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Assessing the Impact of Removable Orthodontic Retainers on Oral Health Related Quality of Life: Non-Randomized Clinical Trial

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A B S T R A C T

Objectives: This study aimed to compare the oral health-related quality of life (OHRQoL) and self-perceived satisfaction of patients wearing Hawley (HR) or Essix retainer (ER) using the Oral Health Impact Profile (OHIP-14) questionnaire.

Materials and Methods: Sixty patients who had recently completed orthodontic treatment and received either an HR or ER were recruited. Participants completed the OHIP-14 questionnaire one week (T_1) and two months (T_2) after receiving their retainers. Self-perceived satisfaction with the retainers was also recorded.

Results: The ER group showed significantly lower overall OHIP-14 scores than the HR group at both T_1 and T_2. In 14 OHIP items, HR scored higher in all except "sense of taste" (T_1 and T_2), "unsatisfactory diet" (T_1), and "uncomfortable eating" (T_2). From T_1 to T_2, overall OHIP-14 scores decreased significantly in both groups, with reductions in 10 items for ER and 8 items for HR. The mean satisfaction score (out of 3) was higher for ER (2.5±0.5) than for HR (1.23±0.43), and satisfaction increased significantly in both groups over time.

Conclusion: ER had less negative impact on OHRQoL than HR. After two months, most OHIP-14 dimensions showed improvement in both groups, indicating patient adaptation to retainers and reduced discomfort over time. Adaptation was slightly greater with ER, and overall satisfaction was higher compared to HR.

Keywords: Appliance; Removable Orthodontic; Orthodontic Retainer; Quality of Life; Questionnaire

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INTRODUCTION

Following a course of fixed orthodontic therapy, a prolonged period is required to rebuild the alveolar bone and allow adaptive changes in soft tissues and muscles surrounding the dentition [1]. Thus, it is paramount to use retainers to achieve a long-term stable result [2]. Post-treatment changes have long been considered one of the most challenging aspects of orthodontic care. Therefore, when orthodontic therapy is completed, regular use of retainers for at least two years is necessary, while adults are often advised to wear them for an even longer duration [3,4].

Hawley retainers (HRs) and vacuum-formed retainers (VFRs)—also known as Essix retainers (ERs)—are the most commonly used removable retainers [5]. Since 1919, HRs have been widely applied in clinical practice. An HR consists of clasps, a labial wire, and a resin base situated on the lingual surface of the teeth [6]. Reported disadvantages of HRs include impaired esthetics due to the visibility of the labial wire and speech problems caused by palatal coverage of the resin

plate [7]. More recently, ERs have gained popularity due to advantages such as improved esthetics, simple fabrication, and lower cost. However, disadvantages such as susceptibility to cracking, discoloration, and occlusal wear have also been noted [8,9].

Several investigations have evaluated the effectiveness of HRs and ERs. In terms of maintaining post-treatment results, the evidence is controversial. Some studies reported similar effectiveness in maintaining incisor alignment but differences in maintaining arch expansion [10,11], while others reported no significant differences in arch width stability [8]. A systematic review concluded that there was insufficient evidence to favor either retainer with respect to occlusal contacts, cost-effectiveness, patient satisfaction, or survival time [12]. Consequently, when selecting a retainer type following fixed appliance therapy, patient-related factors such as comfort and preference may play a more decisive role.

Inadequate patient cooperation is widely recognized as a challenge in the use of removable retainers [13]. Pain associated with orthodontic appliances has been shown to negatively affect both acceptability and compliance [14]. Other common complaints include speech difficulties [15], excessive salivation, and embarrassment [16]. Several approaches have been proposed to increase compliance, including rewards and attractive appliance designs. However, the success of these strategies ultimately depends on patient acceptance. Orthodontists must therefore select a removable retainer that ensures both adequate retention and good acceptance, thereby enhancing long-term treatment stability. The less an appliance disrupts daily function and comfort, the more likely patients are to cooperate.

Functional and emotional impacts of retainers are difficult to measure due to their subjective nature. Previous studies comparing HRs and ERs have shown that HRs impair speech more significantly by affecting articulatory movements [17]. In terms of patient satisfaction, no significant difference in discomfort has been reported between groups; however, greater embarrassment was noted with HRs compared to ERs, particularly regarding speech and esthetics [18]. As such, studies have evaluated these factors using different scales, leading to variability and making it difficult to draw definitive conclusions.

Recently, increasing attention has been given to assessing emotional and functional impacts through oral health-related quality of life (OHRQoL). OHRQoL reflects how oral conditions affect quality of life across multiple dimensions [14]. Several instruments have been developed for this purpose, including the Oral Health Impact Profile (OHIP-14) [15]. This questionnaire consists of 14 items across seven dimensions [19], covering functional limitations, social disability, and handicaps [20]. The Persian version of OHIP-14 has been validated as a reliable tool for evaluating OHRQoL among native Persian speakers [21].

While fixed retainers are more frequently used, removable retainers depend heavily on patient cooperation. If these appliances negatively affect quality of life, compliance may decrease, ultimately compromising treatment outcomes. To the authors' knowledge, no research has specifically examined how removable retainers affect OHRQoL. Therefore, this non-randomized clinical trial was conducted to assess and compare OHRQoL and self-perceived satisfaction in patients wearing HRs and ERs, using the OHIP-14 questionnaire.

MATERIALS AND METHODS

This non-randomized clinical trial was conducted to evaluate and compare the oral health–related quality of life (OHRQoL) of patients wearing two types of removable retainers, HRs and ERs, using the OHIP-14 questionnaire. The study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, Tehran University of Medical Sciences (TUMS), Tehran, Iran, from July to September 2021. The protocol was approved by the TUMS School of Dentistry Ethics Committee (approval number IR.TUMS.DENTISTRY.REC.1400.094). Based on $\alpha=0.05$, $\beta=0.2$, a standard deviation of 9.52, and a power of 80%, the minimum sample size was calculated to be 20 patients per group.

Eligible participants were adults (≥18 years) who had recently completed fixed orthodontic treatment, with a prescribed retention

protocol consisting of a removable retainer for the upper jaw and a fixed retainer for the lower jaw. Patients with cleft palate or lip, orofacial syndromes, systemic disease, mental retardation, tooth malformation or agenesis, or who had undergone orthognathic surgery were excluded.

All patients had received fixed orthodontic treatment in both jaws at the orthodontic department of TUMS. Removable retainers (HR or ER) were prescribed and delivered for the maxilla according to treatment plan and patient preference. Participants were informed about the study, and those who agreed to participate signed a written consent form. The OHIP-14 questionnaire was administered one week (T_1) and two months (T_2) after retainer delivery. Patients were enrolled until the sample size exceeded the minimum requirement by 10%.

Retainers were fabricated to standardized designs by one trained laboratory technician. HRs consisted of an acrylic plate, stainless steel labial bows with U-loops passing distal to the canines, and two Adams clasps on the first permanent molars. Wires passing through occlusal embrasures were tightly adapted to avoid interference with opposing teeth. ERs were fabricated from 1-mm polycarbonate sheets using a Biostar® machine (Iserlohn, Germany), cut to provide 2-mm buccal and 3–4-mm palatal extensions, and covered the occlusal surfaces of all teeth except the terminal molars.

All retainers were fitted on the day of debonding or the following day. Patients were instructed to wear them 24 hours a day for the first six months, followed by 12 hours a day (nighttime only) for the next six months [22]. Both written and verbal instructions were provided. In cases of loss or breakage, patients were instructed to return promptly for replacement.

OHRQoL was assessed using the validated Persian version of the OHIP-14 [21], which includes 14 items across seven conceptual dimensions: functional limitation, pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Responses were rated on a five-point Likert scale (0= never, 1= hardly ever, 2= occasionally, 3= fairly often, 4= very often) [23]. Total OHIP-14 scores ranged from 0 to 56, with higher scores indicating greater impact. Additionally, participants rated their overall satisfaction with their retainers on a 0–3 scale (0= completely dissatisfied, 1= relatively dissatisfied, 2= relatively satisfied, 3= completely satisfied).

One week after delivering the retainers, the patients were asked to fill out the OHIP-14 questionnaire. After 2 months, the patients were reminded to fill out the same questionnaire for the second time [7]. For those patients who could not attend their dental visit, the questionnaire was sent virtually and filled out in an online interview. The patients who failed to answer the questionnaire for the second time were excluded from the study.

Retainers were delivered, and the patients' data were registered by one researcher (ASS) and the other researcher (RB), who interviewed the patients for filling out the questionnaire, was unaware of the patient's group or the questionnaire's administration timing during data processing. The laboratory technician who made the retainers was unaware that they were manufacturing retainers for participants in this experiment.

Statistical analysis was performed using SPSS version 26 (SPSS Inc., Chicago, IL, USA). Independent t-tests were used to compare groups at each time point and to evaluate changes in OHIP-14 scores over time. The Wilcoxon signed-rank test was applied to compare overall satisfaction scores and OHIP dimensions. A p-value<0.05 was considered statistically significant.

RESULTS

Participants and follow-up:

The OHIP-14 questionnaire was administered to 85 patients who had completed orthodontic treatment. The response rate was 72.8% (60 of 85). A total of 30 males and 30 females participated, equally distributed across the two study groups. The mean age of participants was 24.17±5.45 years in the ER group and 22.27±3.74 years in the HR group, with no significant difference between groups (p>0.05).

OHIP-14 scores:

The mean overall OHIP-14 scores and scores for individual items are summarized in Table 1.

Table 1. Oral Health Impact Profile questionnaire at one-week (T1) and two months after receiving their retainers (T2) in Essix and Hawley retainer groups (mean± SD).

Questions	Essix			Hawley		
	T_1	T_2	P#	T_1	T_2	P#
Functional limitation						
1- Have you had trouble pronouncing any words because of problems with your retainer?	0.84±0.74+	0.37±0.49X	0.006*	3.07±0.78	2.63±0.72	0.030*
2- Have you felt that your sense of taste has worsened because of problems with your retainer?	0.77±1.35	1.20±0.76	0.132	1.27±0.98	1.07±1.26	0.495
Physical pain						
3- Have you had painful aching in your mouth?	0.77±1.13+	0.43±0.63X	0.164	2.43±1.41	1.43±1.19	0.004*
4- Have you found it uncomfortable to eat any foods because of problems with your retainer?	0.44±0.68+	0.47±0.68	0.850	1.67±1.56	0.6±0.85	0.002*
Psychological discomfort						
5- Have you been self-conscious because of your retainer?	1.57±1.35+	0.47±0.73X	0.000*	2.70±1.39	2.43±1.16	0.425
6- Have you felt tense because of problems with your retainer?	0.4±0.81+	0.07±0.25X	0.036*	2.07±1.68	0.77±1.07	0.001*
Physical disability						
7- Has your diet been unsatisfactory because of problems with your retainer?	0.27±0.58	0.00±0.00X	0.015*	0.47±0.82	0.34±0.48	0.445
8- Have you had to interrupt meals because of problems with your retainer?	0.4±1.07+	0.00±0.00X	0.045*	1.57±1.61	0.23±0.43	0.000*
Physical discomfort						
9- Have you found it difficult to relax because of problems with your retainer?	0.37±0.67+	0.07±0.25X	0.025*	1.83±1.62	2.10±1.21	0.474
10- Have you been a bit embarrassed because of problems with your retainer?	0.23±0.50+	0.07±0.25X	0.111	1.40±1.30	0.50±0.94	0.003*
Social disability						
11- Have you been a bit irritable with other people because of problems with your retainer?	0.23±0.43+	0.00±0.00X	0.004*	1.77±1.71	0.94±0.94	0.023*
12- Have you had difficulty doing your usual jobs because of problems with your retainer?	0.43±0.68+	0.13±0.43X	0.046*	1.20±0.92	1.13±0.63	0.745
Handicap						
13- Have you felt that life in general was less satisfying because of problems with your retainer?	0.3±0.59+	0.00±0.00X	0.008*	1.30±1.62	0.27±0.58	0.002*
14- Have you been totally unable to function because of problems with your retainer?	0.13±0.35+	0.00±0.00X	0.039*	0.67±0.88	0.63±0.56	0.862
OHIP-14	10.34±1.8+	5.8±3.5X	0.005*	17.9±3.27	10.8±1.98	0.025*

#p value; *p value<0.05 means significant difference between T_1 and T_2 in whether ER or HR; +p value<0.05 means significant difference between ER and HR at T1; X p value<0.05 means significant difference between ER and HR at T_2. T_1.

Overall OHIP-14 scores decreased significantly over time in both groups (ER: p=0.005; HR: p=0.025). Scores were highest at T_1 in the HR group and lowest at T_2 in the ER group. In the ER group, 10 of 14 items showed a significant reduction from T_1 to T_2, with the exception of "taste worse," "painful aching," "discomfort during eating," and "embarrassment". In the HR group, significant reductions were observed in most items except "taste worse," "self-conscious," "unsatisfactory diet," "difficulty relaxing," "difficulty doing jobs," and "total function". Interestingly, the response to "difficulty relaxing" increased slightly from T_1 to T_2, but the change was not significant (p=0.474).

Table 2 shows mean changes across OHIP-14 dimensions. Both ER and HR groups demonstrated reductions in all dimensions from T_1 to T_2 (p<0.05). These reductions were significant in all dimensions except functional limitation (p=0.89) and physical pain (p=0.50) in the ER group, and psychological disability (p=0.14) in the HR group. Overall satisfaction increased significantly over time in both groups (ER: p=0.02; HR: p=0.01).

Table 2. Comparison of the mean of Oral Health Impact Profile (OHIP-14) dimensions in each group between one-week (T1) and two months after receiving their retainers (T2).

Dimension	T_1 vs. T_2	
	Essix	Hawley
Functional limitation	0.89	0.02*
Physical pain	0.50	0.001*
Psychological discomfort	<0.001*	0.001*
Physical disability	0.01*	0.001*
Psychological disability	0.02*	0.14
Social disability	0.01*	0.02*
Handicap	0.01*	0.02*
Total score of OHIP-14	0.001*	<0.001*
Self-perceived satisfaction	0.02*	0.01*

Wilcoxon Signed Rank Test; *p value<0.05.

Comparison between retainers:

Table 1 also compares OHIP-14 scores between groups. The overall score was significantly lower in the ER group than in the HR group at both T_1 (p=0.006) and T_2 (p<0.001). At T_1, significant differences between ER and HR were observed in all items except "taste worse" (p=0.107) and "unsatisfactory diet" (p=0.281). At T_2, ER scores remained significantly lower for most items, with no significant differences for "taste worse" (p=0.621) and "uncomfortable eating" (p=0.507). According to Table 3, ER had significantly lower OHIP scores than HR in all but three items. "Worsening of taste" showed no difference at either time point. "Uncomfortable eating" was not significantly different at T_2, while "unsatisfactory diet" was not significantly different at T_1.

Table 3. Comparison of the mean of Oral Health Impact Profile (OHIP-14) dimensions between Essix and Hawley groups in each time.

Dimension	Essix vs. Hawley	
	T_1	T_2
Functional limitation	<0.001*	<0.001*
Physical pain	<0.001*	0.004*
Psychological discomfort	<0.001*	<0.001*
Physical disability	0.002*	<0.002*
Psychological disability	<0.001*	<0.001*
Social disability	<0.001*	<0.001*
Handicap	0.02*	<0.001*
Total score of OHIP-14	<0.001*	<0.001*
Self-perceived satisfaction	<0.001*	<0.001*

*p value<0.05. T_1 one week and T_2 two months after retainer delivery.

Response variation:

Figure 1 illustrates the variation in responses. In the ER group, OHIP scores ranged from 0% to 40% across dimensions, whereas in the HR group, heterogeneity was greater, with scores ranging from 0% to 100%. Overall, variation in responses was larger in the HR group, though variability decreased over time in both groups.

Self-perceived satisfaction:

At T_1, mean self-perceived satisfaction was significantly higher in the ER group (2.50±0.50) than in the HR group (1.23±0.43; p<0.001). At T_2, satisfaction increased in both groups, reaching 2.23±0.43 in the ER group and 1.63±0.85 in the HR group (p<0.001). In both groups, satisfaction improved significantly over time (T_1 to T_2).

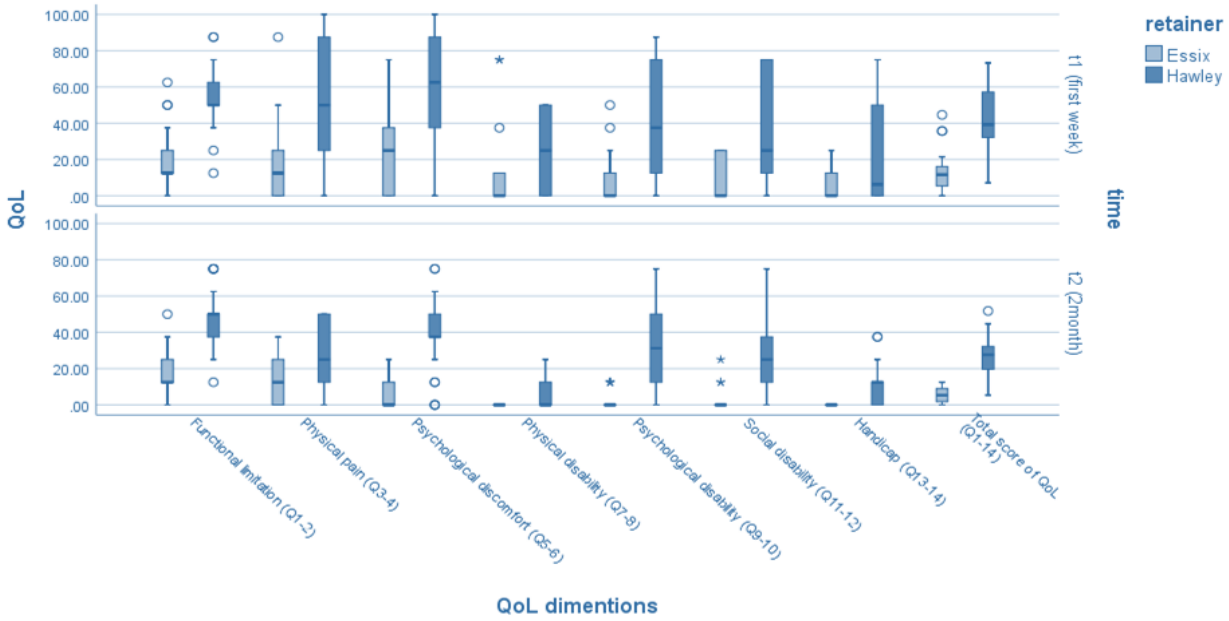

Fig 1. variation in responses to various questionnaire dimensions

DISCUSSION

Evaluating OHRQoL is highly recommended when developing oral health prevention and treatment programs. Recently, orthodontists have placed greater emphasis on patient-based measures such as OHRQoL. Although orthodontic treatment improves OHRQoL by correcting malocclusion—a condition with significant psychosocial implications—the use of orthodontic appliances can impair OHRQoL during treatment [24–26]. This is particularly relevant for removable appliances, as discomfort may reduce patient compliance and jeopardize treatment outcomes [27,28].

Although fixed retainers bonded to the lingual surface of anterior teeth are the most common retention method, removable retainers remain widely used, particularly in the upper jaw [29]. Their advantages explain their continued application [30]. First, removable retainers are associated with less plaque and calculus accumulation and reduced gingival inflammation compared with fixed retainers, making them more favorable for oral hygiene [29]. Second, their removability provides convenience and flexibility in social settings. Third, Medina et al.[31] reported that upper fixed retainers negatively affected patients' quality of life during the early weeks following treatment completion—a critical period for maintaining treatment results. However, the effectiveness of removable retainers is highly dependent on patient compliance [32]. Given the physical, practical, and emotional impacts of orthodontic appliances, it is important to evaluate their influence on patients' OHRQoL and self-perceived satisfaction [27,28,33]. The present study aimed to compare the effects of two commonly used removable retainers, ER and HR, on patients' OHRQoL and satisfaction. The findings show that both HRs and ERs affect OHRQoL, with HRs impairing it more than ERs. Overall OHIP-14 scores were higher in the HR group at both T_1 and T_2. However, scores declined in both groups over time, suggesting that patients adapt to their retainers. Statistically significant differences between HRs and ERs were observed across multiple OHIP-14 domains. After one week, ERs had less impact on speech and eating than HRs. This aligns with Saleh et al. (2018), who attributed the finding to the minimal palatal coverage of ERs, which reduces tongue interference during speaking and eating [7].

The significantly higher level of social ability and considerably lower level of handicap with the ER may be attributable to the retainer's clear appearance, reduced visibility, and increased speaking ability. Additionally, the significantly higher level of physical comfort with the ER may

be attributable to the retainer's lighter weight and less mucosal coverage. The only item which was not significantly different between ER and HR whether in T_1 or T_2 was sense of taste. This can be attributed to the fact that patients normally remove their retainers during eating food. These differences remained significant after two months, except for patient discomfort while eating. This (uncomfortable to eat) was mostly due to a decrease in the level of discomfort with the HR and no significant changes in the level of discomfort with the ER, which may result from patients getting more adapted in removing their retainers before eating [34,35].

Another noteworthy finding was the improvement in OHRQoL over time. From T_1 to T_2, OHIP scores decreased for 10 items in the ER group and 8 items in the HR group, indicating slightly greater adaptation to ERs. Previous studies have similarly reported that the negative effects of orthodontic appliances on OHRQoL diminish with time [25,36–38]. According to the findings of this study, patients with ERs were significantly more satisfied than HRs across all domains and overall satisfaction. This result concurred with Hichens et al. (2007), who assessed patient satisfaction and discovered that wearing an ER causes less embarrassment than wearing a HR [39]. A similar result was reported in a study by Pratt et al. (2011), who observed that following debonding of fixed appliances, patients were more compliant with the ER than the HR [40]. ERs are made of clear plastic and are more aesthetically pleasing and lighter than HRs, which have a stainless-steel wire across the labial surface of the anterior teeth [12].

Additionally, speech articulation may be a factor in patient satisfaction; the present study demonstrated that the HR impacted speaking [18,41]; other studies reported that both the HR and ER might contribute to speech difficulties [17,42–44]; however, HR-induced speech disturbances were more pronounced and lasted longer [17,43]. The observed association between HRs and articulation difficulties may result from the retainer's design interfering with the tongue and making word articulation more difficult. Moreover, previous research indicated that the retainer caused temporary speech changes, although patients were able to adapt their speech patterns and reported rapid tongue adaptation [41].

The number of daily, weekly, and monthly hours varies from patient to patient, and there is no standard protocol [45]. In the application of removable retainers, the duration of wear is beyond the orthodontist's control, and the patient's cooperation is crucial in the utilization of removable appliances [46]. The OHRQoL significantly influences the patient's cooperation in wearing the retainer during the retention phase [47]. The results of this study indicate that OHIP-14 scores decreased significantly over two months, indicating an improvement in OHRQoL during the retention phase.

In summary, during the study period, the ER had a less negative effect on patients' quality of life and function. Although patients' satisfaction with the HR was variable in the first week, and data related to it were heterogeneous, data homogeneity increased over time, and most patients reported compliance with the retainer. The HR's larger volume, metal wire components, and palatal coverage were all possible reasons for users' dissatisfaction with this retainer. In comparison, patients with ERs adjusted faster, possibly due to their clear appearance and light weight, which had no negative impact on their daily performance.

The current study has several strengths compared with previous research. A major strength is the use of the comprehensive OHIP-14 questionnaire to assess quality of life across multiple dimensions. Unlike earlier studies that relied on self-developed questionnaires or limited response options (such as simple yes/no formats), the OHIP-14 provides a more detailed and standardized measure of quality of life. However, it is important to acknowledge that the current study also has some methodological limitations. First, participants were recruited from a single clinic, which may limit the generalizability of the findings. Future research would benefit from including participants from multiple clinics or more diverse settings to ensure a

more representative sample. Second, this study focused only on adults aged 18 years and older. Patients under 18 may also use retainers and could experience different impacts on their quality of life. For example, the type of retainer may influence younger patients' ability to attend school or participate in academic activities. Future studies should therefore include a broader age range to capture these experiences. Third, data variability in the present study made it difficult to assess potential correlations between gender, education, and quality of life. Increasing the sample size in future research would allow for more robust analyses and clearer examination of these relationships. Therefore, to gain a deeper understanding of how different retainer types affect patients' well-being and satisfaction with orthodontic treatment, further long-term studies with larger, more diverse samples—including both fixed and removable retainers—are needed.

CONCLUSION

The findings of this study indicate that patients' OHRQoL was less impaired by (ERs) than by HRs. In most of the 14 items of OHIP, the score of HR was higher than those of ER, particularly in domains related to psychological discomfort, speech ability, appearance, self-consciousness, social interactions, relaxation, and comfort. In contrast, differences between the two groups were minimal for items related to taste and eating. The impact of wearing retainers on OHRQoL decreased over time, suggesting that patients gradually adapted to their appliances. This adaptation was observed across more OHIP items in the ER group than in the HR group. Overall satisfaction was consistently higher among ER users compared with HR users, and satisfaction improved over time in both groups.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Li B, Xu Y, Lu C, Wei Z, Li Y, Zhang J. Assessment of the effect of vacuum-formed retainers and Hawley retainers on periodontal health: A systematic review and meta-analysis. PLoS One 2021;16:e0253968.
2. Steinnes J, Johnsen G, Kerosuo H. Stability of orthodontic treatment outcome in relation to retention status: An 8-year follow-up. Am J Orthod Dentofacial Orthop. 2017 Jun;151(6):1027-1033.
3. Al-Moghrabi D, Pandis N, Fleming PS. The effects of fixed and removable orthodontic retainers: a systematic review. Prog Orthod 2016;17:24.
4. Lyros I, Tsolakis IA, Maroulakos MP, Fora E, Lykogeorgos T, Dalampira M, et al. Orthodontic Retainers—A Critical Review. Children 2023;10:230.
5. Johnston CD, Littlewood SJ. Retention in orthodontics. Br Dent J 2015;218:119-22.
6. Wong PM, Freer TJ. A comprehensive survey of retention procedures in Australia and New Zealand. Aust Orthod J 2004;20:99-106.
7. Saleh M, Hajeer MY, Muessig D. Acceptability comparison between Hawley retainers and vacuum-formed retainers in orthodontic adult patients: a single-centre, randomized controlled trial. Eur J Orthod 2017;39:453-61.
8. Barlin S, Smith R, Reed R, Sandy J, Ireland AJ. A retrospective randomized double-blind comparison study of the effectiveness of Hawley vs vacuum-formed retainers. Angle Orthod 2011;81:404-9.
9. Gardner GD, Dunn WJ, Taloumis L. Wear comparison of thermoplastic materials used for orthodontic retainers. Am J Orthod Dentofacial Orthop. 2003 Sep;124(3):294-7.
10. Rowland H, Hichens L, Williams A, Hills D, Killingback N, Ewings P, et al. The effectiveness of Hawley and vacuum-formed retainers: a single-center randomized controlled trial. Am J Orthod Dentofacial Orthop. 2007 Dec;132(6):730-7.
11. Blake M, Garvey MT. Rationale for retention following orthodontic treatment. J Can Dent Assoc 1998;64:640-4.
12. Mai W, He J, Meng H, Jiang Y, Huang C, Li M, et al. Comparison of vacuum-formed and Hawley retainers: a systematic review. Am J Orthod Dentofacial Orthop. 2014 Jun;145(6):720-7.
13. Geramy A, Retrouvey JM, Sobuti F, Salehi H. Anterior Teeth Splinting After Orthodontic

Treatment: 3D Analysis Using Finite Element Method. J Dent (Tehran) 2012;9:90.
14. Alzoubi E, Hariri R, Mulligan K, Attard N. An evaluation of oral health-related quality of life in orthodontic patients treated with fixed and twin blocks appliances. J Orthod Sci 2017;6:65-70.
15. Alzarea BK. Assessment and Evaluation of Quality of Life (OHRQoL) of Patients with Dental Implants Using the Oral Health Impact Profile (OHIP-14) - A Clinical Study. J Clin Diagn Res. 2016 Apr;10(4):ZC57-60.
16. Locker D, Quiñonez C. To what extent do oral disorders compromise the quality of life? Community Dent Oral Epidemiol 2011;39:3-11.
17. Atik E, Esen Aydinli F, Kulak Kayikçi ME, Ciger S. Comparing the effects of Essix and Hawley retainers on the acoustics of speech. Eur J Orthod. 2017 Aug 1;39(4):440-445.
18. Najjar HE, Alzaid SA, Alasmari AM, Alrashdi SA, Alqahtani AM, Alrhile SM, et al. Impact of orthodontic treatment on speech and phonetics: a review. Int J Community Med Public Heal 2023;10:2995.
19. Shueb SS, Nixdorf DR, John MT, Alonso BF, Durham J. What is the impact of acute and chronic orofacial pain on quality of life? J Dent 2015;43:1203-10.
20. Brennan DS, Spencer AJ. Dimensions of oral health related quality of life measured by EQ-5D+ and OHIP-14. Health Qual Life Outcomes 2004;2:35.
21. Ravaghi V, Farrahi-Avval N, Locker D, Underwood M. Validation of the Persian short version of the Oral Health Impact Profile (OHIP-14). Oral Health Prev Dent. 2010;8(3):229-35.
22. Proffit WR, Fields HW, Larson BE, Sarver DM. Contemporary orthodontics 6th edition William proffit. 2019;6:579-85.
23. Barkokebas A, Silva IHM, de Andrade SC, Carvalho AAT, Gueiros LAM, Paiva SM, et al. Impact of oral mucositis on oral-health-related quality of life of patients diagnosed with cancer. J Oral Pathol Med 2015;44:746-51.
24. De Oliveira CM, Sheiham A. Orthodontic treatment and its impact on oral health-related quality of life in Brazilian adolescents. J Orthod 2004;31:20-7.
25. Feu D, Miguel JAM, Celeste RK, Oliveira BH. Effect of orthodontic treatment on oral health-related quality of life. Angle Orthod 2013;83:892-8.
26. Silvola AS, Rusanen J, Tolvanen M, Pirttiniemi P, Lahti S. Occlusal characteristics and quality of life before and after treatment of severe malocclusion. Eur J Orthod 2012;34:704-9.
27. Chen M, Wang DW, Wu LP. Fixed orthodontic appliance therapy and its impact on oral health-related quality of life in Chinese patients. Angle Orthod 2010;80:49-53.
28. Kettle JE, Hyde AC, Frawley T, Granger C, Longstaff SJ, Benson PE. Managing orthodontic appliances in everyday life: A qualitative study of young people's experiences with removable functional appliances, fixed appliances and retainers. J Orthod 2020;47:47-54.
29. Quinzi V, Carli E, Mummolo A, De Benedictis F, Salvati SE, Mampieri G. Fixed and removable orthodontic retainers, effects on periodontal health compared: A systematic review. J Oral Biol Craniofac Res. 2023 Mar-Apr;13(2):337-346.
30. Lyros I, Tsolakis IA, Maroulakos MP, Fora E, Lykogeorgos T, Dalampira M, Tsolakis AI. Orthodontic retainers—a critical review. Children. 2023;10:230.
31. Medina MCG, dos Santos CCO, Lima BO, Ferreira MB, Normando D. Impact of fixed orthodontic retainers on oral health-related quality of life: a longitudinal prospective study. Dental Press J Orthod 2024;29:e242317.
32. Westerlund A. Stability and Side Effects of Orthodontic Retainers - A Systematic Review. Dentistry 2014;04:1.
33. Alghamdi MA, Farsi NJ, Hassan AH. Comparison of oral health-related quality of life of patients treated by palatal expanders with patients treated by fixed orthodontic appliances. Patient Prefer Adherence 2017;11:699-705.
34. Bibi K, Jan A, Hameed M, Afgan N, Alamzeb H, Malik S. Comparative Assessment of Patient's Acceptability between Hawley and Vacuum-Formed Retainer in Patients Treated with Fixed Orthodontics Appliance. Pakistan Armed Forces Med J 2023;73:682.
35. Devi S, Jain RK, Balasubramaniam A. Comparative evaluation of patient satisfaction following the use of two different orthodontic removable retainers: A prospective randomized controlled trial. J Int Oral Heal 2022;14:370-6.
36. Zheng DH, Wang XX, Su YR, Zhao SY, Xu C, Kong C, et al. Assessing changes in quality of life using the Oral Health Impact Profile (OHIP) in patients with different classifications of malocclusion during comprehensive orthodontic treatment. BMC Oral Health 2015;15:148.
37. Mary AV, Mahendra J, John J, Moses J, Ebenezar AVR, Kesavan R. Assessing Quality of Life using the Oral Health Impact Profile (OHIP-14) in Subjects with and without Orthodontic Treatment need in Chennai, Tamil Nadu, India. J Clin Diagn Res. 2017 Aug;11(8):ZC78-ZC81.
38. Cunningham SJ, Hunt NP. Quality of life and its importance in orthodontics. J Orthod 2001;28:152-8.

39. Hichens L, Rowland H, Williams A, Hollinghurst S, Ewings P, Clark S, et al. Cost-effectiveness and patient satisfaction: Hawley and vacuum-formed retainers. Eur J Orthod 2007;29:372-8.
40. Pratt MC, Kluemper GT, Lindstrom AF. Patient compliance with orthodontic retainers in the postretention phase. Am J Orthod Dentofacial Orthop. 2011 Aug;140(2):196-201.
41. Chen J, Wan J, You L. Speech and orthodontic appliances: A systematic literature review. Eur J Orthod 2018;40:29-36.
42. Haydar B, Karabulut G, Ozkan S, Aksoy AU, Ciger S. Effects of retainers on the articulation of speech. Am J Orthod Dentofacial Orthop 1996;110:535-40.
43. Wan J, Wang T, Pei X, Wan Q, Feng W, Chen J. Speech effects of Hawley and vacuum-formed retainers by acoustic analysis: A single-center randomized controlled trial. Angle Orthod 2017;87:286-92.
44. Kayikci MEK, Akan S, Ciger S, Ozkan S. Effects of Hawley retainers on consonants and formant frequencies of vowels. Angle Orthod 2012;82:14-21.
45. Kacer KA, Valiathan M, Narendran S, Hans MG. Retainer wear and compliance in the first 2 years after active orthodontic treatment. Am J Orthod Dentofacial Orthop. 2010 Nov;138(5):592-8.
46. Bartsch A, Witt E, Sahm G, Schneider S. Correlates of objective patient compliance with removable appliance wear. Am J Orthod Dentofacial Orthop. 1993 Oct;104(4):378-86.
47. Freitas LRP, Oliveira DD. Orthodontic retreatment: Positive effects on the patient's self-esteem and quality of life. Dental Press J Orthod 2021;26:e21bbo5.