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Comparison of Two Retention Appliances with Respect to Clinical Effectiveness in preventing Relapse.

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ABSTRACT

OBJECTIVE:

This study aimed to compare the clinical effectiveness of Essix and Hawley retainers during the orthodontic retention phase**.**

METHODS:

Thirty subjects who completed fixed orthodontic treatment were evaluated using the American Board of Orthodontics Phase III Objective Grading System. After appliance removal, participants were randomly assigned to either upper-lower Essix or upper-lower Hawley retainer protocols. All subjects wore their retainers full-time for 6 months (except during meals), then nights-only for another 6 months. Clinical effectiveness was assessed by measuring overjet, overbite, maxillary and mandibular intercanine widths, intermolar widths, arch lengths, irregularity indexes, and lateral cephalometric parameters at three time points: pre-treatment, post-treatment, and post-retention. All measurements were performed by the same investigator**.**

RESULTS:

No statistically significant differences were found between the Essix and Hawley groups in overjet, overbite, intercanine widths, intermolar widths, arch lengths, or lateral cephalometric measurements across all time points. Both groups showed a slight, non-significant increase in maxillary and mandibular irregularity indexes from post-treatment to post-retention.

INTRODUCTION

Long-term stability of treatment outcomes is a key indicator of success in orthodontic therapy (11). Achieving stability requires a balance between forces exerted by gingival and periodontal tissues, orofacial soft tissues, occlusion, and post-treatment facial growth and development (1). At this stage, it becomes crucial to understand the requirements of the retention phase and identify the factors that contribute to relapse (10).

Relapse is defined as the tendency of dental and skeletal corrections, achieved both aesthetically and functionally, to return toward their pre-treatment conditions following active orthodontic therapy (12). A critical factor in preventing relapse is allowing sufficient time for the reorganization of gingival and periodontal tissues and stabilization of the modified morphology and function, along with growth-related changes (12). Therefore, the use of retainers following active orthodontic treatment is essential to maintain results and prevent relapse (9).

Retainers used during the retention phase are broadly categorized into removable and fixed types (12,13). Among removable retainers, Essix, Hawley, and Positioners are commonly used, whereas fixed retainers include devices made from polyethylene, fiber-reinforced resin composites, and the widely preferred multistranded stainless steel wires, as recommended by Zachrisson in 1977 (3,4,12).

Although there is no definitive consensus regarding which type of retainer is most effective or the optimal duration for its use, both Essix and Hawley retainers are frequently employed in clinical orthodontic practice (9). Comparative studies evaluating Essix and Hawley retainers have focused on aspects such as periodontal health and patient compliance , cost-effectiveness , number of occlusal contacts , survival time , and clinical effectiveness (20,26). Studies assessing clinical parameters like overjet, overbite, intercanine and intermolar widths, arch length, and irregularity index have generally reported no significant differences between the two retainer types (20,26). Moreover, the existing literature suggests insufficient evidence to definitively conclude which retainer offers superior effectiveness (9).

Additionally, Sheridan et al. (19) noted that the Hawley retainer's design might provide inadequate retention for anterior teeth due to the limited contact of the labial bow and the acrylic coverage near the cervical region.

Therefore, the present study aims to compare the clinical effectiveness of Essix and Hawley retainers over a one-year retention period. The null hypothesis posited that there would be no difference in clinical effectiveness between the two types of retainers.

METHODS

This study included 30 patients who had completed fixed orthodontic treatment using the straight-wire technique with 0.018-inch slot Roth brackets.

Inclusion criteria were: Class I skeletal pattern, no history of previous orthodontic treatment, completion of treatment with fixed appliances, achievement of optimum occlusion, suitability for retainer use and long-term follow-up, and good oral hygiene.

Exclusion criteria included the necessity for a bonded retainer, the requirement to include a pontic in the retainer due to congenital tooth absence, presence of cleft lip and palate, or history of orthognathic surgery.

The study protocol was approved by Ethics Committee. Informed consent was obtained from all participants, or their legal guardians, after providing detailed information about the study.

Before debonding, treatment outcomes were assessed using the Objective Grading System of the American Board of Orthodontics Phase III clinical examination.

Following the removal of fixed appliances with a debonding plier (Dentaurum, Pforzheim, Germany), residual adhesive was eliminated using a 12-bladed tungsten carbide bur (Axis Dental, Irving, Texas) at low speed under water-cooling. Tooth surfaces were then polished with fluoride-free pumice (İmıpomza, İmıcryl, Konya, Turkey). Alginate impressions were taken, and dental models of the upper and lower arches were prepared.

Participants were randomly assigned to two groups based on the type of retainer. Fifteen patients (8 extraction, 7 non-extraction cases) received upper and lower Essix retainers (Dentsply Raintree Essix, New Orleans, Louisiana, USA), and fifteen patients (7 extraction, 8 non-extraction cases) received upper and lower Hawley retainers. The type of retainer was randomly selected by the dental technician.

Essix retainers were fabricated by thermoforming 0.040-inch thick sheets according to the manufacturer's instructions. They were trimmed to cover all occlusal surfaces, including the most distal teeth, with a 1–2 mm buccal extension and a 3–4 mm lingual extension, avoiding gingival impingement (Figure 1a).

Hawley retainers were constructed using Adams clasps on the first molars, a labial bow extending from canine to canine, and an acrylic baseplate. The Adams clasps and labial bows were fabricated with 0.7 mm stainless steel wire (Figure 1b).

Figure 1. Retainers used in this study: (A) Essix retainer and (B) Hawley retainer.

Patients were instructed to wear their retainers full-time (except during meals) for the first six months, followed by nighttime wear only for the subsequent six months.

Retention outcomes were assessed through analysis of lateral cephalometric radiographs and dental models obtained at pre-treatment, post-treatment, and post-retention stages.

All cephalograms were taken with the patients in centric occlusion, lips relaxed and closed, using the same Sirona Orthophos XG system (Bensheim, Germany). Subjects' heads were stabilized with ear rods placed in the external auditory meatus, ensuring the Frankfurt horizontal plane was parallel to the floor and perpendicular to the sagittal plane (24).

Cephalometric analyses were performed using the NemoCeph NX 2005 software (Nemotec, Madrid, Spain) to evaluate dental and skeletal changes. Angular and linear measurements assessed are listed in Table 1.

Table 1. Lateral cephalometric measurements

Measurement	***Angular and Linear Measurements***
1-NA (mm)	Distance between the most labial point of maxillary incisor and the NA line
1-NA (°)	Angle formed between the long axis of maxillary incisor and the NA line
1-SN (°)	Angle formed by the extension of the long axis of maxillary incisor to the SN plane
1-NB (mm)	Distance between the most labial point of mandibular incisor and the NB line
1-NB (°)	Angle formed between the long axis of mandibular incisor and the NB line
IMPA (°)	Angle formed by the extension of long axis of mandibular incisor to the mandibular plane
U1L1 (°)	Angle formed by the extensions of long axes of maxillary incisors to the mandibular incisors
SN/GoGn (°)	Angle formed between the mandibular plane (GoGn) and the SN plane

Additionally, dental models were used to measure overjet, overbite, maxillary and mandibular intercanine widths, intermolar widths, arch lengths, and Little's Irregularity Index (Figure 2) (21,23). Little's Irregularity Index was calculated by summing the linear displacements of anatomical contact points between the five anterior teeth in both the maxillary and mandibular arches, parallel to the occlusal plane (21). Measurements were taken using a digital caliper (Mitutoyo Corp., Kanagawa, Japan) with an accuracy of 0.01 mm.

All cephalometric and dental model measurements were conducted by the same investigator (MT) to ensure consistency.

STATISTICAL ANALYSIS

Measurement precision and intra-examiner reliability were assessed, yielding a high intraclass correlation coefficient (ICC = 0.890, $p < 0.001$). Random measurement error was calculated using Dahlberg's formula, revealing error values ranging from 0.056 to 0.042 mm for linear measurements and from 0.29° to 0.14° for angular measurements.

Based on previous studies where the standard deviation (s) varied between 0.4 and 4, a standard deviation value of 2 was adopted for the present study. Assuming an effect size (d) of 1 and a Z value of 1.96 for a 0.05 Type I error rate, the required sample size was calculated using the formula:(n = (n=Z2 s2/d2) resulting in a sample size of 15.13, rounded to 15 subjects per group.

Descriptive statistics for continuous variables were expressed as mean, standard deviation, minimum, and maximum values, while categorical variables were reported as frequencies and percentages.

To compare groups and time periods for continuous variables, a repeated measures analysis of variance (ANOVA) with two factors was employed (time as the dependent factor and treatment as the independent factor). Post-hoc comparisons were conducted using the Duncan multiple comparison test.

A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software, version 13.0 (SPSS Inc., Chicago, IL, USA)

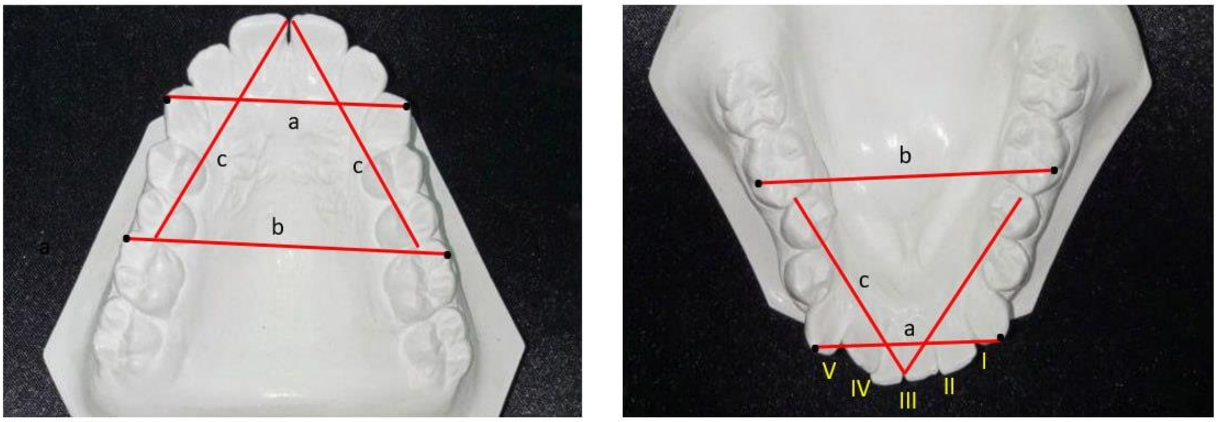

Figure 2. Dental model measurements: Irregularity Index (I+II+III+IV+V); (a) Intercanine width; (b) Intermolar width; (c) Arch length.

RESULTS

The mean age of patients in the Essix group was 17.53 ± 3.89 years, and in the Hawley group, it was 16.54 ± 2.24 years. The mean treatment durations were 2.90 ± 0.62 years for the Essix group and 3.11 ± 0.53 years for the Hawley group. No statistically significant differences were observed between the groups in terms of the number of patients, mean age, or mean treatment durations (Table 2).

Table 2. Descriptive statistics

		Number of Patients (n)					
		Extraction	Non-extraction	**Mean±SD**	**Min.**	**Max.**	**p**
Mean Age	Essix	8	7	17.53±3.89	11.16	23.5	0.402
	Hawley	7	8	16.54±2.24	13.00	19.00	
	Total	15	15	17.03±3.16	11.16	23.5	

Treatment Duration	Essix	8	7	2.90±0.62	2.00	3.75	0.306
	Hawley	7	8	3.11±0.53	1.91	4.00	
	Total	15	15	3.01±0.58	1.91	4.00	

The pre-treatment, post-treatment, and post-retention dental model measurements for both the maxillary and mandibular arches in the Essix and Hawley groups are provided in Table 3. There were no statistically significant differences between the groups or time points for overjet, overbite, maxillary and mandibular intercanine widths, intermolar widths, or arch lengths.

Furthermore, although both the maxillary and mandibular irregularity indexes increased from the post-treatment to the post-retention phase, these differences were not statistically significant.

Lateral cephalometric measurements at pre-treatment, post-treatment, and post-retention stages for the Essix and Hawley groups are shown in Table 4. No statistically significant differences were found between the groups or time points for the lateral cephalometric measurements.

Table 3. Pre-treatment, post-treatment, and post-retention maxillary and mandibular dental model measurements

		ESSIX (MEAN±SD)	HAWLEY (MEAN±SD)	P
OVERJET	Pre-treatment	2.93±2.16a	2.58±1.59a	0.620
	Post-treatment	2.26±0.78a	2.03±0.69a	0.399
	Post-retention	2.37±0.62a	2.33±0.72a	0.850
	p	0.347	0.414	
OVERBITE	Pre-treatment	3.16±2.29a	3.30±2.33a	0.877
	Post-treatment	2.27±0.88a	2.51±0.92a	0.485
	Post-retention	2.70±0.87a	2.70±1.24a	0.996
	p	0.256	0.409	
MAXILLA	Irregularity Index			
	Pre-treatment	7.92±4.09a	7.60±3.67a	0.827
	Post-treatment	0.76±0.47b	0.87±0.88b	0.647
	Post-retention	1.23±0.70b	1.56±1.07b	0.322
	p	0.001	0.001	
	Intercanine Width			
	Pre-treatment	33.84±2.51a	33.84±2.21a	0.997
	Post-treatment	34.21±2.20a	33.98±1.85a	0.764
	Post-retention	34.60±2.37a	34.15±1.71a	0.566
	p	0.667	0.916	
	Intermolar Width			
	Pre-treatment	49.19±4.71a	49.89±4.19a	0.671
	Post-treatment	48.10±2.78a	48.46±3.27a	0.749
	Post-retention	49.12±2.68a	48.74±3.99a	0.756
	p	0.623	0.582	
	Arch Length			
	Pre-treatment	66.11±8.19a	66.34±5.63a	0.931
	Post-treatment	62.29±6.45a	63.50±7.09a	0.627
	Post-retention	62.98±5.75a	64.05±6.42a	0.634

	p	0.255	0.468	
MANDIBLE	Irregularity Index			
	Pre-treatment	5.68±3.76a	4.50±2.44a	0.322
	Post-treatment	0.83±0.57b	0.98±0.63b	0.484
	Post-retention	1.55±0.97b	1.71±1.15b	0.682
	p	0.001	0.001	
	Intercanine Width			
	Pre-treatment	25.60±2.50a	26.37±2.31a	0.389
	Post-treatment	25.77±2.05a	26.07±1.58a	0.664
	Post-retention	25.43±2.12a	25.67±1.42a	0.730
	p	0.912	0.593	
	Intermolar Width			
	Pre-treatment	48.81±2.73a	49.49±4.35a	0.606
	Post-treatment	48.05±1.70a	48.42±3.10a	0.687
	Post-retention	49.02±1.67a	49.34±4.58a	0.794
	p	0.394	0.750	
	Arch Length			
	Pre-treatment	55.32±5.19a	55.77±5.01a	0.199
	Post-treatment	54.20±5.04a	56.26±5.06a	0.323
	Post-retention	54.18±4.91a	56.06±5.99a	0.292
	p	0.809	0.380	

Table 4. Pre-treatment, post-treatment, and post-retention lateral cephalometric measurements

Lateral Cephalometric Measurements		**Essix (Mean±SD)**	**Hawley (Mean±SD)**	**p**
SNA	Pre-treatment	80.77±3.30a	79.13±3.42a	0.244
	Post-treatment	80.24±2.85a	79.26±3.08a	0.376
	Post-retention	80.31±2.94a	79.09±3.30a	0.259
	p	0.862	0.768	
SNB	Pre-treatment	78.49±3.56a	76.34±3.78a	0.121
	Post-treatment	77.94±3.00a	76.24±3.36a	0.153
	Post-retention	77.87±3.06a	76.03±3.50a	0.345
	p	0.765	0.981	
ANB	Pre-treatment	2.26±1.97a	2.98±2.02a	0.330

	Post-treatment	2.21±1.91a	2.85±1.88a	0.366
	Post-retention	2.22±1.84a	3.16±1.52a	0.142
	p	0.998	0.398	
SN/GoGn	Pre-treatment	32.09±5.46a	31.19±4.65a	0.574
	Post-treatment	32.29±5.02a	32.05±5.01a	0.895
	Post-retention	32.33±4.73a	31.65±5.02a	0.715
	p	0.989	0.898	
1-NA (mm)	Pre-treatment	5.02±2.55a	3.74±1.66a	0.120
	Post-treatment	3.10±2.03b	2.88±1.80a	0.756
	Post-retention	3.19±2.10b	2.91±1.68a	0.699
	p	0.031	0.336	
1-NA (°)	Pre-treatment	22.76±7.56a	21.34±6.40a	0.586
	Post-treatment	19.67±5.44a	19.14±5.35a	0.790
	Post-retention	19.49±5.98a	19.23±5.43a	0.854
	p	0.278	0.526	
1-SN (°)	Pre-treatment	103.04±7.22a	101.54±5.42a	0.532
	Post-treatment	99.89±6.74a	98.96±6.67a	0.706
	Post-retention	100.28±6.79a	98.78±6.90a	0.553
	p	0.383	0.548	
1-NB (mm)	Pre-treatment	3.64±1.72a	4.01±1.26a	0.505
	Post-treatment	3.21±1.53a	3.64±0.92a	0.376
	Post-retention	3.20±1.52a	3.66±0.90a	0.335
	p	0.679	0.562	
1-NB (°)	Pre-treatment	41.36±5.54a	25.72±6.85a	0.465

	Post-treatment	23.69±5.77a	25.39±4.17a	0.370
	Post-retention	24.17±6.48a	25.26±4.74a	0.606
	p	0.465	0.973	
IMPA (°)	Pre-treatment	90.59±7.91a	96.09±6.55a	0.050
	Post-treatment	91.51±7.71a	95.64±5.70a	0.111
	Post-retention	91.92±7.74a	95.85±5.94a	0.134
	p	0.886	0.981	

DISCUSSION

Existing literature indicates that no single type of retainer is universally recognized for long-term stability, with variability in retainer types and wear durations reported (17,28). Notably, no significant difference has been found between retention protocols that involve either night-time wear only for 1 year or a 6-month full-time wear followed by 6 months of night-only wear. Proffit (12) emphasized that the retention phase should last at least 12 months, suggesting that reducing wear time to 4-6 months post-treatment could allow for night-time wear only. Consistent with these guidelines, the present study adopted a 1-year retention protocol, with the first 6 months of full-time wear followed by 6 months of night-time wear.

Meade and Millett (15) found that orthodontists commonly recommend Essix retainer sheets with thicknesses between 0.75 mm and 1 mm. In a study by Zhu et al. (28), no significant differences were noted between 0.75 mm and 1 mm Essix retainers in terms of survival time, failure rate, or patient comfort. For this reason, we opted for a 1 mm (0.040-inch) Essix retainer thickness in our study.

While there is insufficient evidence to definitively determine which retainer type is more effective (9), clinical effectiveness was assessed by examining parameters such as overjet, overbite, maxillary and mandibular intercanine widths, intermolar widths, arch lengths, and irregularity indexes. Lindauer and Shoff (29) evaluated these parameters over a 6-month retention period and found no statistically significant differences between groups, although increased crowding was observed in the Hawley group for both dental arches. Barlin et al. (29) also reported no significant differences in intercanine and intermolar widths, arch length, or irregularity indexes at the 2nd, 6th, and 12th months of retention. However, Ramazanzadeh et al. (6) found significantly lower upper arch length and irregularity indexes in the Essix group by the 8th month of retention. In our study, no significant differences in overjet, overbite, intercanine widths, intermolar widths, or irregularity index were observed between the Essix and Hawley groups during the 1-year retention phase.

Rowland et al. (26) compared the clinical effectiveness of Essix and Hawley retainers after extraction and non-extraction orthodontic treatments over 6 months. They found no significant differences in rotation or intercanine and intermolar widths, which aligned with our results. However, for Little's irregularity index, the Essix retainer proved more effective in both maxillary and mandibular labial segments, especially in the lower arch. Babacan et al. (30) also found that Essix retainers had a greater effect on reducing mandibular anterior crowding compared to Hawley retainers, although their study did not include cephalometric measurements or arch lengths.

Demir et al. (20) conducted a similar comparison of Essix and Hawley retainers over 1 year of retention, followed by a 2-year follow-up period. In line with our findings, they observed no statistically significant differences in intercanine widths, maxillary arch lengths, or mandibular arch lengths in the Essix group. In the Hawley group, however, mandibular arch length showed a statistically significant difference between the post-treatment and 2-year follow-up periods, although other time periods showed no significant change. Little's irregularity index showed significant differences in both groups, with the Essix retainer proving more efficient in the mandibular anterior region during retention.

Gómez-Gómez et al. (31) also found no significant difference in dental stability between Essix and Hawley retainers over 6 months of retention, although they did not provide pre-treatment cephalometric data.

A gradual decrease in arch length and the potential for anterior crowding, particularly in the lower arch due to the absence of third molars, may occur during the retention period (31). Maintaining pre-treatment arch forms is crucial for achieving long-term stability, as intercanine and intermolar widths that increase during treatment tend to decrease afterward (33). This suggests that even with well-functioning occlusion after orthodontic treatment, relapse may occur over time, and patients should be made aware of this possibility.

The primary limitations of this study include the small sample size, lack of post-retention follow-up, and the focus on only two types of retention protocols. Future studies with larger sample sizes, longer follow-up periods, and additional retainer types in both extraction and non-extraction cases are recommended.

CONCLUSION

There were no significant statistical differences between the Essix and Hawley retainers with respect to overjet, overbite, maxillary and mandibular intercanine widths, intermolar widths, or arch lengths.

While the maxillary and mandibular irregularity indexes showed an increase from the post-treatment to the post-retention phase, these changes were not statistically significant.

Lateral cephalometric measurements taken at pre-treatment, post-treatment, and post-retention phases revealed no significant differences either between or within the groups.

ETHICS COMMITTEE APPROVAL:

This study was approved by the Ethics Committee of

Informed Consent: Written informed consent was obtained from all participants involved in the study.

Peer Review: The study underwent external peer review.

Conflict of Interest: The authors declare no conflicts of interest.

Financial Disclosure: This research did not receive any financial support.

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