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Research Article

Retention protocols and use of vacuum-formed retainers among specialist orthodontists in India

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ABSTRACT

Aim: The study was conducted with the aim of evaluating general retention practices, current trends, and difficulties with vacuum-formed retainers (VFR) by the orthodontists in India.
Method: A questionnaire link was generated using the Google Forms App in total with 28 multiple-choice questions representing general retention practice in the first part and VFR practice in the second part.
Results: The overall response rate was 54.4%. On receiving of the completed questionnaires, the data were statistically analyzed. Most practitioners prescribe retainer wear for 1 to 2 years irrespective of the age of the patients, with 2 to 4 years of follow-up. Also VFR of 1 mm thickness with full-occlusal coverage extending 1 to 2 mm beyond the gingiva is recommended immediately after debonding with full-time wear. Discoloration and breakage within 6 to 9 months of VFR wear are commonly encountered problems. In case of relapse with VFR, practitioners prefer to switch over to removable retainers, which shows the major drawback with VFR usage.
Conclusion: Removable and fixed retainers are currently the main preferences of retainers. VFR as the esthetic alternative will replace other retainers in the future provided problems with its usage are resolved.

1. Introduction

The stability of treatment results is a major concern in orthodontics. In 1934, Oppenheim stated, "Retention is one of the most difficult problems in orthodontia; in fact, it is the problem" [1]. Although many types of retainers are available, the Hawley retainer (HR), fixed retainer (FR), and vacuum-formed retainer (VFR) are the most commonly used clinical retainers. The HR was designed by Charles Hawley in 1919, has been used for nearly a century and has become the most popular removable retention appliance. The alternative removable retainer is an invisible retainer that was designed in 1971 and has been referred to by the following names: VFR, clear overlay retainer, and Essix retainer. Essix retainers have proven quite versatile. Their flexibility and positioner effect make them an alternative to spring retainers in correcting minor tooth movements. They can be used to reduce occlusal forces from the opposing arch when moving posterior teeth with air-rotor stripping mechanics. They can serve as a temporary bridge for a missing anterior tooth, when thermoformed over a pontic placed in the edentulous space on the cast. They can also act as night guards for bruxism and as bite planes to relieve bracket impingement until the bite can be opened. The use of Essix retainers, in combination with telephone monitoring, opens the way to a practical, patient-friendly method of true permanent retention [2]. In this study, for simplicity, we considered any invisible retainer as a VFR, instead of the other names. This questionnaire survey was conducted with an aim to evaluate general retention practices, current trends, and difficulties with VFRs by the orthodontists in India.

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2. Materials and methods

An original questionnaire was designed that incorporated some aspects of a validated survey carried out on retention practices [3–5]. The questionnaire was framed in two parts featuring mainly multiple-choice questions (28 in total) representing general retention practice in the first part and VFR practice in second part (Supplementary Data 1). An electronic (e-) version (using the Google Forms App) of the questionnaire link was devised.

The questionnaire was evaluated by orthodontic practitioners to ensure clear understanding of questions, relevant to retention procedures, VFR usage, relapse tendencies, and difficulties encountered by patients. The questionnaire link was sent to the orthodontists through the WhatsApp link. The overall response rate was 54.4%. A total of 136 of 250 orthodontic practitioners answered the questionnaire survey link. Once received, the data were transferred to a Microsoft (Redmond, WA) Excel (2010) spreadsheet for data analyses.

All statistical analyses were performed using GraphPad (La Jolla, CA) Prism software. Descriptive analyses were expressed in frequencies and percentages. Cross-tabulation tables and χ^2 tests were used to detect the differences between background information and preferred retainer choice and between retainer choice and prescribed protocols. The level of statistical significance was set at $P < 0.05$.

3. Results

The overall response rate was 54.4%. A total of 136 of 250 orthodontic practitioners answered the questionnaire survey link. Online response rates may only approximate 25% to 30% without follow-up e-mail and reinforcements [6]. Demographic details of the respondents were not enquired except for the area of practice and experience in the field of orthodontics. Not all respondents answered all the questions.

Our results revealed that 55.9% of the respondents were practitioners with less than 5 years of experience, with most of them practicing in urban areas of our city. The most commonly preferred retainer was the HR by 47.1% of orthodontists in the maxilla and FR by 67.6% in the mandible. The VFR was the second most preferred of retainers in both the maxilla and mandible. Of the respondents, 89.7% think that age is an influential factor in a patient's compliance of retainer wear, with adults being more compliant. Irrespective of the age of the patients, most of the respondents recommend a retention period of approximately 1 to 2 years with a follow-up period of 2 to 4 years and review of once in 3 months. A relapse situation with removable retainers was encountered by 84.3% of respondents. Verbal instructions were given by 75.7% of the respondents.

In most of the situations, retainer choice was primarily influenced by the pretreatment characteristics of the malocclusion. Respondents of the various retainers in different clinical situations are given in the Table 1.

The second part of the questionnaire specifically dealt with VFR practice. Forty-three percent of the respondents preferred to deliver the VFR immediately after debonding, with 68.9% prescribing full-time wear. A 1-mm thickness of thermoplastic retainer was preferred by 70.1% of practitioners, and 72.4% of the VFRs were fabricated in commercial laboratories. Fifty-six percent of the respondents preferred full-occlusal coverage of VFR with 1 to 2 mm beyond gingival margin. There were 48.1% of respondents who reported patients in the variable time period regarding difficulties with VFR wear. The various problems with VFR usage and the number of respondents are listed in Table 2.

Table 1
Retainer choice in various clinical situations

Treatment procedures	Retainer		
	Hawley, %	Vacuum-formed, %	Fixed, %
Extraction	44	18.7	37.3
Expansion	59.7	20.2	20.1
Diastema closure	9.6	9.7	80.7
Intrusion of anterior teeth	22.2	52.6	25.2
Extrusion of anterior teeth	30.3	34.9	34.8
Severe rotations of anterior teeth	5.9	17.9	76.2
Anterior open bite	51.1	20.4	28.5
Impacted anterior teeth	31.3	18.6	50.1
Root resorption of anterior teeth	22.5	36.2	41.3
Retreatment cases	6.7	23.2	70.1
Orthognathic surgery	37.3	24.6	38.1

Table 2 shows that discoloration and breakage were frequently encountered difficulties by the patients with VFR wear. Occurrence of breakage is mostly reported during 6 to 9 months of VFR wear and 76.1% of the respondents preferred a new impression for new VFR fabrication. With the discoloration of VFR, most commercial laboratories were not providing the new VFR free of cost. Of the respondents, 43.9% encountered a relapse situation with VFR. There were 53.8% of respondents who preferred to use other removable retainers to handle the relapse situation, which is the major drawback with VFR. Of the respondents, 39.1% were not aware of the material used for VFR fabrication, and 69.6% conveyed their opinion that cost of the VFR is an influential factor in a patient's choice of retainer.

4. Discussion

Among various available retainer options, it is the choice of orthodontists that will determine the successful retention of achieved treatment results. This study revealed the variable opinions of orthodontists regarding their retention practices and difficulties they are encountering with the retainers.

HR in maxilla (47.1%) and FR in mandible (67.6%) were the most common retainer choices by orthodontic practitioners in India (Figs. 1 and 2). The choice of maxillary retainers varied in different countries as follows: FRs in Switzerland and the Netherlands [7], HRs in the United States [8] and Saudi Arabia [9], and the VFR in the United Kingdom [10], Ireland [3], and Malaysia [4]. FRs were the mandibular retainer of choice in the United States [8] and Saudi Arabia [9]. VFRs, in addition, were the second most common maxillary and mandibular retainer choice, which is similar to the United States and the Netherlands.

Our results revealed that 89.7% of our respondents felt age is an influential factor in retainer wear and almost 72.1% responded that adults were more compliant than the adolescents. These findings are similar to the findings of Vig [11], who found that younger patients were more likely to be complaint initially with retainer wear than older patients; however, as time out of braces increased, the compliance of younger patients decreased at a faster pace than that of older patients. Another study [12] stated that adolescent

Table 2
Problems with vacuum-formed retainer usage

Associated problems	Yes, %
Discoloration	71.1
Retention	35.1
Breakage	68.8
Discomfort while speaking	55.5
Others	28.8

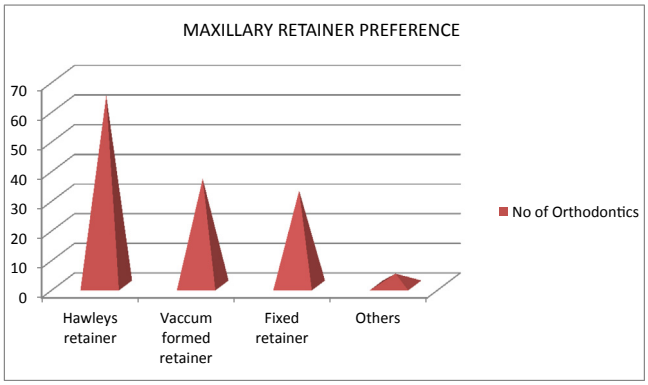

Fig. 1. Maxillary retainer preference among orthodontists in India ($P < 0.001$ and χ^2 value 53.176).

patient compliance was greater with VFRs than with HRs. Parental attitude and doctor-patient relationship had a great impact on compliance in the adolescent orthodontic patients.

Wear time of retainers is still a matter of debate. Of our respondents, 36.8% recommended a retention time of 1 to 2 years, and 36.0% recommended 9 months to 1 year for patients younger than 15 years; 51.5% recommended 1 to 2 years of retention time for patients older than 18 years. This shows that irrespective of age, most practitioners followed the retention duration of 1 to 2 years. According to Parker [13], at least 232 days of retention are needed to ensure the regeneration of the fibers surrounding the apical, middle, and marginal areas of the root and to provide the stability after orthodontic treatment.

Most orthodontists were reviewing their patients once in 3 months for a period of 2 to 4 years. This in accordance with studies [5,14] showing that review of patients in regular intervals is necessary to check with the stability and/or changes with the results achieved. Of the respondents, 84.3% encountered relapse with removable retainers, which is similar to a study by Jäderberg et al. [15] in which they concluded that there is a significant increase in the Irregularity Index of the mandibular incisors during retention in patients wearing HRs compared with patients with FRs, and also patients wearing mandibular HRs perceived their crowding significantly more than patients with FRs.

When taking various clinical scenarios into consideration, HRs were preferred in cases of extraction, expansion, and anterior open bite. According to Littlewood et al. [16], there was no difference between lower removable thermoplastic and bonded retainers in cases of intercanine width, intermolar width, arch length, and extraction site space opening. FRs for diastema closure, severe

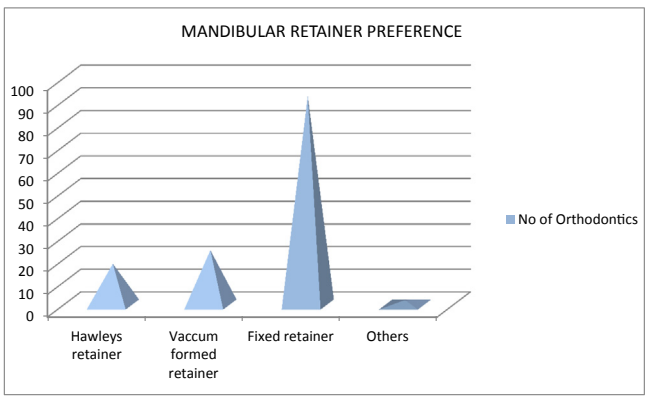

Fig. 2. Mandibular retainer preference among orthodontists in India ($P < 0.001$ and χ^2 value 139.52).

rotations of anterior teeth, impacted anterior teeth, and retreatment cases. VFRs were preferred after intrusion of anterior teeth, whereas the choice of retainers was nonsignificant for extrusion of anterior teeth, root resorption of anteriors, and orthognathic surgery situations (P values 0.767, 0.0235, and 0.1013, respectively).

In patients with an expanded arch, the HR is the retainer of choice due to its sufficient rigidity [17]. According to Chaimongkol and Suntornlohanakul [17], a patient with pretreatment anterior open bite can also use a clear retainer with an amplified retention system, which consists of cuspid-to-cuspid bonded lingual retainers, lingual caplin hooks, and intraoral elastics. It was fabricated with the instruction to use vertical elastic at night to maintain overbite. Vertical elastics were placed at the lingual side with slight force (100 g). With the use of elastic, the patient had no difficulty while sleeping [17].

Seventy-five percent of the respondents gave verbal instructions to their patients during retainer delivery; however, in the medical field they realized that patients had a better understanding of the care needed when given both written and verbal instructions, rather than verbal instructions alone. Similarly, as retention is a critical situation in post-orthodontic care, it is necessary to provide written instructions to the patients, including information about any detachment and breakage of the retainers, follow-up visits, and oral hygiene.

4.1. VFR practice

This is the first study to deal with preferable time of VFR delivery in which 43% of the respondents preferred to deliver VFR immediately after debonding rather than after 3 months of removable retainer wear (28.1%) and along with FRs (28.9%).

Among the respondents, 68.9% advocated the full-time wear of VFR, which is in accordance with a study [3] in which the preferred mandibular retainer was the VFR only, a period of full-time wear was significantly more likely to be prescribed and contrast to a study [2] that concluded that the Essix retainer is sufficient for maintaining the results after orthodontic treatment and that nighttime wear is adequate.

Of the practitioners, 72.4% depended on commercial laboratories for VFR and in case of discoloration of VFR, most of the commercial laboratories were not ready to replace it free of cost. According to a study [3], for those practitioners with office laboratories, the ease and cost saving of manufacturing replacement VFRs may have compensated for the inconvenience associated with a relatively high VFR replacement rate.

Most respondents preferred 1-mm-thick VFRs with full-occlusal coverage extending 1 to 2 mm beyond the gingival margin, and lowest percentage (13.4%) of practitioners opt for 1.5-mm VFR. But in a randomized clinical trial [18], comparison of survival time of HRs and VFRs in orthodontic patients took place. They observed 4.5% breakage in 1.5-mm VFRs and 20% in the 1-mm VFR group. So, considering the higher breakage rate of 1-mm VFRs, the 1.5-mm VFR seems to be the retainer of choice.

Most of the patients had discomfort in VFR wear during variable time periods ($P < 0.00001$ and χ^2 value 61.6644). Discoloration and breakage are the frequently reported problems with VFRs. Most of the breakages were reported to occur in 6 to 9 months of VFR wear. Wan et al. [19] compared the speech effects of HRs and VFRs by acoustic analysis. They concluded that although sound distortion could be found in both the HR group and the VFR group, changes in articulation were more obvious in the HR group.

Fifty-nine percent of the respondents indicated that VFRs are more effective in retention phase than removable/bondable retainers. This is in accordance with findings of Rowland et al. [20] that VFRs are more effective than HRs at holding the correction of

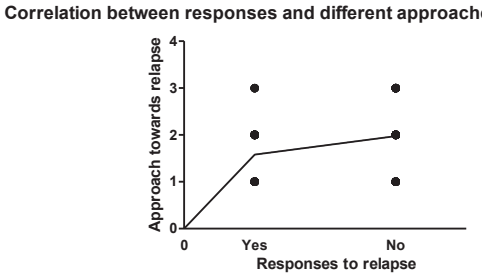

Fig. 3. Correlation between responses and different approaches after vacuum-formed retainer (VFR) failure.

the maxillary and mandibular labial segments and in contrast to a study [21] stating that bondable retainers are better than VFRs in holding mandibular anterior segment.

Among the respondents, 43.9% encountered relapse with VFR, and in such a scenario most of them preferred to revert to removable retainers such as HRs along with a new impression. According to a review article [17], slightly malaligned teeth can be realigned using the same clear retainer without fixed appliances or another clear retainer; if required, Hilliard thermoplier can be used to adjust the VFR. However, the range of correction carried out with the VFR has not been mentioned clearly. According to Spearman correlation analysis, the result was weak correlation for the treatment options in case of relapse with the VFR as shown in Figure 3.

Apart from the respondents who were not aware (39.1%) of the material used for VFR manufacturing, polypropylene copolymers (32.3%) were preferred more than the polyethylene copolymers (28.6%). According to a laboratory study [22], polyethylene copolymer materials exhibited significantly less wear than the polypropylene material. This indicated that clinicians should be aware of the material properties used in fabrication of VFRs.

Most respondents (69.6%) felt that the cost factor will affect the patient's preference for a VFR. This is in contrast to other studies [3,17], in which they considered speed, ease, and lower cost of VFR fabrication influences many practitioners to use it. The main limitation of the study is the less subject enrolment (n = 250) and reduced response rate (54.4%). Being an epidemiological study, more subject enrolment as well as reponse rate might have yielded more valid and accuarte results. This points to the requirement of an elaborate study towards identifying problems with retention devices after orthodontic treatment.

5. Conclusion

HR in the maxilla and FR in the mandible were the most common retainers of choice, with VFR being second commonly preferred in both maxilla and mandible.

VFRs were preferred to deliver immediately after debonding, and full-time wear advised. Design of full-occlusal coverage, extending 1 to 2 mm beyond the gingiva with a thickness of 1.0 mm was prescribed by most respondents.

The doctor-patient relationship had a greater impact on compliance in retainer wear, and it is the responsibility of the clinician to explain the importance of wearing retainers to the patients. Patients should be given written instructions and they should be advised to contact the clinicians in case of any untoward events.

Major problems reported were discoloration, breakage, and usage of other retainer types in case of relapse. Further clinical and laboratory studies are recommended to overcome those problems with VFRs.

Supplementary data

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.ejwf.2019.02.004.

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