

# Comparison of survival time of Hawley and Vacuum-formed retainers in orthodontic patients– a randomized clinical trial

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## Abstract

**Background:** Maintaining the results of orthodontic treatment and keeping the teeth in the corrected position is a great challenge in orthodontics. This study aimed to compare the survival time of three types of retainers including Hawley, 1-mm Vacuum-Formed (VF), and 1.5-mm VF within 6-month period. **Methods:** In this randomized clinical study, 152 patients were allocated into three groups to receive one type of the retainers. They were visited 1, 3, and 6 months after retainer delivery and checked for breakage, loss, local perforation, and discoloration from the patient's and clinician's point of view as indicators of failure. Chi-square and Fisher's exact tests were used as appropriated. **Result:** The results revealed that breakage was among the main reasons of failure of retainers within 6 months, which was statistically significantly different between Hawley and VF retainers, as well as between 1-mm and 1.5-mm VF retainers in the three intervals ( $p < 0.05$ ). Concerning the loss of retainer and discoloration from the clinician's point of view, there was no significant difference between the retainers in any interval ( $p > 0.05$ ). Assessing the discoloration from the patient's point of view revealed statistically significant differences between Hawley and VF retainers within the first month; however, the difference was not significant at the third and sixth months ( $p < 0.05$ ). The difference between the two thicknesses of VF retainer was not significant in any interval ( $p > 0.05$ ). By the end of the sixth month, some of the VF retainers had perforation; while, perforation was not observed in Hawley retainers.

**Conclusion:** Considering the higher breakage rate of 1-mm VF, 1.5-mm VF seems the retainer if choice.

**Key words:** survival time; retainer; Hawley retainer; Vacuum-formed retainer;

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Receive date: 2016-11-01 | Accept date: 2016-12-21 | Publish date: 2017-02-10

DOI: 10.7575/aiac.abcm.17.05.01.02



## Introduction

The success of treatment in orthodontics is determined by facial esthetics, occlusion, and stability.(1) Maintaining the results of orthodontic treatment and keeping the teeth in the corrected position is a great challenge in orthodontics. As stated by Angle, retention problems are greater than the difficulties being encountered in orthodontic treatments.(2)

Several attempts to find the best strategy of stabilizing the teeth in the new position after orthodontic treatment and to prevent relapse have resulted in introduction of various fixed and removable retainers.(3) Among the removable retainers, Hawley, Vacuum-Formed, Begg, and Positioner are more frequently used than others.

Choosing the appropriate type of retainer for each patient requires considering several factors, namely, the patient's pre-treatment conditions, age, oral health, and periodontal status, as well as his preference.(4) Since there are not adequate scientific evidence, the decision depends mostly on the clinician's personal preferences. To improve the treatment stability and patient cooperation, the orthodontists mainly adopt a combined use of various removable and fixed retainers.(5)

Having been introduced nearly hundred years ago, Hawley is among the most prevalent appliances of removable retention in orthodontic clinics.(6) The patients might find this retainer esthetically inconvenient because the labial bow that is made up of round steel wire contacts the labial surface of 4 or 6 anterior teeth.(1)

Attempting to overcome the esthetic problem of Hawley retainers, Sheridan and colleagues introduced Essix appliances or Vacuum-Formed (VF) retainers, in 1993, as a replacement for the conventional retainers. These transparent retainers have become

increasingly popular in recent years due to several reasons such as ease of fabrication, improved esthetic, and lower cost.(7,8) The patients mostly prefer the nearly-invisible VF retainers. Despite multiple advantages, these transparent retainers often become opaque, eroded, cracked, or ruptured over time.(5,7,9)

Several studies have investigated different aspects of success and failure of Hawley and VF removable retainers. Having compared the efficiency of these two, some researchers declared that the retention created by Hawley is insufficient due to the single-point contact of the wire on the labial surface and an acrylic mass in proximity of lingual cervix of anterior teeth. Meanwhile, VF retainer thoroughly encapsulates the dentition and the superior part of alveolus, thus providing better retention.(7)

Several studies have also assessed and compared the role of these two types of retainer in maintaining the intercanine width, intermolar width, rotation, overjet, overbite,(10) and occlusal contacts.(11,12) Some investigations compared their speech articulation during retention.(13)

Most orthodontists prescribe a period of full-time wear of retainers and recommend continuing their part-time use throughout the life; hence, endurance and persistence of retainer are of paramount importance. If short-lived, the economic burden increases on the patient, consequently the patient cooperation and treatment outcome would be negatively impressed.(14)

Multiple studies has been carried out on the endurance of bonded retainers; whereas, only few prospective investigations assessed the survival time of removable retainers. Previous systematic studies mentioned the lack of adequate clinical evidence about the survival time of removable retainers. Comprehensive



clinical studies have been suggested to evaluate and compare the survival rate of Hawley and VF removable retainers.(15,16)

Nor was found any inclusive clinical study on the effect of different thicknesses of VF retainers on their survival rate. Hence, the present clinical study was designed to assess and compare the survival rate of Hawley, and the most commonly-used thicknesses of VF removable retainers (1-mm and 1.5-mm VF) within 6 months.

### Materials and Method

In this multicentric clinical study, the target population was patients whose comprehensive orthodontic treatment was performed and finished in the researchers' private office. The patients were gradually enrolled with informed consent until the required number of subjects was achieved.

According to Hichens et al. (2007),the prevalence of fracture of Hawley retainer during the retention period was 19%. Considering a clinically significant difference of 15%,  $\alpha=0.05$ , and power=80%, the required number of samples should be 105. With regard to the sample attrition in long-term studies, a total of 152 patients were recruited to increase the reliability of the study.

The inclusion criteria were having finished the orthodontic treatment in an optimal occlusion, indication of using removable retainer, and the patient's willingness to participate in the study. The exclusion criteria were having several missing teeth and the need for prosthetic replacement, bruxism, syndromic diseases (e.g. cleft lip and cleft palate, hemifacial microsomia), allergic sensitivity to acrylic resin, temporomandibular joint problems, oral habits that would cause malocclusion, patients with maxillary expansion treatments, preterm debonding, and generalized spacing.

The subjects were randomly allocated into three groups according to the table of random numbers retrieved from [www.randomizer.org](http://www.randomizer.org) website for each center. The patients in each of the three groups received fixed bonded retainer in the mandible. In the maxilla, the first group was administered with Hawley removable retainer, the second group received 1.5-mm VF retainer, and the third group received 1-mm VF retainer.

By the end of orthodontic treatment when the subjects were ready for debonding, the brackets were removed, impression was taken by using alginate material (Tropicalgin Zhermark; Italy), and retainers were fabricated on the plaster model. The removable Hawley retainers prepared in each center consisted of Adams Clasp on the first molar teeth, labial bow with 28-mil SS wire (Dentaurum, Germany) and self-cure acrylic (Dentaurum; Germany). The VF retainers made of 1- and 1.5-mm thermoplastic platens (3A Co.; Korea) were trimmed in a way that they lie along the gingival margin in the buccal surface, 3-4 mm beyond the gingival margin in the lingual surface, and cover the most distal tooth in the occlusal surface.

A time interval of 1-2-days was considered between taking the impressions and placing the retainers. Prior to being delivered, the retainer was checked for accordance, presence of any plausible damage, and patient comfort. The patients were trained to wear the retainer at all times, except when eating. Regardless of the type of retainer, the patients in each center received identical practical instructions on how and when to use and health care. The printed instruction was also handed out to the patients

In order to determine the survival time of retainers, special forms were prepared to record breakage (wire components or base of the retainer), lose, perforation or any type of abrasion that would result in perforation observable with naked eyes. Minor cracks on



the surfaces were not considered as breakage unless their spreading would make the retainer useless.

The patients were followed up at 1, 3, and 6 months after placing the appliances to evaluate the survival time of retainers. Since the assessment was performed by clinicians, clinician blindness was impossible. It should be noted that the survival time was only calculated for the main retainer (the first retainer).

The obtained data were statistically analyzed by using SPSS software, version 22. First, the descriptive parameters were calculated in each group. Then to evaluate the frequency of breakage in the three types of retainer at different time intervals, Chi-square and Fisher's exact tests were used ( $\alpha=0.05$ ).

## Results

Out of 152 participants, 117 were females and 35 were males. There were 52 subjects in Hawley group (39 females and 13 males), 52 in 1-mm VF group (40 females, 12 males), and 48 in 1.5-mm VF group (38 females, 10 males). The patients were sex-matched, there was no statistically significant difference between the two sexes regarding the distribution of retainers ( $p=0.885$ ). Matching was also done

on the retainers distributed among the clinicians and no statistically significant difference was noted ( $p=0.397$ ). Having not referred at the scheduled appointment, a number of patients were excluded from the study.

## Breakage

The most common reason of replacing the retainer within the 6-month period was breakage of the retainer. Table 1 shows that 1 month after retainer delivery, 4.5% breakage was observed in 1.5-mm VF retainer, and 20% in 1-mm VF group. No retainer breakage was noted in Hawley group. Based on the results of Fisher's exact test, breakage was significantly different between Hawley and VF groups 1, 3, and 6 months after retainer delivery ( $p=0.009$ ,  $p=0.042$ , and  $p=0.017$ , respectively). However, significantly different breakages were observed between different thicknesses of VF retainers only after 1 month ( $p=0.031$ ); their difference was not significant at the third and sixth months ( $p=0.227$  and  $p=0.717$ , respectively). The highest rate of breakage in 6-month period was noted in 1-mm VF retainer (41.2%).

Types of Retainer	Breakage	N (%)	1 month		3 months		6 months	
			Yes	No	Yes	No	Yes	No
			Hawley	0 (0.0)	46 (100)	1 (3.2)	30 (96.8)	1 (5.6)
VFR 1.5mm	2 (4.5)	42 (92.5)	4 (11.1)	32 (88.9)	4 (33.3)	8 (66.7)		
VFR1mm	10 (20)	40 (80)	9 (23.1)	30 (76.9)	7 (41.2)	10 (58.8)		
*p value to compare Hawley and VF			0.009		0.042		0.017	
*p value to compare types of VF			0.031		0.227		0.717	

\*p value from Fisher's exact test

**Table 1:** Frequency of breakage of different retainers in the three intervals

Types of Retainer	Loss	N (%)	1 month		3 months		6 months	
			Yes	No	Yes	No	Yes	No
Hawley		N (%)	2 (4.2)	46 (95.8)	2 (6.3)	30 (93.8)	0 (0.0)	18 (100)
1.5-mm VF		N (%)	2 (4.3)	44 (95.7)	2 (5.4)	35 (94.6)	1 (7.7)	12 (92.3)
1-mm VF		N (%)	0 (0.0)	50 (100)	0 (0.0)	40 (100)	0 (0.0)	18 (100)
*p value to compare Hawley and VF			0.601		0.579		0.633	
*p value to compare types of VF			0.227		0.228		0.419	

\*p value from Fisher's exact test

**Table 2:** Distribution of lost retainers within the three time intervals

### Loss

Table 2 shows that losing the retainer within the first month was 4.2% in Hawley, 4.3% in 1.5-mm VF, and zero in 1-mm VF group. No significant difference was noted between loss of the Hawley and VF retainers at 1-, 3-, and 6-month intervals ( $p=0.601$ ,  $p=0.579$ , and  $p=0.633$ , respectively). No significant difference was noted between 1-mm and 1.5-mm VF retainers at the three intervals ( $p=0.227$ ,  $p=0.228$ , and  $p=0.419$ , respectively).

### Discoloration

Being considered as another influential factor of the retainer survival time, discoloration was investigated from both the patient's and clinician's the point of view in the current study.

### Discoloration from the patients' point of view

The obtained results demonstrated that discoloration within the first month was 2.2% in Hawley, 18.2% in 1.5-mm VF, and 22.4% in 1-mm VF group. Accordingly, discoloration was significantly different between Hawley and VF retainers in the first month ( $p=0.004$ ); and

insignificant at the third and sixth months ( $p=0.106$ ,  $p=0.140$ , respectively). As demonstrated in Table 3, there was no significant difference between discoloration of 1-mm and 1.5-mm VF retainers in the first, third, and sixth months ( $p=0.797$ ,  $p=0.793$ , and  $p=0.459$ , respectively).

### Discoloration from the clinician's point of view

From the clinicians' point of view after one month, discoloration was 10.9% in Hawley, 18.2% in 1.5-mm VF, and 18.4% in 1-mm VF group. No significant difference existed between Hawley and VF retainers in terms of discoloration in the first, third, and sixth month ( $p=0.328$ ,  $p=0.501$ , and  $p=0.769$ , respectively). Nor was significant difference noted between 1-mm and 1.5-mm VF retainers at any of the time intervals ( $p=1.000$ ,  $p=0.627$ , and  $p=0.252$ , respectively) (Table 4).

### Perforation

Assessing the frequency of perforations created in retainers revealed no significant difference between Hawley and VF retainers in the first month after retainer delivery ( $P=1.000$ ). In the third month, the frequency of

perforations was 17.1% in 1.5-mm VF, 30.6% in 1-mm VF, and 0% in Hawley retainers (no perforation), indicating a statistically significant difference between Hawley and VF retainers at this interval ( $p= 0.02$ ). This difference was also significant in the sixth month ( $p= 0.04$ ). Comparison of the frequency of perforation

revealed no significant difference between 1-mm and 1.5-mm VF in any of the time intervals ( $p= 0.496$ ,  $p=0.267$ , and  $p=0.673$ , respectively) (Table 5).

Types of Retainer	Discoloration	N (%)	1 month		3 months		6 months	
			Yes	No	Yes	No	Yes	No
Hawley		N (%)	1 (2.2)	45 (97.8)	7 (23.3)	23 (76.7)	6 (33.3)	12 (66.7)
1.5-mm VF		N (%)	8 (18.2)	36 (81.8)	9 (25.7)	26 (74.3)	8 (66.7)	4 (33.3)
1-mm VF		N (%)	11 (22.4)	38 (77.6)	11 (30.6)	25 (69.4)	8 (50.0)	8 (50.0)
* $p$ value to compare Hawley and VF			0.004		0.106		0.140	
* $p$ value to compare types of VF			0.797		0.793		0.459	

\* $p$  value from Fisher's exact test

**Table 3:** Distribution of retainer discoloration from the patients' point of view at the three time intervals

Types of Retainer	Discoloration	N (%)	1 month		3 months		6 months	
			Yes	No	Yes	No	Yes	No
Hawley		N (%)	5 (10.9)	41 (89.1)	9 (30)	21 (70.0)	8 (44.4)	10 (55.6)
1.5-mm VF		N (%)	8 (18.2)	36 (81.8)	12 (34.3)	23 (65.7)	8 (33.3)	4 (66.7)
1-mm VF		N (%)	9 (18.4)	40 (81.6)	15 (41.7)	21 (58.3)	6 (37.5)	10 (62.5)
* $p$ value to compare Hawley and VF			0.328		0.501		0.769	
* $p$ value to compare types of VF			1.000		0.627		0.252	

\* $p$  value from Fisher's exact test

**Table 4:** Distribution of retainer discoloration from the clinician's point of view within the three time intervals

Types of Retainer	Perforation	N (%)	1 month		3 months		6 months	
			No	Yes	No	Yes	No	Yes
Hawley			46 (100.0)	0 (0.0)	30 (100.0)	0 (0.0)	18 (100.0)	0 (0.0)
VFR1.5mm			44 (100.0)	0 (0.0)	29 (82.9)	6 (17.1)	10 (83.3)	2 (16.7)
VFR 1 mm			47 (95.9)	2 (4.1)	25 (69.4)	11 (30.6)	13 (76.5)	4 (23.5)
*p value to compare Hawley and VF			1.000		0.02		0.04	
*p value to compare types of VF			0.496		0.267		0.673	

\*p value from Fisher's exact test

**Table 5:** Comparison of the frequency of perforations in the three study groups at different time intervals

Six months after retainer delivery, 16.7% of 1.5-mm VF retainers were perforated and they all had 2 perforations. On the other side, 23.5% of 1-mm VF retainers were perforated, 25% of which had 1 perforation, and 75% had more than 3 perforations.

## Discussion

The results of this study revealed that VF retainers were more susceptible to breakage than Hawley retainer in 1-, 3-, and 6-month intervals ( $p=0.009$ ,  $p=0.042$ , and  $p=0.017$ , respectively). Within the first month, 1-mm VF retainers experienced more breakage than 1.5-mm VF retainers ( $p=0.031$ ). However, they had no statistically significant difference at the third and sixth months ( $p=0.227$  and  $p=0.717$ , respectively).

With respect to the shape of Hawley retainers, as well as the relatively high coverage of palatal surface in this type of retainer, lower breakage compared with the VF retainers is

expected. Comparing the two types of VF retainers in the first month, breakage was higher in 1-mm VF than that in 1.5-mm type; however, in the third and sixth months, they had no statistically significant difference. It might indicate the breakage resistance of 1.5-mm VF in the first month, deterioration of this resistance and increased breakage in the following months.

Concerning the losing of retainer and discoloration from the clinician's point of view, there was no significant difference between VF and Hawley retainers, nor between the two thicknesses of VF retainers ( $p>0.05$ ).

In terms of discoloration from the patient's point of view within the first month, VF retainer represented more discoloration than Hawley retainer ( $p=0.004$ ). Yet, the difference was not significant in the following months ( $p=0.106$  and  $p=0.140$ , respectively). In the same regard, the two types of VF retainer were not significantly different in any of time intervals

( $p=0.797$ ,  $p=0.793$ , and  $p=0.459$ , respectively). The higher discoloration of VF retainer compared with Hawley was expected in the first month. In the following months, discoloration was still higher in VF groups; although, the difference was not statistically significant. It can be concluded that discoloration occurs earlier in VF retainer and later in Hawley.

Perforation was not observed in any of Hawley retainers; whereas, a considerable percent of VF retainers were perforated. These findings are justifiable according to the shape of Hawley retainers and the fact that it does not cover the occlusal surface of teeth.

There are only few studies on the survival time of removable retainers whose results can be compared with those of the current study. One of the prominent findings of this study was the statistically considerably different breakage between Hawley and VF retainers, and on the other hand between 1-mm and 1.5-mm VF retainers.

Sun J *et al.* reported no statistically considerable difference between the survival time of Hawley and 0.75-mm VF retainers.(17) That study did not separately investigated different causes and factors that affected the survival time of retainers. They reported the results under the general title of survival time. Furthermore, mandibular retainers (Hawley and VF) were also included in the study. Apparently, their results cannot be comparable to ours.

Based on our results, losing the retainers was not considerably different between Hawley and VF retainers; whereas, Sun J *et al.* reported the rate of lost retainer to be higher in transparent retainers than that in Hawley. This contradiction might be due to the difference in the time intervals, which was 1, 3, and 6 months in our study; while, Sun J *et al.* assessed this factor after one year. In other words, long-term wear of the retainer that probably

decreases the daily hours of wearing the retainer, increases the possibility of losing VF retainer because of transparency and lower visibility.

Hichens *et al.* (2007) evaluated the breakage in Hawley and VF retainers within 6 months, and reported higher breakage rate in Hawley retainers.(18) Such difference with the current study can be attributed to the fact that they did not clearly explained the details of VF and Hawley retainers, besides their different definition of breakage.

Mc Dermott (2008) mentioned breakage (28%), abrasion (28%), and losing (14%) as the main problems of using VF retainers.(19) In the present study, breakage, loss, and perforation caused by abrasion were the major causes of failure of VF retainers.

Campbell *et al.* (2009) reported that the main reason for replacing the VF retainers within one year was over-abrasion. Likewise, we observed that abrasion-caused perforation was among the reasons of failure of VF retainers.

In a study, Pratt reported that 10% of all participants lost their retainers within 2 years.(20) In our study, losing was evaluated as a reason of failure of the studied retainers; however, the retainers had no significant difference in terms of being lost within 6 months. Concerning other reasons for replacement of the retainer, namely perforation and discoloration of the retainer, there was no similar clinical study to be compared with the present one.

## Conclusion

With respect to the results of this study, it can be concluded that:

- concerning the breakage, there were statistically significant differences between Hawley and VF retainers, and also between 1-mm and 1.5-mm VF



retainers within the three time intervals.

- There was no statistically significant difference between the studied retainers within the three time intervals concerning losing the retainer and discoloration from the clinician's point of view. Nevertheless, discoloration from the patient's point of view was found to be significantly

different between Hawley and VF retainers within the first month. Yet, the two thicknesses of VF retainer had no statistically significant difference in any of the studied time intervals.

- By the end of the sixth month, some of VF retainers had perforation; whereas, Hawley retainers had no perforation.

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