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Original Article

Orthodontic Retainers: Review Paper

Abdulfatah B. Khmaj[1] *, Mofida R. Khmaj[1], Zakaria A. Khmaj[2]

1. Zawia University, Faculty of Dentistry, Department of Prosthodontics and Dental Materials, Alzawiyah, Libya.
2. Belarusian Medical Academy of Postgraduate Education, Department of Orthodontics and Dentofacial Orthopedics, Minsk, Republic of Belarus.
*Correspondence: a.khmaj@zu.edu.ly or akhmaj@aol.com

Abstract:

To ensure that the results of fixed orthodontic therapy are maintained and do not relapse, it is crucial to retain and preserve the treatment outcomes. Retention is an essential aspect of orthodontics and can be viewed as the final stage of treatment. It is necessary to maintain an optimal esthetic and functional occlusion following orthodontic therapy.
Aim : The objective of the article is to acknowledge the significance of maintaining the outcomes of orthodontic therapy and to assess the various techniques used to fabricate fixed and removable appliances for retention.
Materials and Methods:
The present article evaluates the different protocols for lingual fixed retainers, as well as removable retentive appliances such as Hawley, Begg, and vacuum-formed retainers (VFR). Removable appliances have been used for retentive purposes for a long period of time. Bonded fixed retainers were introduced in the 1970s, and they have several advantages over removable retentive appliances, such as better esthetics, the absence of patient cooperation, and suitability for lifelong retention. Fixed retainers can be of conventional or digital type. Conventional fixed retainers can be fabricated and attached directly or indirectly to the teeth using a transfer tray. Moreover, bonded retainers can now be digitally manufactured using computer-aided design and computer-aided manufacturing (CAD-CAM).

Results: Effective retention and stability of orthodontic treatment results are highly dependent on various factors such as the chosen retention technique, survival rate, and the individual patient's case. Therefore, a thorough diagnosis, comprehensive treatment plan, and careful selection of a suitable retentive appliance play crucial roles in ensuring optimal post-treatment stability.
Conclusion: Extensive study of literatures and previous publication suggests that there is a lack of sufficient evidence to determine the superiority of any specific retention protocol. Therefore, there is a need for evidence-based studies and controlled clinical trials to evaluate various orthodontic retentive appliances, determine the optimal duration of retention period, and evaluate the success and failure rates of retention based on each specific technique

Key words: Tooth stability; Removable retainers; Fixed retainers; Dual retention; Life-long retention.

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Introduction:

The long-term stability of the treatment is the goal of every orthodontist. The concluding stage of orthodontic treatment is retention. Many practitioners believe that, some degree of relapse will occur even with a retentive appliance. The retention of the treatment result starts at the very beginning of treatment, as retention depends deeply on a correct diagnosis of the case and on a sound treatment plan. Moreover, obtaining an appropriate functional occlusion that fits well with the patient's facial features and muscular structures will aid tremendously in maintaining stable post treatment results.

In the 19th century, occlusion was believed to be the most important factor for stability of teeth after orthodontic treatment. In the 20th century Lundstrom supported the idea that the most important factor for stability is the apical base, whereas Mcauley insisted on the importance of canines and molar relationship (1). On the other hand, Tweed claimed that the inclination of incisors plays a role, and that upright incisors help in occlusion stability (2).

Removable appliances such as the vacuum formed retainer (VFR), Begg and Hawley retainers are among the most common removable retentive appliances. The Begg and Hawley retainer have an advantage over other types of retainers as its possible to activate the loop or the clasp to slightly adjust or re-straighten teeth if necessary. Also, removable retentive appliances are more practical in maintaining the achieved arch expansion after orthodontic treatment.

As more studies of long-term teeth stability were introduced, the idea of fixed retention developed. In 1973, Robert W. Kneirim introduced the application of fixed retainers after orthodontic treatment for the first time (3). These retainers were bonded to the lingual surface of the teeth based on the acid-etch technique. In 1977, Zachrisson presented the structural advantages of multi-stranded flexible wires, as he explained that because of their flexibility, multi-stranded wires did not restrict physiological tooth mobility (4).

Discussion:

The long-term age changes of the skeletal and soft tissue predict that relapse of the teeth after orthodontic treatment is highly possible. As a result, every treated case should be considered as a potential lifelong retention to maintain the stability of the treatment outcomes. In the case of removable retentive appliances, the patient is allowed to remove them from the mouth to maintain oral hygiene, but the success of their application depends on the patient's compliance. The Hawley removable retainer is fabricated with acrylic resin, which covers the palatal or lingual soft tissue. This acrylic resin is connected to a stainless steel vestibular bow that extends from the distal surface of the canines. In addition, the Hawley appliance has Adams or circumferential clasps. The Hawley appliance can be applied to both the upper and lower jaw. Moreover, the Begg retainer, which is mainly applied to the upper jaw, is also fabricated with acrylic resin that covers the palate, but the stainless steel vestibular arch begins on the distal surfaces of the second molars contouring the vestibular surface of the posterior and anterior teeth without the need for retentive clasps. In some cases, retentive clasps can be added to stabilize the

appliance (5). Both the Hawley and Begg removable retentive appliances have good durability (5), promote intercuspation of molars (6) and can be used to provide force on a tooth or teeth to re-straighten them if necessary (7).

In many literatures, the term Vacuum Formed Retainer (VFR), thermoplastic retainer, or invisible retainer (clear) is used interchangeably. In 1971, Ponitz first introduced the thermoplastic retainer (9) and it was further developed by Sheridan (10). The VFR is the most commonly chosen removable retainer by orthodontists in the Republic of Ireland (11), Australia (12), and in the National Health Service (NHS) and hospital practices in the United Kingdom (13). The VFR has good durability and esthetic appearance, and it also proposes patient comfort and acceptability (14).

Fixed retainers are the retainers of choice for many orthodontists, especially for stabilizing the treatment result of the lower jaw. Zachrisson in 1977 demonstrated the advantages of using multi-stranded metallic wires as fixed retainers (18). In 1982, Artun and Zachrisson introduced the bonding of multi-stranded wires to the lingual surface of canines only (19). The wires used in manufacturing fixed retainers were characterized into several generations since their introduction to orthodontics (15). The first generation of fixed retainers is blue elgiloy or stainless steel round wire with a diameter of 0.025-0.036 inches. The first generation had a terminal loop that was bonded only to the lingual surface of the right and left canines (16). The second generation of fixed retainers is a triple-stranded wire with a diameter of 0.032 inches and is bonded to the lingual surface of all anterior teeth (16). The multi-stranded wires replaced the stainless steel round wire as they have higher elasticity that helps maintain the physiological mobility of the retained teeth (16). The third-generation retainer can either be a round 0.032-inch stainless steel or a rounded 0.030-inch gold-coated plain wire, bonded to the lingual surface of the canines only (16). The tip ends of this generation of retainers are sandblasted with aluminum oxide to improve mechanic retention (16). The fourth generation of retainers is made of five-stranded wires with a 0.032-inch diameter and could be bonded to all anterior teeth (16). The fifth and last generation of retainers is blue elgiloy wires with a 0.032-inch diameter and is sandblasted at the end, as they are bonded strictly to the lingual surface of the canines (16). Zachrisson, in his studies, bonded triple-stranded wires to all anterior teeth. However, in his paper where he shared a 20-year experience with fixed bonded retainers, he reported that a five-stranded wire with a 0.0215-inch diameter provided better retention results based on failure rates observed in follow-up sessions of his patients (20).

Fiber reinforced composite materials were introduced as an alternative to fixed wire retainers (17). Resin fiberglass is more aesthetic and smaller in size; however, their high long-term failure rates and inability to maintain the physiological mobility of teeth decreased their demand among orthodontists (17).

Computer-aided design and manufacturing technology are very commonly used in oral and dental science to provide stable and efficient treatment. Fixed lingual retainers have not changed over the years until more recently, as bonded fixed retainers can now be manufactured using computer-aided design and manufacturing (CAD/CAM) technology. This digital method could offer stable post-treatment results for simple and severe orthodontic cases. Techniques and types of wires to manufacture a bonded fixed retainer using CAD/CAM vary. The SureSmile technology was designed to deliver high-quality care with a minimal amount of patient discomfort, as well as reduce errors in treatment results (21). SureSmile technology provides precise retentive appliances that can help orthodontists deliver truly customized care (21). SureSmile uses the technique

of bending prefabricated copper-nickel-titanium wire by the handle of a machine to manufacture the retainer (21). The Memotain retainers are manufactured using a different technique, which includes carving out a block of nickel-titanium wire of 0.014x0.014 inch thickness (31).

Methods of Manufacture:

Removable retentive appliances, such as Hawley, Begg, and Vacuum-formed retainers, are fabricated in the dental laboratory. For Hawley and Begg removable retainers, the lab technician prepares the working model by applying a small amount of liquid separator foil (22). This separator is applied everywhere except along the areas where the wires (bow, loop, and clasps) will be waxed in place. Next, the technician adapts the wire for the bow and clasps to the dental cast using hot baseplate wax on the facial surface (22). Further, the technician adds the acrylic polymer in layers and gradually builds up the baseplate to the desired dimension. The acrylic retainer is cured under pressure to ensure that the acrylic is fully hardened (22). The following step is the trimming procedure, divided into two categories: cut-out/rough trim and the final trim (22). Cut-out/rough trim involves cutting out the basic shape of the retainer, followed by thinning and smoothing excessive bulkiness. In the final trim, the anterior acrylic is rounded down to the interdental papilla to maintain palatal tooth contact and not interfere with the antagonist teeth. Finally, the acrylic retainer is sanded and smoothed along the previously trimmed areas (22). The Vacuum-Formed Retainer (VFR) can be fabricated in the dental laboratory or in the dental office if the necessary materials and vacuum machine are available, as the process of manufacture is much faster than other removable retentive appliances. Its fabrication requires taking a dental impression after debonding of the bracket system and preparing a working model. A rectangular or round blank of materials such as co-polyester and ethylene co-polymer, with a thickness ranging from 0.6 to 2.0 mm, is used to manufacture the retainer (14). Co-polyester is more aesthetic but tends to fracture easily, while ethylene co-polymer is much more resilient but less retentive (14). The VFR is fabricated using a plastic thermoforming pressure machine, which adapts the heat-softened plastic over the dental cast with the help of positive pressure or by using a vacuum machine, which adapts the softened plastic blank to the dental cast by negative pressure (14).

Conventional fixed retainers can be bonded to the lingual surface of anterior teeth from the canine to the canine directly or indirectly. First and foremost, the practitioner should perform professional oral hygiene and treat the lingual surface with a sandblaster using a 50 micro alumina silicate, which is removed using high-volume suction (32). The sandblaster has been shown to increase the shear bond strength of the lingual retainer (32). A suitable prefabricated multi-stranded stainless steel retainer wire is chosen, and the orthodontist fixes the retainer using the acid etch technique. Placing a fixed retainer with a direct bonding (chair-side) technique requires a lot of skill and accuracy from the orthodontist. Various materials and methods are used to deliver the wire in place prior to bonding, including dental floss, elastics, ligature wire, and/or finger pressure (32). Also, it must be stressed that good moisture control is a requirement for the successful bonding of the retainer via direct technique and this is achieved using cotton rolls, a field retractor, and dental saliva suction. Further, the retainer wire should be annealed to reduce the stiffness of the wire and to place it according to the shape of the frontal segment of the arch (23). Next, the lingual surface of the teeth is etched with 37% orthophosphoric acid for 15 to 30 seconds (23). After carefully rinsing and drying the teeth, an etched appearance will appear on the lingual surface of the anterior

teeth. A foam sponge is then used to place the liquid bonding resin (the adhesive) onto the recently etched surface, and it is briefly polymerized with a light reaction (23). A small amount of low-viscosity composite material is applied to the lingual surface of the 6 frontal teeth. The foam sponge is used to adjust the composite over the wire, and then each tooth is cured for 40 seconds. The amount of composite should be enough to cover the wire only in the middle of the crown and not all the way along the lingual crown surface (23).

In the case of the indirect bonding (laboratory) technique for fixed retainers, the treatment protocol closely resembles that of the chair-side technique. The procedure includes taking a dental impression, preparing a plaster model, passively adapting a stainless steel multi-stranded wire to the lingual surface of the anterior teeth on the model, applying a separation liquid to the lingual surface of the frontal teeth, bonding the retainer with a low viscosity composite, and polymerizing it. A transfer tray is fabricated using a vacuum machine and a thermoplastic plate. The tray is then placed in the patient's mouth, and the retainer is bonded using the etch-rinse adhesive bonding technique. Finally, the transfer tray is carefully removed, the fixed retainer is examined, and oral hygiene instructions are provided.

In a randomized clinical survey, Bovail et al. compared the direct and indirect fixation of the retainer in terms of time efficiency. They concluded that indirect fixation was 20% faster than direct (24).

Effectiveness and Survival Rates of Retainers:

In a randomized clinical trial, Tynelius et al. compared various retention strategies to maintain the results of orthodontic treatment of the upper and lower jaw (26). Tynelius et al. used vacuum-formed retainers and bonded canine-to-canine retainers on both arches. They concluded that the VFR and the bonded canine-to-canine retainer both proposed favorable clinical results (26,27). On the other hand, Renkema et al. assessed the long-term success of canine-to-canine lingual retainers in maintaining the alignment of the mandibular anterior teeth post orthodontic treatment in 221 patients (28). Five years post orthodontic treatment, the alignment of the mandibular anterior teeth was maintained in 200 patients (90.5%) (28). Moreover, the most common problem related to fixed retainers is bond failure. In a randomized clinical trial, Pandis et al. evaluated the survival of fixed mandibular lingual retainers with chemical or photo polymerization over a period of 2 years (30). The results showed the absence of a particular difference between the survival of mandibular fixed lingual retainers using chemical or light-cured adhesives, as the overall failure rate was 46.4%.

The Duration of the Retention Period:

A Cochrane review published in 2016 showed that there is insufficient evidence to favor a particular retention duration period or a retention protocol (29). Many practitioners agree on providing long-term or indefinite retention using a combination of fixed and removable retention, a term widely known as dual retention. In case the bonded fixed retainer fails, the removable retainer prevents the relapse of teeth. This is especially common for the mandibular arch as it possesses a high tendency to relapse.

Conclusion:

It is important to give thorough consideration to the type of retainer, the method of fabrication, and the retention plan to ensure that the treatment outcomes remain stable over time. Although there is no clear evidence to support any particular retention technique, additional randomized clinical trials of high quality are necessary to assess the effectiveness of various orthodontic retentive appliances and techniques.

Figure 1: Vacuum Formed Retainer (VFR) and Lingual Fixed Retainer (3-3) on the upper arch.

References

1) Lundström AF. Malocclusion of the teeth regarded as a problem in connection with the apical base. *Am J Orthod Dentofac Orthop.* 1925;11:591–602.
2) TWEED CH. Indications for the extraction of teeth in orthodontic procedure. Am J Orthod Oral Surg. 1944-1945;42:22-45.
3) Knierim RW. Invisible lower cuspid to cuspid retainer. Angle Orthod. 1973 Apr;43(2):218-20.
4) Zachrisson BJ. Third-generation mandibular bonded lingual 3-3 retainer. J Clin Orthod. 1995 Jan;29(1):39-48.
5) Rinchuse DJ, Miles PG, Sheridan JJ. Orthodontic retention and stability: a clinical perspective. J Clin Orthod. 2007;41(3):125-132.
6) Sauget E, Covell DA Jr, Boero RP, Lieber WS. Comparison of occlusal contacts with use of Hawley and clear overlay retainers. Angle Orthod. 1997;67(3):223-30.
7) Al-Suliaman S, Hashim HA, Cordovez JL. The reinforced removable retainer. J Contemp Dent Pract. 2006 May 1;7(2):145-52.

8) Consolaro A, Cardoso MA. Mandibular anterior crowding: normal or pathological? Dental Press J Orthod. 2018 Mar-Apr;23(2):30-36.
9) Ponitz RJ. Invisible retainers. Am J Orthod. 1971 Mar;59(3):266-72.
10) Sheridan JJ, LeDoux W, McMinn R. Essix retainers: fabrication and supervision for permanent retention. J Clin Orthod. 1993 Jan;27(1):37-45.
11) Meade MJ, Millett D. Retention protocols and use of vacuum-formed retainers among specialist orthodontists. J Orthod. 2013 Dec;40(4):318-25.
12) Wong PM, Freer TJ. A comprehensive survey of retention procedures in Australia and New Zealand. Aust Orthod J. 2004 Nov;20(2):99-106.
13) Singh P, Grammati S, Kirschen R. Orthodontic retention patterns in the United Kingdom. J Orthod. 2009 Jun;36(2):115-21.
14) Meade, M. J., & Millett, D. T. (2015). *Vacuum-formed retainers: an overview*. *Dental Update, 42(1), 24–34.*
15) Degirmenci Z, Ozsoy OP. Retention after fixed orthodontic treatment. Cumhur Dent J 2009; 12: 83-90.
16) Kartal Y, Kaya B. Fixed Orthodontic Retainers: A Review. Turk J Orthod. 2019 Jun;32(2):110-114.
17) Geserick M, Ball J, Wichelhaus A. Bonding fiber-reinforced lingual retainers with color-reactivating flowable composite. J Clin Orthod. 2004 Oct;38(10):560-2.
18) Zachrisson BU. Clinical experience with direct-bonded orthodontic retainers. Am J Orthod. 1977 Apr;71(4):440-8.
19) Artun J, Zachrisson B. Improving the handling properties of a composite resin for direct bonding. Am J Orthod. 1982 Apr;81(4):269-76.
20) Zachrisson BU. Multistranded wire bonded retainers: from start to success. Am J

Orthod Dentofacial Orthop. 2015 Nov;148(5):724-7.

21) Sachdeva RC. SureSmile technology in a patient--centered orthodontic practice. J Clin Orthod. 2001 Apr;35(4):245-53.

22) Dogramaci, E. J., & Littlewood, S. J. Removable orthodontic retainers: practical considerations. British Dental Journal. 2021;230(11), 723–730.

23) Shah AA, Sandler PJ, Murray AM. How to ... place a lower bonded retainer. J Orthod. 2005 Sep;32(3):206-10.

24) 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 Dec;146(6):701-8.

25) Karaman AI, Polat O, Büyükyilmaz T. A practical method of fabricating a lingual retainer. Am J Orthod Dentofacial Orthop. 2003 Sep;124(3):327-30.

26) Edman Tynelius G, Bondemark L, Lilja-Karlander E. A randomized controlled trial of three orthodontic retention methods in Class I four premolar extraction cases -- stability after 2 years in retention. Orthod Craniofac Res. 2013 May;16(2):105-15.

27) Edman Tynelius G, Petrén S, Bondemark L, Lilja-Karlander E. Five-year postretention outcomes of three retention methods--a randomized controlled trial. Eur J Orthod. 2015 Aug;37(4):345-53.

28) Renkema AM, Renkema A, Bronkhorst E, Katsaros C. Long-term effectiveness of canine-to-canine bonded flexible spiral wire lingual retainers. Am J Orthod Dentofacial Orthop. 2011 May;139(5):614 21.

29) Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces.

Cochrane Database Syst Rev. 2016 Jan 29;2016(1):CD002283.

30) Pandis N, Fleming PS, Kloukos D, Polychronopoulou A, Katsaros C, Eliades T. Survival of bonded lingual retainers with chemical or photo polymerization over a 2-year period: a single-center, randomized controlled clinical trial. Am J Orthod Dentofacial Orthop. 2013 Aug;144(2):169-75.

31) Kravitz ND, Grauer D, Schumacher P, Jo YM. Memotain: A CAD/CAM nickel-titanium lingual retainer. Am J Orthod Dentofacial Orthop. 2017 Apr;151(4) 812-815.

32) Reicheneder C, Hofrichter B, Faltermeier A, Proff P, Lippold C, Kirschneck C. Shear bond strength of different retainer wires and bonding adhesives in consideration of the pretreatment process. Head Face Med. 2014 Nov 28;10:51.