Review Article

Clear retainer

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Abstract

A clear retainer is a removable retainer that is popular in the present day. Compared with conventional fixed and removable orthodontic retainers, it is a more esthetic, comfortable, and inexpensive appliance. Although several studies have been published about clear retainers, it could be difficult to interpret the results because of the variety of study designs, sample sizes, and research methods. This article is intended to compile the content from previous studies and discuss advantages, disadvantages, fabrication, insertion, and adjustment. Moreover, the effectiveness in maintaining dental position, occlusion, retention protocols, thickness, and survival rate of clear retainers is discussed.

Key words: Clear retainer, thermoplastic retainer, vacuum-formed retainer

INTRODUCTION

The retention phase is an important phase in keeping teeth in a debonding position and inhibiting the teeth from returning to their original position.[1] Both removable and fixed retainers can be used to provide retention. A clear retainer (Essix® retainer, thermoplastic retainer, or vacuum-formed retainer) is a removable retainer that was introduced in 1993 by Dr. John Sheridan[2] as an esthetic, comfortable, and inexpensive appliance compared with conventional fixed and removable orthodontic retainers.[3] It is a transparent and thin but strong vacuum-formed appliance. Nowadays, clear retainers are produced by many companies such as Essix®, which is a registered trademark of Raintree Essix, Inc., Zendura®, which is produced by Bay materials LLC and Vivera®, which is produced by Align Technology, Inc.

To date, several studies have been published about the effectiveness, retention protocols, occlusal contacts, survival time, and wear of retainers. However, it could be difficult to interpret the results and evidence presented in these studies because of the variety of study designs, sample sizes, and research methods. This review aims to compile the content from previous studies and discuss advantages, disadvantages, fabrication, insertion, and adjustment. Moreover, the effectiveness in maintaining dental position, occlusion, retention protocols, thickness, and survival rate of clear retainers are discussed in the discussion part.

Advantages

- More esthetic and less visible[3,4]
- Inexpensive[3,4]
- Ease of fabrication[2]
- Ability to place on the day the fixed appliance is debonded[2]
- Decreased chair time[2]
- Capable of correcting minor tooth discrepancies[4] due to flexibility and positioner effect[2]
- Provides better oral hygiene than fixed retainer[5]
- Serves as a temporary bridge or crown for missing teeth[2]
- Acts as night guard for bruxism.[2]

Access this article online	
Quick Response Code:	Website: www.apospublications.com
	DOI: 10.4103/2321-1407.199173

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How to cite this article: Chaimongkol P, Suntornlohanakul S. Clear retainer. APOS Trends Orthod 2017;7:54-60.

Disadvantages

- Demands good compliance[6]
- Nonsettling of occlusion due to occlusal surface coverage of clear retainer[7,8]
- Prone to wear and needs replacement at least annually[4]
- Easily lost due to transparency[4]
- Looseness of retainer in case of gingival inflammation or puffy gum.[4]

FABRICATION

Steel trays with multiple retention holes and polyvinyl siloxane are recommended for impression to prevent distortion, and polyvinyl siloxane has excellent elastic recovery so the impression does not distort. It remains dimensionally stable for 6 months and can be repoured again without distortion. Moreover, it is easy to work with and can register interproximal morphology precisely. It comprises light and heavy bodies; a light body provides excellent detail of interproximal space whereas a heavy body ensures the stability of the impression. Alginate is not the material of choice for Essix® impressions because it is not dimensionally stable and accurate enough to provide precise anatomic detail of retentive undercuts below the contact points. Die stone is recommended because it has high compression strength and minimal expansion. After obtaining a dental cast, interproximal areas and gingival borders should be distinct and excessive undercut should be blocked out with compound filling to enable the patient to remove it more easily. Then, plastic thermoforming machines will be used for Essix® retainer construction.[4] A clear retainer must fit on the model and adjustment is not usually needed. However, the area of muscle attachment must be reduced.[9]

INSERTION AND ADJUSTMENT

A clear retainer can be inserted by seating the retainer with finger pressure. Normally, the retainer should not slip easily over the teeth but should be inserted with a reasonable amount of pressure to press it over interproximal undercuts gingival to the contact points. If it does not seat properly, it is usually because of interproximal ridges that have not been adequately reduced. This area can be reduced and smoothed at chairside using a blade. During the first insertion, the patient might feel tight during the use of the retainer but the warmth in the mouth will make this sensation disappear.[2] After that, occlusion should be equilibrated using double-sided articulating paper and grinding the high spot with a trimmer bur.[4]

PROBLEMS DURING INSERTION AND USE OF ESSIX® APPLIANCES

Looseness of appliance

During insertion, if appliance is too loose, it can be tightened at chairside by using a Hilliard Undercut Enhancing Thermoplier #82510.[10]

Too tight appliance

A clear retainer should be flexible when passing through the undercuts. If excessive force is needed to insert or remove the retainer, it is mostly because of plastic adaptation into undercuts gingival to contact points. The way to prevent this problem is blocking out excessive undercuts on the cast prior to thermoforming. Otherwise, these undercuts have to be cut-off by using a blade and that will consume chairside time.[10]

Gingival compression

If a clear retainer presses on surrounding tissue, it leads to a pale tissue color at the border of the appliance. Excessive gingival retainer height can be reduced with curved Mayo scissors #18001. Nevertheless, the border of the appliance should not be trimmed until it conforms to the cervical line because that will reduce plastic adaptation in retentive undercuts.[10]

Minor relapse

Failure to wear the retainer leads to the retainer losing its fit during the retention period. However, slightly malaligned teeth can be realigned using the same clear retainer without fixed appliances or another clear retainer. Since a clear retainer is semi-elastic and has resiliency and shape-memory, a minor relapse can be corrected until the teeth return to their debonded position. The patient has to wear the retainer full-time until it passively fits and malaligned teeth are realigned. After that, a night-time appliance is prescribed.[2,11] In addition, adjusting a retainer with Hilliard thermopliers can realign teeth and the retainer should be worn full-time. Then, a new retainer is constructed and can be worn at night.

Repair

If the appliance has wear, crack, separation, or split areas, it is preferable to make a new appliance instead of repairing. However, heat guns can be used to repair the appliance if necessary.[9]

MAINTENANCE

The care after receiving an Essix® retainer is important. Appliances should be worn full-time except during eating to allow natural consumption and to avoid crushing of

the appliance. Regular cleaning of removable dental appliances promotes good hygiene but toothpaste is not allowed because it can dull the plastic and may crack the appliance. If the retainer becomes loose and the patient can use their tongue to remove the appliance, they should discontinue wearing it and call their doctor immediately. Moreover, chewing gum while wearing the retainer is not allowed.[10]

CONTRAINDICATION OF CLEAR RETAINER

Swollen interproximal tissue

The appearance of interproximal tissue affects the retention of the appliance. In this situation, a Hawley retainer or fixed retainer should be used until the patient has normal morphology of interproximal tissue.[4]

Severe pretreatment dental rotation

In cases of severe dental rotation, especially of the incisors, a fiberotomy is recommended before the retention phase. Moreover, a fixed retainer should be used combined with an Essix® retainer.[10]

Use as bleaching tray

A vacuum-formed retainer should not be used as a bleaching tray because it has a different design to a bleaching tray, for example in the area of the bleaching gel reservoir and gingival margin. Moreover, bleaching trays are thinner and softer.[12,13]

Dental arch expansion

For patients who had constricted arches at the beginning of treatment and were treated by dental arch expansion, a Hawley retainer is recommended, whereas a vacuum-formed retainer is not advised because it may not be rigid enough in this situation.[14]

Patient with anterior open bite

A canine to canine clear retainer should not be used in patients with an anterior open bite tendency,[3] whereas a full posterior occlusal coverage design should be used in these patients to prevent posterior teeth eruption and recurrence of anterior open bite.[8,15]

DESIGNS

The extension of clear retainers varies from canine to canine[2,3] to all teeth in both maxillary and mandibular arches.[8,16] However, a full posterior occlusal coverage design has been commonly chosen[8] because it can reduce the risk of posterior teeth eruption during retention.[15] Moreover, Wang[17] and Sheridan *et al.*[18] recommended that in cases of extraction, the distal margin should be lengthened to mesiobuccal grooves of first molars or a full coverage retainer should be used.

The border of the appliance should extend gingivally 3–4 mm on both facial and lingual sides.[4] The gingival edge should be notched in the area of labial and lingual frenums.[4]

An Essix® retainer is U-shaped and does not cover the palate, so if expanded arch stabilization is needed, U-shaped 0.030-inch wire should be bent to conform to the shape of the palate and placed 2–3 mm from the cervical margins of the teeth.[4]

Sometimes, a canine to canine retainer is difficult to remove. A modification of a fingernail purchase tool can be added to help the patient remove the appliance more easily. The appliance remover tool is a helping tool for removing a clear retainer by using it from the cheek side and from the tongue side and can provide comfort, especially for men with large fingers.[4]

Another design is a clear retainer with a bite plane. There are two-ways to create a bite plane on an Essix® retainer, using acrylic or Hilliard thermoplaster.[10]

A patient with pretreatment anterior open bite can also use a clear retainer with an amplified retention system, which consists of cuspid to cuspid bonded lingual retainers, lingual caplin hooks, and intraoral elastics. It was fabricated with the instruction to use vertical elastic at night to maintain overbite. Vertical elastics are placed at the lingual side with slight force (100 g). With the use of elastic, the patient has no difficulty while sleeping [Figure 1].[10]

For a patient who lost teeth, a clear retainer with a crown or denture teeth can be constructed [Figure 2].[19] One useful application of a clear retainer is to fabricate a temporary bridge to replace missing anterior teeth. It is challenging for orthodontists and implantologists to provide both function and esthetics during the period that a patient is waiting for final single tooth restoration.[20] This design of a clear retainer can be used to restore edentulous areas in

Figure 1: Amplified retention system

Figure 2: Clear retainer with maxillary right canine denture tooth

patients who have had an emergency extraction, and a new prosthesis is unavailable. However, it should be used in the short term when waiting for hard or soft tissue grafting and implant. Moreover, it is inappropriate for occlusal function restoration and use in patients with a high lip line who are aware of esthetics.[19]

The advantages of a clear retainer with a prosthesis are its low cost, abutment teeth conservation, short fabrication time and the provision of good retention. Moreover, it can be used immediately for tooth replacement after dental extraction and it does not impede wound healing if it is relieved around the area of the dental socket. However, it presents a slight compromise in terms of esthetics and it has poor color stability in the long-term, thus it should be used temporarily.[19]

Loss of clear retainers is one of the problems that often occurs. The technique for preventing this problem is to add a colored stripe along the lingual border of the retainer to make it visible.[4]

EFFECTIVENESS IN MAINTAINING DENTAL POSITION

Rowland *et al.*[16] compared the effectiveness of using a Hawley retainer and a clear retainer for 6 months and found that no statistically significant differences in tooth rotation, intercanine width and intermolar width were found in either maxillary or mandibular arches. However, the results found significant changes in the irregularity of incisors with a Hawley retainer and the mandibular labial segment has greater irregularity than the maxillary labial segment. In addition, there was no clinically significant difference unless single-tooth displacement is located in the mandibular arch. Another study also showed more irregularity in both maxillary and mandibular arches in the Hawley group than in the vacuum-formed retainer group, even though no statistically significant difference was found.[3] Moreover, Demir *et al.*[21] also investigated the clinical effectiveness of clear and Hawley retainers at 1 and 2 years after the treatment phase and showed that clear retainers were more effective for mandibular anterior teeth retention. Thus, they concluded that both types of retainer were successful but the vacuum-formed retainer is more effective at holding the correction of incisors on both arches, especially in the mandible.[3,16,21] In addition, patients were more compliant with vacuum-formed retainers than Hawley retainers[22] and they have semi-elasticity and shape-memory so minor relapses can be corrected.[2] These factors might be related to irregularity on both arches. Although clear retainer is effective at maintaining the position of incisors, in the case of a patient with severe pretreatment dental rotation, especially in the lower incisors, a fixed retainer was suggested to used combined with an Essix® retainer.[10]

With the use of thermoplastic retainers, intercanine and intermolar width was maintained[16,21] and no statistically significant differences were found at any time interval between part-time and full-time wear groups.[23] However, in patients with an expanded arch, the Hawley retainer is the retainer of choice due to its sufficient rigidity.[14]

OCCLUSION

Achieving occlusal stability is a goal of retention. Occlusal contacts or centric stops are one of the important factors that have an effect on occlusal stability. Moreover, increasing occlusal contacts in centric occlusion can reduce the force distributed on the teeth.[24] Good occlusal contacts and intercuspation are important factors for stable orthodontic results.[25] Therefore, the ideal retainer should enable occlusal settling.[4]

A previous study determined the change of occlusal contact in centric occlusion during retention with a full-coverage Essix® retainer at 9 months and 2.5 years. Regimens for using retainers are 6 months full-time use and 3 months night-time use. The results showed that no significant change was found in the number of posterior teeth occlusal contacts at 9 months whereas posterior occlusal contact significantly increased at 2.5 years. They concluded that occlusal contacts did not increase because Essix® retainers covered occlusal surfaces of the teeth. In addition, after Essix® retainer removal, teeth continued mobility and occluded each other.[8] Moreover, another study also showed that after 3 months of using clear retainers, posterior occlusal settling was significantly less likely to occur than with Hawley retainers. The regimen for using a Hawley retainer was 3 months' full-time use while the clear retainer was 3 days' use and nightly thereafter. Thus,

it was concluded that the Hawley retainer enables settling of occlusion whereas the clear retainer holds teeth in a debonding position.[7] Thus, before using a clear retainer for retention, good posterior intercuspation has to be created when debonding.

Many studies found that a clear retainer created anterior open bite. Jäderberg *et al*.[26] found no significant change in overbite during the use of a clear retainer for a 6-month observation phase, which is in line with Lindauer and Shoff.[3] However, Sheridan *et al*.[2] reported that slight bite opening was detected by clinicians in 2.3% of their patients, but the amount of bite opening was very small so the patients did not notice the change. Furthermore, many clinicians reported that individual cases of anterior open bite after using an Essix® retainer are probably because of disclusion of posterior teeth while anterior teeth are in contact with the Essix® retainer.[3] Moreover, canine to canine Essix® retainers was used on the mandibular arch in the studies of Sheridan *et al*.[2] and Jäderberg *et al*.[26] Therefore, a theoretical risk of anterior open bite does exist due to the eruption of posterior teeth.

RETENTION REGIMEN

Although removable retainers have many advantages, a long period of full-time use is required and that is an obstacle for many young patients.[27] Immediate full-time use of an Essix® retainer after debonding is suggested but there are many opinions about the length of time. Although periodontal fibers take a minimum of 232 days for reorganization,[28] previous studies recommended different durations of full-time use. For example, Rowland *et al*.[16] suggested 1 week whereas Wang[17] recommended 2 months and Lindauer and Shoff[3] showed that 3 months of full-time use is effective.

A previous study compared full-time and part-time use of an Essix® retainer by measuring the irregularity index, intercanine width, intermolar width, arch length, overbite and overjet at 6 months and 1 year after debonding. The regimen for the full-time group was 3 months' full-time use and 10 h/day of part-time use. The results showed no statistically significant differences in the irregularity index, intercanine width, intermolar width, arch length and overjet whereas overbite increased statistically significantly in the part-time group. However, the difference was 0.6 mm and it may not be clinically significantly noticeable. Therefore, part-time wearing of an Essix® retainer was suggested.[23]

Another study evaluated and compared the stability of Essix® retainer use after 6 months between 3 months' full-time wear and 1 week of full-time wear. After full-time use, night-time use was recommended for both groups. The study found that the 1-week full-time group had higher irregularity but there was no significant difference between the groups. In addition, no significant differences in overjet and overbite were found over a 6-month observation period. Thus, night-time wear after 1 week of full-time wear was sufficient for stabilization after orthodontic treatment.[26]

Although many previous studies have investigated the effectiveness and stability of using an Essix® retainer after orthodontic treatment with full-time use, 6 months is a short observation period when studying. However, it coincides with the reorganization period, which takes around 200 days.[26] It would be more interesting if longitudinal studies with a 1–5-year follow-up period or longer were constructed to evaluate the effectiveness of retention regimens.

THICKNESS

Nowadays, there are various thicknesses of plastic sheet on the market. However, thicknesses ranging from 0.63 to 2.0 mm have been used in previous studies[2,7,16,29] and vacuum-formed retainer sheet thicknesses of 1.0 mm (68%) and 0.75 mm (16%) were most commonly recommended by orthodontists.[30] Moreover, one study showed that Essix® retainers that had <0.35 mm thickness were capable of maintaining dental irregularity, overjet, and overbite. Therefore, the thickness of a clear retainer is not prone to be a factor for maintaining dental position.[26]

In a previous study, 0.75 mm-thick thermoplastic sheets were used and it was found that they broke at the midline.[31] However, bruxism was not investigated in this study. Bruxism could be the cause of breakage because vacuum-formed retainers cover occlusal surfaces, and they can be broken under the stresses from functional and parafunctional activities.[22] Thus, this condition of a patient is an important factor that should be evaluated to make a decision on choosing the thickness of plastic sheets. For a patient who has bruxism, thicker sheets should be used. Moreover, the property of the plastic sheets should be considered in terms of durability, wear, and impact resistance. In addition, these patients should wear a clear retainer during the day instead of at night to lengthen the lifetime of the clear retainer.

SURVIVAL RATE

A previous study compared the survival time of a Hawley retainer and a clear retainer for 1 year and found no statistically significant difference between the groups in

either the maxillary or mandibular arch.[31] However, the duration of use for both types of retainer is different. The Hawley retainer was prescribed for longer periods, i.e., 3 and 6 months' full-time wear, whereas patients receiving clear retainers were instructed to wear retainers full-time but for <3 months. Moreover, patient compliance was not presented. Other recent prospective randomized trial studies showed that survival rates of vacuum-formed retainers were 6.6%–20% and 6.6%–73% due to loss and breakage, respectively.[15,31]

There are many factors that can shorten the lifetime of a clear retainer; for example, wear and flexibility make it more prone to cracking, staining and oral fluid absorption. Moreover, it tends to break from the stresses of functional and parafunctional activities because it covers occlusal surfaces whereas a Hawley retainer does not cover occlusal surfaces,[22] so this type of retainer can be worn full-time, including by patients who have bruxism.

CONCLUSION

Even though many studies have indicated that clear retainers have many advantages,[2-4,15] many factors should be considered before choosing the type of retainer, for example periodontal and occlusal factors, soft tissue pressures and growth,[1] along with the cost, fabrication, risk of breakage, patient compliance, and patient preference or satisfaction.[7]

Besides the types of retainer that affect the effectiveness of stabilization, minimizing the chance of relapse is also important. To reduce relapse, the existing arch form, intercanine width and anteroposterior position of the lower incisors should be maintained.[32,33] Circumferential fiberotomy should be carried out after dental derotation.[28] Moreover, interdental stripping of interproximal contacts for triangular lower incisors to increase the size of the contact area can reduce relapse.[34] In patients who still have growth, active retention of skeletal change throughout growth is required.[25] In addition, frenectomy should be considered for patients with median diastema.[35]

Although many previous studies have investigated the effectiveness of maintaining dental position and preventing teeth from relapse, further studies are still needed. However, studies of long-term postorthodontic retention are difficult to undertake as financially demanding and long-term follow-up of patients is difficult.[36] Longitudinal studies with a 1–5 years follow-up period and possibly longer are required.[26] Moreover, few studies have evaluated the suitable thickness of retainers, and thus further studies are necessary.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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