients received Hawley retainers (41 patients) and the other group got vacuum-formed Essix retainers (45 patients). All of them were instructed to wear the retainers 24 hours per day for the first six months (except when eating or maintaining oral hygiene) and then 12 hours per day for the following six months.

The levels of acceptability of the appliance in orthodontic patients were examined by using a questionnaire that included questions on wearing of the appliance, speech, appearance, oral hygiene, the durability of the appliance, gingival irritation, swallowing, self-esteem, and comfort.

The study¹⁷ concluded that vacuum-formed Essix retainers were found to be more acceptable in terms of speech, appearance, gingival irritation, swallowing, self-esteem and comfort. No significant difference was found in the perception of oral hygiene, biting, and fitting of the appliance in the mouth after six months after receiving the retainer.¹⁷

Bonded retainers vs. Removable retainers

O'Rourke et al. have made a study¹⁸ aimed at comparing the clinical effectiveness of two types of retainers in the mandibular arch; specifically, bonded retainers and vacuum-formed Essix retainers.¹⁸ The parameters examined were Little's irregularity index, the sum of distances between the contact points of the mandibular incisors), intercanine width, the arch length, the opening of the extraction space.

The results of study¹⁸ show that there was a significant difference in the retainment of the position of the lower incisors in favor of the bonded retainers. Changes in the Little's irregularity index (LII) may be associated with further growth of the patients or insufficient wearing of the mobile retainers. An additional

reason for that may be attributed to insufficient adhesion of the vacuum-formed Essix retainer to the teeth.¹⁹ There is no statistically significant difference in the change in intercanine width, which was also confirmed by other authors such as Renkema et al.²⁰, Edman et al.²¹

The intermolar width remained the same in both groups, although in the patients with a bonded orthodontic retainer, it was more dependent on the interdigitation of the buccal segments. The change in the arch length observed in both groups was insignificant. In contrast, the opening at the point of extraction was equally observed in both groups (in 7 patients with bonded retainers and 8 patients with vacuum-formed retainers). The opening of space in the bonded retainers can be explained by the fact that the bonded retainer does not reach these areas, while in the vacuum-formed Essix retainers, the only explanation seems to be attributed to insufficient wearing.¹⁸

The conclusion reached at the end of the study¹⁸ was that the bonded orthodontic retainer is more effective in retaining the position of the lower incisors, compared with the vacuum-formed Essix retainer.¹⁸

The limitation of this study was difficulty in directly comparing results of this study with others because, although similar research questions are asked in other studies, they are not all similar in their methods, outcome measures, measurement techniques, and durations of recall.¹⁸

One of the important characteristics of every retainer is that they have no adverse long-term effects on the periodontal tissue. Storey et al. examined the effectiveness of the retainers in this regard, in a study examining the periodontal health effects of two types of retainers: bonded and vacuum-formed Essix retainers after the end of 12 months following the start of wearing.²²

Periodontal health was evaluated by using: Calculus Index, Gingival Index, and Plaque Index. Measurements were made after debonding, 3,6 and 12 months after the removal of the appliance. A total of 60 respondents were evaluated.

The conclusion of the study²² was that after 12 months of wearing these two types of retainers, bonded retainers were recorded to have a greater accumulation of plaque, calculus and gingival inflammation compared with vacuum-formed Essix retainers. However, one year after, it had no adverse effects on the overall periodontal health to any clinically significant degree.²²

The limitation of this study²² was that the minimum sample size; the power calculation was based on the primary outcome measure of the study.

It was not possible to control for any professional cleaning carried out by the patients' dentists in-between review appointments. This could potentially lead to lower debris scores independent of the type of retainer used.²²

This study only reports the periodontal health of patients in

the first year of retention and further research is required to determine if these findings continue long-term.²²

In addition to the effects on periodontal health, the effectiveness of bonded and vacuum-formed retainers, resistance to damage, and patient satisfaction with wearing them was also examined in the same sample of respondents. The effectiveness was examined by measuring Little's Irregularity Index (LII), the anterior and posterior arch widths, arch length, overjet, and overbite.²³

The results show that there is no significant statistical difference in the maxilla in terms of the retainers' effectiveness or their resistance to damage, while in the mandible, the bonded orthodontic retainer proves to be more effective in maintaining the incisor position, but less resistant to damage. Patients confirmed that with bonded retainers fitted to their teeth, they have observed to have fewer speech difficulties, that these retainers are easier to wear and that they are more comfortable to wear in comparison with vacuum-formed retainers. However, maintaining oral hygiene proves to be more difficult with bonded orthodontic retainers.²³

To aid a direct comparison of the data obtained with that from a previous study, further research may be needed to devise a more appropriate and validated questionnaire for different types of retainers.

A study²⁴ conducted by Tynelius et al. compared the effectiveness of three retention protocols over a 5-year period after the end of therapy.²⁴ The three retention protocols that were compared were:

- 1) vacuum-formed Essix retainers in the upper jaw and bonded retainers in the lower jaw,
- 2) vacuum-formed Essix retainers in the upper jaw and stripping in the lower jaw without retainers
- 3) prefabricated positioners in the upper and lower jaws.

The measured parameters included: Little's irregularity index (LII), intercanine width and intermolar width, arch length, overbite, and overjet. The sample contained 75 patients, of whom 45 were female and 30 were male patients.

Study²⁴ concluded that all three retention protocols showed equally good clinical results and that they all could be highly recommended to clinical practitioners in their dental practice.²⁴

In any retention treatment with removable appliances, the responsibility and result lie with the patient and is out of control to the orthodontist, and this may be the limitation of this study.²⁴

CONCLUSION

This research paper concludes that bonded retainers prove to be most effective in stabilizing the position of the incisors, particularly the lower ones, but that their disadvantages include the reopening of the extraction space and the retention of

plaque due to difficulties in maintaining oral hygiene. Vacuum-formed Essix retainers appear to be more effective than Hawley retainers in retaining the position of the incisors, and patients have indicated that they are more acceptable to wear. Hawley retainers prove to be most effective in preserving a closed extraction space; however, when it comes to maintaining the incisor position, they do not show reliable results. Changes in the overjet, overbite, arch length and anterior and posterior widths did not show any significant statistical differences in the different types of retainers.

Variables that must certainly be considered when selecting a type of retention are an orthodontic diagnosis, an expected level of patient cooperation, patient preferences, and the patient's financial situation.

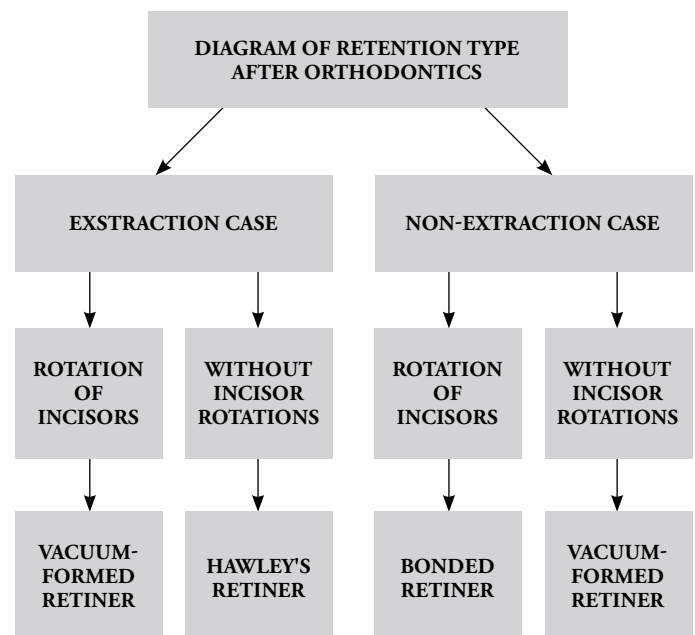


Figure 2. Diagram of retention type after orthodontics

COMPETING INTERESTS

The authors declare that they have no competing interests. No funding was received.

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