REVIEW

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Systematic review regarding the difference in dental plaque accumulation associated with fixed orthodontic retainers and vacuum formed removable retainer.

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Abstract

Introduction: Orthodontic retention is fundamental to prevent tooth relapse after the treatment. Plaque accumulation is a serious concern, affecting periodontal health. In this study, the effects of fixed retainers with removable vacuum formed retainers on plaque accumulation by evaluating the Plaque Indices were compared.

Aim of the study: The aim of the present systematic review is to comprehend which orthodontic retainer between fixed retainers and the removable vacuum formed retainers results in the least amount of plaque accumulation.

Material and Methods: For evaluation a literature review was carried out by all the reviewers by consulting PubMed, ScienceDirect, The Lancet, Sciendo, and Google Scholars electronic databases for biomedical and health literature. The articles were selected from 2017 onwards with the restriction of the English language.

Results: 5 studies were selected, reporting on a total of 249 patients both males and females who after debonding orthodontic appliances followed up with either a fixed or vacuum formed retainer.

Conclusion: Within their limits, the results seem to show that patients who wear Vacuum Formed Retainers tend to accumulate less plaque than the ones that wear Fixed Retainers. However, subsequent studies are required to address this matter and draw a definitive conclusion.

Keywords: Orthodontic retainer, Vacuum Formed retainer, Fixed retainer, Plaque Index, Review.

Introduction

Retention plays a fundamental role at the end of an orthodontic treatment, serving as a crucial element to prevent orthodontic relapse [1]. This is the natural tendency of teeth to revert to their original position before treatment. Regardless of the final result of the orthodontic treatment, in a stable or unstable position, retention is extremely important for the reorganization at gingival and periodontal level [2]. The success of an orthodontic treatment depends on the control of the teeth position and occlusal relationship to achieve the best long-term result, hence orthodontic retention should be part of the treatment plan [3].

Orthodontic therapy, including retention appliances are found to be one of the iatrogenic factors predisposing the individual to plaque accumulation [4].

Dental plaque is a key index when assessing oral health, it is considered the main cause of gingival inflammation [5]. To measure the plaque accumulation during a treatment with orthodontic retention appliances two Plaque Indices have been taken into consideration in this systematic review: the Silness and Loe Plaque Index and the Quigley and Hein plaque index modified by Turesky-Gilmore-Glickman [6]. There are two main categories of orthodontic retainers: fixed and removable. Fixed retainers are wires (that can be made of different materials) bonded to the lingual/palatal surface of the teeth using composite material. On the other hand, removable retainers are not bonded to teeth, they are kept in position by adhering on the teeth [7]. They can be displaced and introduced in the mouth by the patient relying on their motivation and compliance [8]. In the first 3 to 4 months after the orthodontic treatment the removable retainer should be kept in the mouth all day, everyday and removed only to eat and brush the teeth while the fixed retainer should not interfere with masticatory movements. In the second phase, from 4 months up to 12 months the retainer should be

used on a part-time basis to allow remodeling of the gingival tissue. After the first 12 months it is suggested to keep the retainer part-time until complete growth is achieved [3]. The aim of this study is to compare the effect on the Plaque Index in fixed and removable retainers.

Material and methods

The criteria employed to conduct this research were:

- Population: who have undergone orthodontic treatment and are using orthodontic retainer.
- Investigated condition: type of orthodontic retainer either fixed retainer, variations of fixed retainer or vacuum-formed retainer (VFR)
- Comparison: different types of fixed retainers and vacuum formed retainer (VFR)
- Outcome: plaque index or plaque accumulation at different points in time
- Time: different time points and intervals for measuring plaque accumulation

As it is commonly used for systematic reviews, the PICOT framework was employed as a guideline.

Search strategy:

The literature search was conducted by the authors consulting databases such as PubMed, ScienceDirect, The Lancet, Sciendo and Google Scholar. The terms used to conduct this search were: "orthodontic retainer" AND "fixed retainer" AND "removable retainer" OR "vacuum formed retainer" AND "plaque index" OR "plaque" AND "periodontal health" in different combinations.

Inclusion criteria:

The studies were included if they respected the following criteria:

- English language
- Studies published from 2017 onwards.
- Studies which included mean values of plaque index
- Studied which analyzed both fixed orthodontic retainer and vacuum formed retainer.

Exclusion criteria:

- Studies published before 2017.
- Studies which did not analyzed both fixed and vacuum formed retainer.

The suitability of the articles found across all the search engines was assessed by reading their respective titles and abstracts. The final selection process involved all authors individually and thoroughly reading the complete studies that met all the inclusion criteria. Any paper that did not meet such criteria was excluded from consideration.

Results

About 1704 articles found in online databases were related to the topic of orthodontic retainers. Of these 122 analyzed in depth the topic of both fixed and removable retainers. After a closer examination 15 articles were found to also discuss plaque accumulation and periodontal health. In the end only 5 articles [9-13] (figure 1) respected all the selection criteria by discussing plaque index, fixed retainer and vacuum formed retainer and were considered adequate for the purpose of this systematic review. The selection process is illustrated in Figure 1.

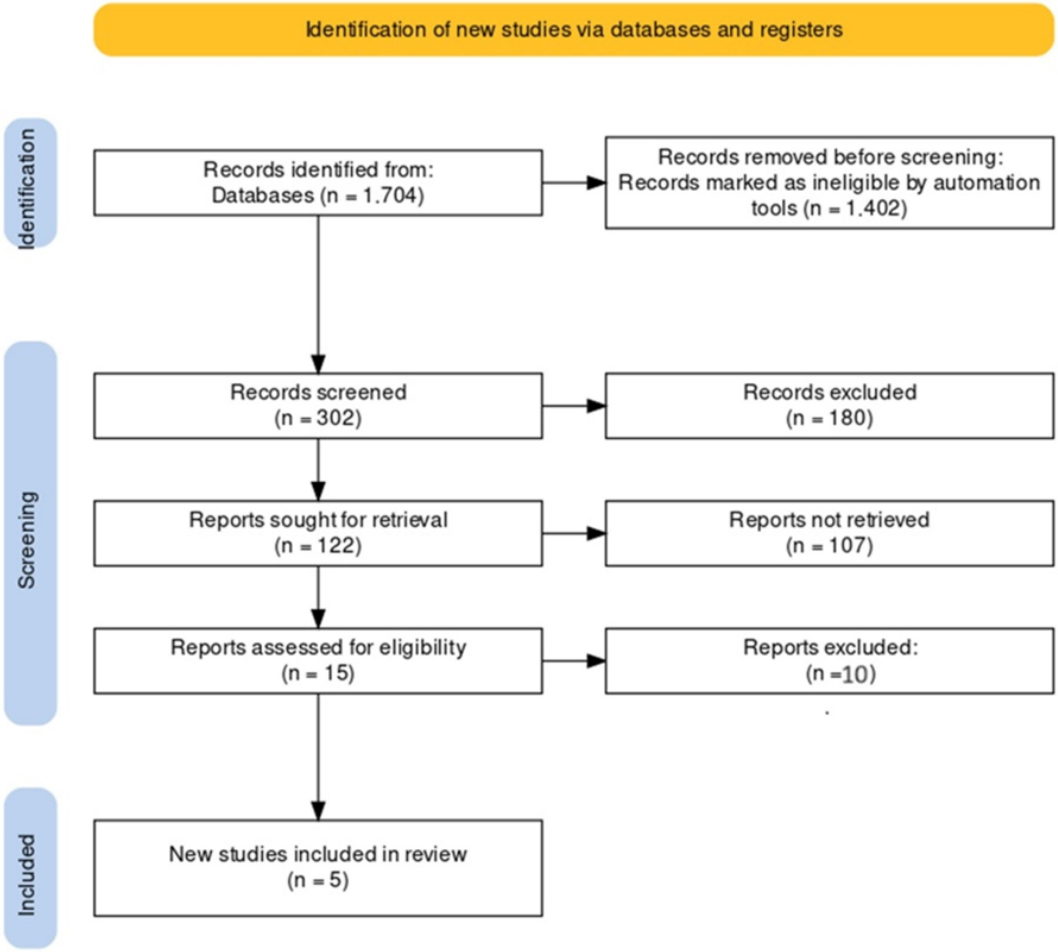

Figure 1. Prisma flow diagram of the literature selection process [14, 15].

Study Characteristics: Of all the studies taken into consideration, 3 of them are RCT [9, 10, 12], one of them is a Comparative study [13], and another is an original research article [11]. The sample size of all these studies ranges from a minimum of 15 [11, 12] patients to a maximum of 21 [10,13] patients per group, with a total of 249 patients both males and females in all the studies. The minimum follow-up time starts from one week [11] to a maximum of 4 years [10, 13]. Each study uses different types of retainers, with the constant of the removable VFR. Of these, one compares 3 types of fixed retainers, made of nickel titanium, stainless steel, and nickel-free titanium, to the removable VFR [12]. Another one compares a stranded wire fixed retainer to the removable VFR and the Hawley retainer [11], and the other 3 compare a fixed retainer made of stainless steel to the removable VFR [9, 10, 13]. In two studies patients were required to wear the VFR full time throughout the study period [11, 12], in two studies patients were initially instructed to wear a retainer full-time at the beginning of the trial, and subsequently reduce the duration gradually [10, 13] and in one study the patient was requested to wear the retainer only during night-time [9]. Each study applies different types of retainers for maxillary and mandibular. Every study has been depicted with a graph from Figure 2 to Figure 5. When the plaque index was measured only in one moment of time [10, 12, 13] and histogram graph was thought to be the best choice, when the plaque index was measured in different moments of time [9, 11] representation through a linear graph was preferred. All the specifics of these studies taken into consideration in this systematic review are reported in Table 1.

Table 1. Characteristics of all studies.

Authors	Year of Publication	Study design	Number of participants	Number per group	Appliances	Dental arches involved	Time of wearing	Follow-up
Storey M, Forde K, Littlewood SJ, Scott P, Luther F, Kang J. Bonded [9]	2017	RTC	60	30 (12M/ 18F) 30 (15M/ 15F)	Vacuum formed retainer. 0.0195″ 3-stranded twistflex stainless steel wire fixed retainer	Maxillary and mandibular arches Maxillary and mandibular anterior teeth	Nights only Full time	3 months 6 months 12 months
Al-Moghrabi D, Johal A, O'Rourke N, Donos N, Pandis N, Gonzales-Marin C, et al. [10]	2018	RTC	42	21 (7M/ 14F) 21 (3M/ 18)	Vacuum formed retainer. 0.0175-in coaxial archwire fixed retainer	Mandibular arch Mandibular anterior teeth	Full time for the first 6 months Nights only for the second 6 months Alternate nights 12th to 18th month Intermittent nights only wear (1–2 nights weekly) from eighteenth month onwards Full time	4 Years
Eroglu AK, Baka ZM, Arslan U. [11]	2019	Original research article	45 (11M/ 34F)	15 15	Vacuum formed retainer. Hawley retainer	Maxillary and mandibular arches Maxillary and mandibular arches	Full time all day, except during meals	Debonding 1 week 5 weeks 13 weeks

				15	0.0215-inch 5-stranded wire	Mandibular anterior teeth	Full time	
Alrawas MB, Kashoura Y, Tosun Ö, Öz U. [12]	2020	RTC	60	15 (2M/ 13F) 15 (6M/ 9F) 15 (5M/ 10F) 15 (4M/ 11F)	Vacuum formed retainer. CAD/CAM NiTi 0.017-in, twisted multi-stranded stainless steel lingual wire 0.027 × 0.011-in single-strand nickel-free titanium lingual wire	Mandibular arch Mandibular anterior teeth Mandibular anterior teeth Mandibular anterior teeth	Full time Full time Full time Full time	6 months
Patyal A, Karpe S, Chacko PK, Khandelwal M, Puri S, Kandikatla P. [13]	2022	Comparative Study	42	21 (7M/ 14F) 21 (3M/ 18F)	Vacuum formed retainer. 0.0175” coaxial arch wire	Mandibular arch Mandibular anterior teeth	Full time for the first 6 months Nights only for the second 6 months Alternate nights 12th to 18th month Intermittent nights only wear (1–2 nights weekly) from eighteenth month onwards Full time	4 years

Qualitative characteristics: in Table 1 we have purposely chosen to exclude information about which study reported specific values about probing depth, gingival index, bleeding on probing, calculus index, plaque index, and clinical attachment loss. This decision aligns with the primary focus of the study on the value of plaque index and all the analyzed study supplies sufficient information on the topic.

Plaque index results:

Plaque accumulation in the context of fixed retainers and vacuum-formed retainers (VFR) was examined in the study by Storey et al. [9]. At the initial assessment at T0 (debonding), no statistically significant difference (P>0.05) was observed in plaque index values between the two retainer types. The values recorded at T0 were 0.5 for fixed retainers and 0.47 for VFR. Later assessments at T1 (3 months) revealed values of 0.33 for fixed retainers and 0.34 for VFR. A notable difference between the two retainer types began to appear at T2 (6 months) (P<0.05), with values of 0.38 for fixed retainers and 0.3 for VFR. Significant differences in plaque indices (P<0.05) were found at T3 (12 months), with fixed retainers measuring 0.45 and VFR measuring 0.33, as depicted with a linear graph in Figure 2.

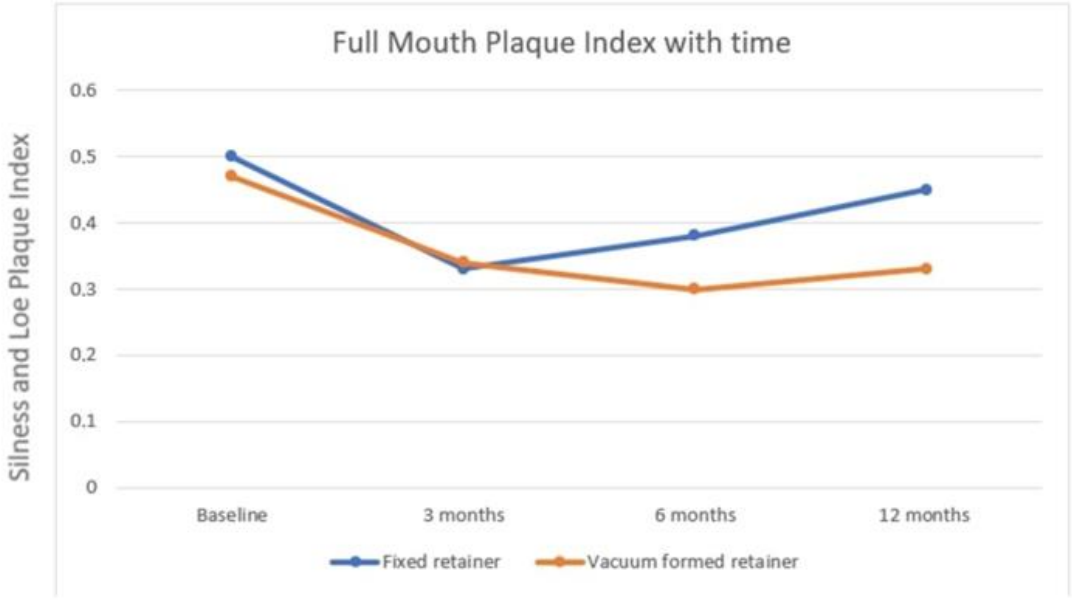

Figure 2. Plaque Index values at baseline, 3 months, 6 months, and 12 months.

On the other hand, the study by Al-Moghrabi et al. [10], which used the Modified Quigley-Hein plaque index, showed no statistically significant difference (P>0.05) in plaque accumulation between the fixed retainer group, registering a value of 3.5, and the VFR group, which reported a value of 3. These values were represented with a histogram graph, as only a single time point at 4 years was analyzed as shown in Figure 3.

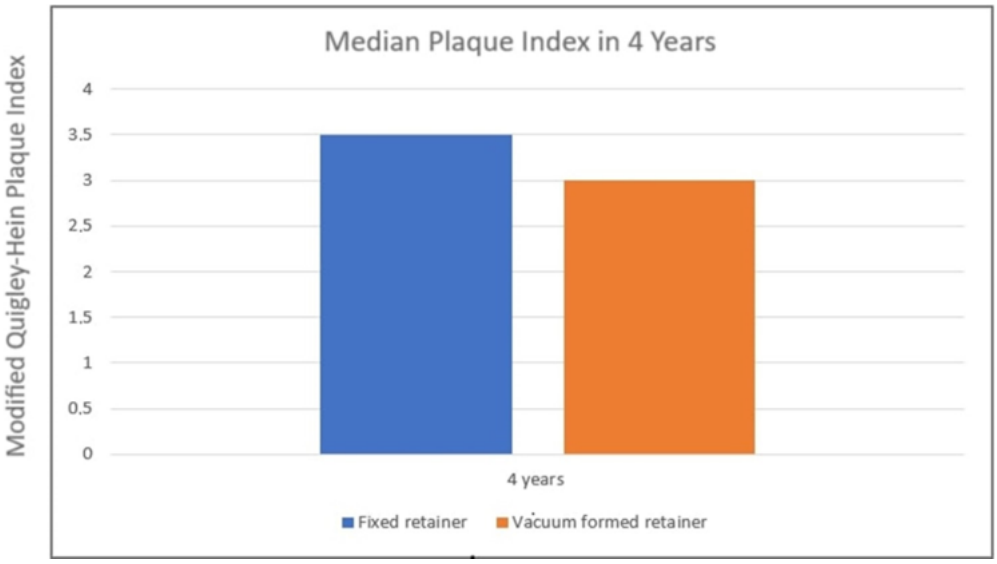

Figure 3. Median Plaque Index values at 4 years follow-up.

In the meantime, in the RTC conducted by Eroglu et al. [11], plaque index values (P>0.05) at T0 (debonding) were 0.44 for the fixed retainer and 0.6 for VFR. At T1 (1 week), values of (P>0.05) 0.16 for fixed retainers and 0.23 for VFR were recorded. At the next interval of T2 (5 weeks) also non-significant differences (P>0.05) were shown with values of 0.07 for fixed retainers and 0.13 for VFR. Lastly, at T3 (13 weeks) non-significant (P>0.05) values were found, with a plaque index amount of 0.03 for fixed retainers and 0.08 for VFR at T3. These results are depicted with a linear graph in Figure 4.

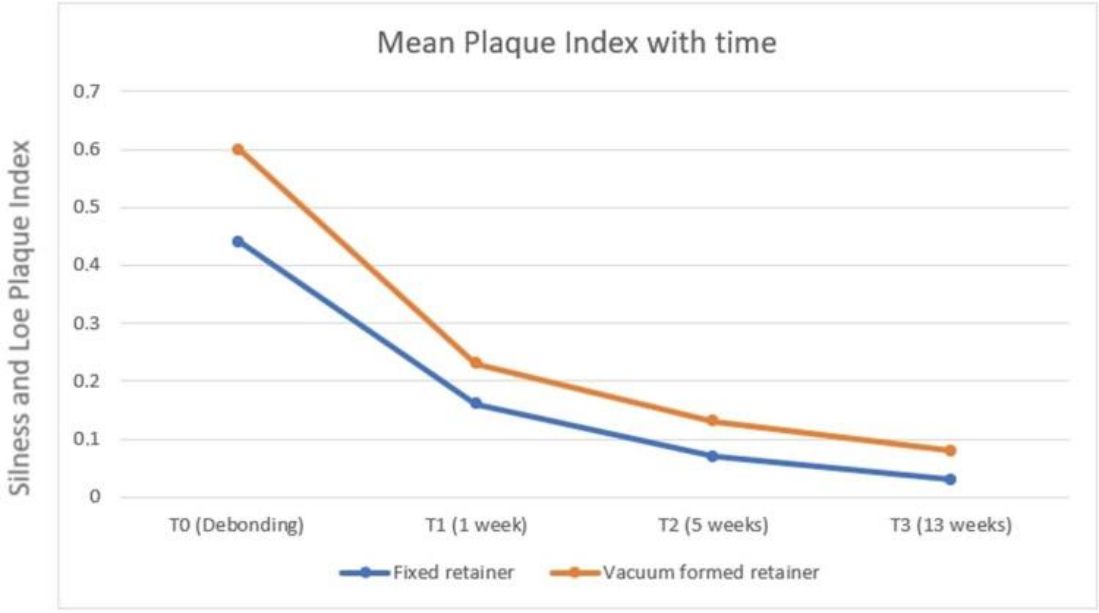

Figure 4. Mean Plaque Index values taken at debonding: 1 week, 5 weeks, and 13 weeks.

In the study by Alrawas et al. [12], which explored three types of fixed retainers, the CAD/CAM NiTi group exhibited a plaque index value of 0.418, which was not statistically different from the other groups (P>0.05), the 0.017-inch, twisted multi-stranded stainless steel lingual wire (MSLR) group reported a value of (P>0.05) 0.6636 and the fixed retainer 0.027 × 0.011-inch single-strand nickel-free titanium lingual wire group displayed a value of (P>0.05) 0.7386. As for VFR, the plaque index value was 0.4567, and no temporal differences were assessed, resulting in another histogram representation, as shown in Figure 5.

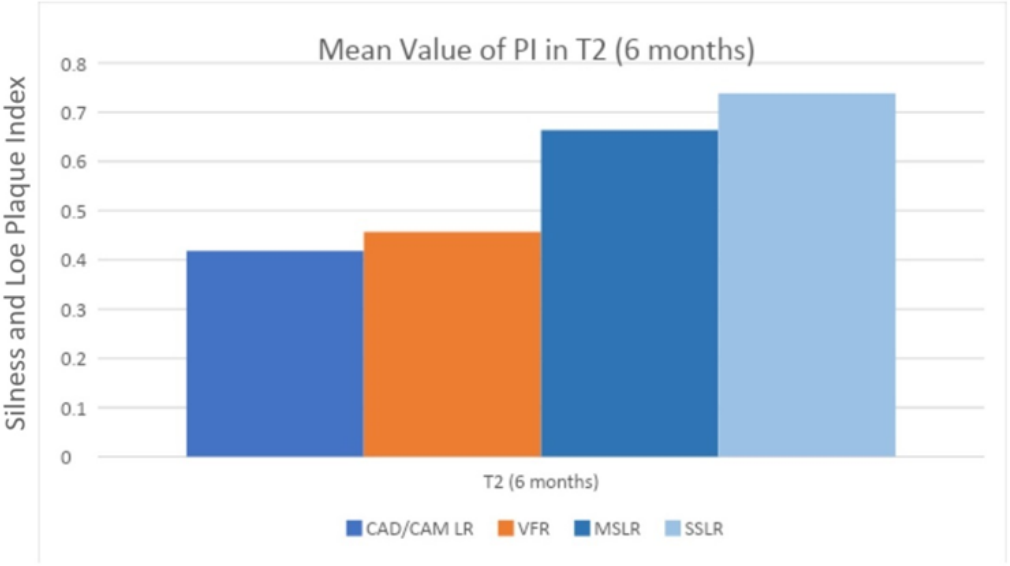

Figure 5. Mean Value of Plaque Index at 6 months.

In conclusion, the study by Patyal et al. [13], which also utilized the Modified Quigley-Hein plaque index, reported a median plaque index value (P>0.05) of 3.5 for the fixed retainer group and 3 for the removable VFR group, as illustrated with a histogram graph in Figure 6.

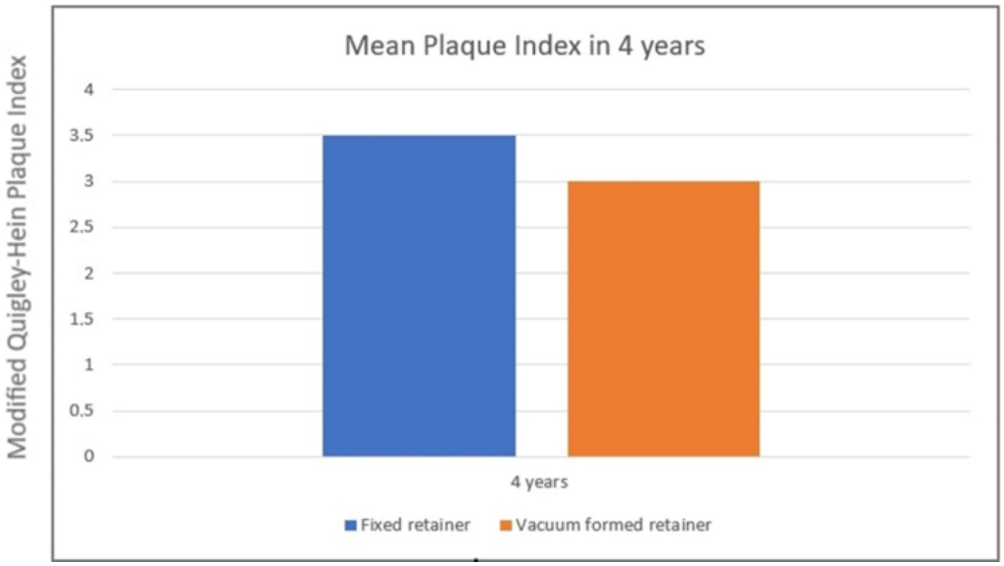

Figure 6. Mean Plaque Index values at 4-year follow-up.

Discussion

This systematic review aimed to evaluate the differences of the plaque levels in both VFR and the different types of Fixed Retainers. Wearing orthodontic retainers for a prolonged time has a significant impact on the patient's oral health, focusing on the importance of the choice of the appropriate type of retainer [16]. While extensive research on periodontal parameters in fixed orthodontic appliances has been conducted [17, 18], limited information on the effects of the different types of retainers is available [19, 120]. It is shown in this study that plaque accumulation is increased in fixed types of retainers compared to removable ones, it also emerged that after the patients were strictly instructed on hygiene techniques and asked to improve dental hygiene habits (e.g., brushing three times a day with given standardized toothpastes and toothbrushes) the plaque scores dropped showing the major importance of correct oral hygiene protocols

[11]. Removable retainers facilitate the oral hygiene procedures, but their effectiveness is solely dependent on the patient's motivation [21]. The study by Eroglu et al. [11] recorded a statistically significant decrease of plaque level accumulation for all groups (VFR group and FR group) from the initial measurement that was taken after debonding to the last one taken at 13 weeks. These results are extremely significant because they show how, under precise and strict oral hygiene instructions, the levels of plaque decreased in both cases independent of the material of the retainer used. Even though the final data of this study show a higher Plaque Index score for the VFR, it is worth noting a higher statistically significant reduction compared to the FR. This study was performed on a limited number of patients, this information is of major importance for upcoming research [11]. When fixed retainers are bonded to the lingual side of the mandibular anterior teeth, they create a plaque retaining area affecting the overall health of the periodontium [16]. Storey et al. [9] analyzed the plaque accumulation after the debonding of the orthodontic appliance, which was higher in the presence of the fixed retainers, along with mild gingival inflammation. In the first 3 months, the patients with VFR showed a significant improvement of oral hygiene while in the patients with FR an increase in plaque accumulation was found. At 12 months after the retainer application the plaque increased in both groups of patients, highlighting a higher plaque index in the mandibular inter-canine region of the FR patients. Unfortunately, in this study the data were analyzed only up to 1 year of retainer wearing so the results should be interpreted with caution [9]. Although not statistically significant, Al-Moghrabi et al. [10] also found a slight increase in plaque score for the patients with FR, compared to the ones with VFR in a 4-year follow-up, showing the importance of oral hygiene and compliance from the patient to avoid periodontal consequences. Nonetheless, due to high levels of dropouts with a small sample size this RCT risked attrition bias. Similar results were seen in the study by Patyal et al. [13] where a slight increase of plaque score can be observed in the patients wearing fixed retainers. When plaque indices in different types of FR material are compared with VFR as Alrawas et al. [12] noted, at the last follow-up (sixth months) after periodontal examination for plaque accumulation, that the ones which showed higher levels were two (MSLR, SSLR) of the three FR (CAD/CAM Ni-Ti LR, MSLR, SSLR). On the other hand, CAD/CAM Ni-Ti LR showed slightly lower retention for plaque accumulations than VFR. In this study the reported microbial colonization seems to have higher retentive capacity for fixed appliances. However, the materials used for manufacturing the FRs have a substantial influence on the susceptibility to plaque accumulation and adherence [12]. Overall, CAD/CAM NiTi wire had the lowest values for PI due to its material, design and electropolishing ability of the wire surface making it smooth, resistant to corrosion and less retentive for microbial colonization [22]. Pandis et al. [23] showed that in the long-term lingual fixed retainers lead to increase in pocket depth, gingival recession and calculus accumulation highlighting the consequences to periodontal health. However, in this article the focus is moved to the plaque accumulation index. Especially in young people calculus and plaque accumulation have a profound influence on predisposition to gingival inflammation and future periodontal diseases [24, 25, 26]. It is also known that fixed retainers, due to their intrinsic nature, are more challenging to clean while removable ones provide easier access. For these reasons, patients who are supposed to wear retainers for an extended period find more difficulties in keeping satisfactory oral hygiene [27]. Mainly, this relies on the patient's knowledge of brushing techniques and adjunctive hygiene methods to maintain overall oral health, this is why it is important to perform regular check-ups at the dental office that include professional dental cleanings at least every 6 months. Motivating and Instructing patients

on good oral hygiene, especially those wearing FR, prevents worsening of periodontal conditions and consequent diseases so that periodontal health will not be compromised by any type of retainer [28, 29, 30]. Further research can explore the effects of retainers on other periodontal indices (e.g. Calculus Index, Gingival Index) for a better understanding of the issue previously discussed.

Conclusion

Vacuum Formed Retainers are associated with less plaque retention compared to Fixed Retainers and in time they show significant reduction in the accumulation of plaque, although an exception is found in CAD/CAM Ni-Ti fixed retainers which are less plaque retentive compared to the VFR. However, the results gathered in this systematic review are not enough to favor one type of retainer over the other. It is necessary to conduct more research on this topic to reach a comprehensive and conclusive understanding. Ultimately, the patient's characteristics should be carefully evaluated to decide which type of retainer is more suitable for the patient's needs. Equally important is the patient's knowledge of potential risks associated with improper care and oral hygiene protocols. The clinician should plan regular check-ups that ensure a positive outcome of the treatment and the overall dental health of the patient.

Conflict of interest: None to declare.

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