



Original Article

The Common Retention Practices Among Orthodontists from Different Countries

Mohammed Almuzian¹, Samer Mheissen², Haris Khan³, Fahad Alharbi⁴, Emad Eddin Alzoubi⁵,
 Mark Brian Wertheimer⁶

¹University of Edinburgh, DclinDent, Department of Orthodontics, Edinburgh, United Kingdom

²Private Practice, Department of Orthodontics, Damascus, Syria

³CMH Lahore Medical College and Institute of Dentistry, Lahore, Pakistan

⁴Prince Sattam Bin Abdulaziz University, College of Dentistry, Department of Preventive Dental Sciences, Al-Kharj 11942, Saudi Arabia

⁵University of Malta, Department of Orthodontics, Msida, Malta

⁶Private Practice, Department of Orthodontics, Johannesburg, South Africa

Cite this article as: Almuzian M, Mheissen S, Khan H, Alharbi F, Alzoubi EE, Wertheimer MB. The Common Retention Practices Among Orthodontists from Different Countries *Turk J Orthod.* 2024; 37(1): 22-29

Main Points

- Pre-treatment spacing, degree of rotation and pre-treatment crowding were the most influencing malocclusion-related factors on the choice of retainers.
- A thermoplastic retainer was the most prescribed retention appliance for the maxillary arch.
- The bonded retainer was the most prescribed retention appliance for the mandibular arch.

ABSTRACT

Objective: To investigate the most common retention practices, factors influencing the retention protocol, and the differences among orthodontists regarding retention practices.

Methods: An online validated questionnaire was anonymously sent to 3,000 orthodontic residents and clinicians. The survey consisted of 19 questions regarding the participants' demographics, prescribed retention appliances, factors affecting retention appliance choices, and adjunctive retention procedures. Descriptive statistics, Chi2 and Kendall's Tau-b tests were applied.

Results: Five hundred fifty-five orthodontic residents and clinicians, 53.3% males and 46.7% females, completed the survey, indicating a response rate of 18.5%. Although participants' demographics, type of treatment and pre-treatment malocclusion influence the choice of retention protocols, thermoplastic retainers (TR) were the most popular retention regime for the maxillary arch for both adults (47.4%) and adolescents (42.3%). Bonded retainers (BR) were the favored option for the mandibular arch (44.9% of adults and 40.7% of adolescents). The degree of arch expansion (64.1%) and the degree of interdigitation (50.1%) after treatment were the most influential factors for the choice of the preferred type of retainers by the respondents. 68.6% of the participants thought professional retention guidelines would be useful.

Conclusion: Thermoplastic retainers were the most common retention appliances for adults and adolescents in the maxilla. At the same time, BR was the most favored retainer in the mandibular arch, with clinical experience, practice setting, and malocclusion- and treatment-related factors influencing the type of the chosen appliance. The demographic differences and the uneven participation in the survey need to be considered while interpreting the findings of this study.

Keywords: Survey, retention, online, orthodontic

Corresponding author: Fahad Alharbi, **e-mail:** fahad.alharbi@psau.edu.sa

Received: December 12, 2022 **Accepted:** May 08, 2023 **Publication Date:** March 28, 2024



INTRODUCTION

The most challenging part of orthodontic treatment is the retention phase. The term retention refers to the procedure of holding teeth in an ideal aesthetic and functional position after orthodontic treatment.¹ Retention permits the reorganization of bone and supragingival/transseptal fibers and neuromuscular and soft tissue adaptation. Static and dynamic occlusal stability, an appropriate retention plan, soft tissue balance, active growth, and patient cooperation are vital parameters to avoid potential post-orthodontic relapse.²

Several researchers have concluded that a certain degree of change is inevitable after active orthodontic treatment. Thilander³ showed that most patients (40% to 90%) reported unacceptable outcomes ten years after treatment. However, orthodontists in clinical practice require an understanding of the etiologies of relapse. The etiologies of relapse include age- and orthodontic-related factors.⁴ Knowledge of different types of retainers and retention protocols can help minimize relapse. Though several types of removable or fixed retention appliances have been proposed with varying protocols to minimize relapse,^{5,6} there is no consensus regarding the optimal appliance and/or ideal protocol. The type of retention choice and protocol depends on many factors, including but not limited to clinician preference and experience, occlusal outcomes, the type of orthodontic movement achieved, and patients age and preferences.⁴

Several studies have reviewed retention protocols, covering a broad spectrum of the types of prescribed retainers and retention protocols adopted by clinicians in different countries.^{7,8} For instance, clinicians in the UK⁹ and Australia¹⁰ preferred removable retainers as the retention protocol for the maxillary arch. A study that involved clinicians from The Netherlands showed that the most commonly used retainer was a fixed retention appliance.⁸ Norwegian orthodontists preferred using a combination of removable and fixed retainers.¹¹ However, it is essential to acknowledge that the selection of retainers and protocol is temporal. For instance, in the USA, the selection of Hawley retainers declined in the period from 1986 to 1996, while the use of spring aligners, clear thermoplastic retainers, and canine-to-canine fixed retainers became more popular.¹² This trend is due to the lack of conclusive findings about the optimal choice of retention appliance and protocol.¹³ Many clinicians justify their choice based on their clinical experience and interpretation of the evidence.

The objective of this global study was first to investigate the most common retention practices and, secondly, to assess the associated rationale and reasoning that affected the retention practices, and to inspect the differences among clinicians regarding their retention practices with a primary focus on age, experience, and practice settings.

METHODS

Sample Population

Orthodontic residents and specialists who subscribed to virtual orthodontic learning sessions hosted by the Orthodontic Mastery Facebook group were eligible to participate in the study. There was no restriction on the country of residence. The participants who opted for a choice of general practitioner were excluded from the survey.

Survey Validity

Initially, 29 questions were designed and agreed upon by the authors. These questions were consistent with contemporary literature and guidelines.^{4,14} For content validity (CV), 20 specialist orthodontists were emailed via SurveyMonkey, and were asked to rate each question as "essential", "useful but not essential", or "not necessary".¹⁵ The CV ratio (CVR) was calculated for each item using Lawshe's¹⁶ method. Questions with a CVR higher than 0.51 were selected for the final survey. Hence, 23 questions remained and were included in the construct face validity (CFV) phase. For the CFV phase, 100 participants (50 residents and 50 specialist orthodontists) were emailed via SurveyMonkey to anonymously rate the remaining 23 questions as "favorable" or "unfavorable". An analysis of the responses using Kappa statistics was undertaken to test the agreement for every question. Questions with a low level of agreement were excluded. In summary, 16 experts and 28 orthodontic specialists and residents participated in the CV and CFV phases, respectively. Expert feedback at the CV phase led us to drop 7, retain 22, revise 5, and add 1 new question to the survey. At the CFV phase, 4 items were dropped, 19 were retained, 2 were revised, and no new questions were added. The final set of 19 questions was used in the final survey.

The Validated Survey

The validated online survey consisted of 19 questions divided into five main domains (Appendix 1):

- Demographic information for participants, including gender, age, years of experience, country of residency, and clinical practice setting.
- The prescribed retention appliances for different age groups and their reasoning.
- Patient and clinician-related factors.
- Malocclusion and treatment factors.
- The adjunctive procedures and the benefit of guidelines.

In the final survey and when necessary, a logical option was implemented in which respondents could skip from certain pages to specific destination pages further ahead, based on their answer to a previous question. To avoid the partial response error, the whole questionnaire was constructed as mandatory. (<https://www.surveymonkey.co.uk/r/Orthodontic1>).

Data Collection

The approval was granted by the Ethical Committee of ITTEFAQ Hospital (registration number: RCDD-IHT-04-2020, date: 21.09.2020).

The anonymous survey link was shared with 3,000 residents and orthodontists. At the commencement of the survey, details about the study objectives and the research team were provided to the participants. Reminders were sent after two weeks to those who failed to participate. The survey remained open for four months until the sample size was met.

Data Analysis and Sample Size

A sample size calculation was performed using the SurveyMonkey calculator (www.surveymonkey.co.uk). Considering that there are 25,000 residents and orthodontists who are actively engaged in virtual learning, to detect a 95% confidence interval with a margin error of 4% and statistical power of 80%, the required sample size was 550 orthodontists.

Statistical analysis consisted of general descriptive analyses for all categorical variables using absolute and relative frequencies. The chi² test assessed the association or dependence between categorical variables. Kendall’s Tau-b test was conducted in the ordinal scale measurement case. The significance level used in the analysis was set at 5% (α=0.05).

All statistical analyses were performed using SPSS software (SPSS Inc., version 25.0 for Windows, Chicago, IL, USA).

RESULTS

Demographic Information of Participants

In total, 555 participants completed the survey (18.5% response rate), of whom 53.3% were males and 46.7% were females. More than half (50.2%) were from Asia, followed by Europe (27.6%) and Africa (14%) (Figure 1).

The majority (43.4%) of the respondents were 30-39 years old. Respondents aged 40-49 years and 50-59 years represented 22.7% and 11% of the total cohort, respectively. The minority of

the participants were either younger than 30 years (18.4%) or older than 60 years (4.5%).

Almost one out of three respondents (34.6%) were novices in clinical orthodontics (less than 5 years), and one out of four (27%) had 5-10 years of clinical experience. In contrast, seasoned clinicians with more than 20 years of clinical orthodontic experience represented 14.6% of the cohort. At the time of the study, most of the participants were certified orthodontists working either in private (46.1%) or mixed settings (29%). In comparison, the remainder (24.9%) were postgraduate students or residents in orthodontics (Figure 2).

Retention Appliances of Choice

1. Based on the age groups of patients

The thermoplastic retainer was the most prescribed retention appliance for the maxillary arch for adults (47.4%) and adolescents (42.3%). However, in the mandibular arch, bonded retainers were the favored retention appliances in both adults (44.9%) and adolescents (40.7%).

2. Based on the gender of the clinician

The results showed that there were no statistically significant differences (p>0.05) between genders in the choice of the retention protocol for adult and adolescent patients, except that females clinicians were more likely to prescribe Hawley retainers for adolescents in the maxillary arch (37.8%, p=0.044), and to combine this with bonded retainers in the maxillary arch for adult patients (18.5%, p=0.049) in comparison with their male peers (Table 1).

3. Based on the clinical settings

The results showed that there was no significant influence (p>0.05) of practice setting on the use of combined Hawley and bonded retainers in the maxillary and mandibular arch for both adults and adolescents (Table 1). In private practices, certified orthodontists significantly favoured the uses of the combined thermoplastic and bonded retainers for adolescent patients. However, the difference was not significant among participants from other settings regarding using this protocol in adults

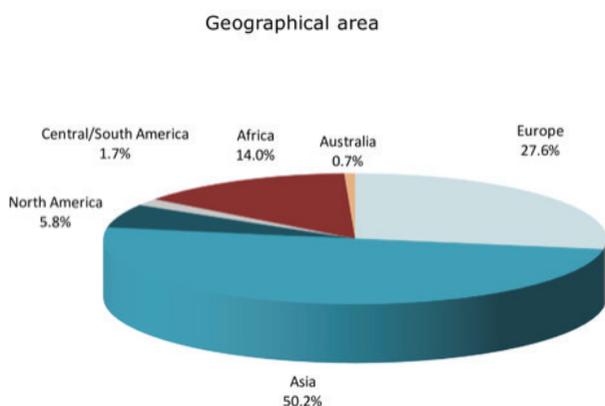


Figure 1. Global distribution of the respondents

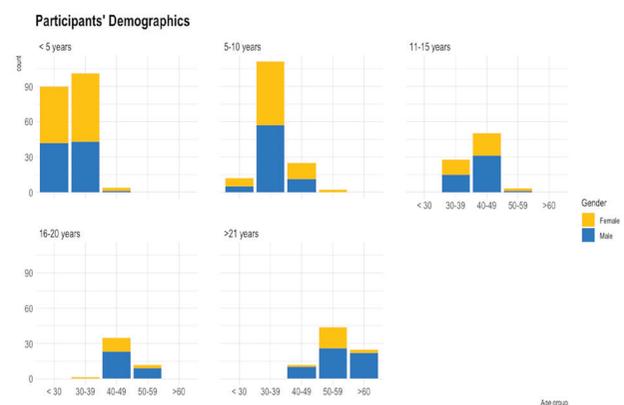


Figure 2. Bar plot depicts the participants demographics; gender (male, female), age group (<30, 30-39, 40-49, 50-59, >60 years), and years of experience (<5, 5-10, 11-15, 16-20, >21 years)

(maxillary and mandibular arch). Hawley retainer was the least favored retention appliance to be used by orthodontists in a private practice setting compared to other practice settings, the differences being statistically significant ($p < 0.001$).

Those from mixed-setting practices significantly used lower thermoplastic retainers for adults in their daily practice ($p = 0.010$) and prescribed bonded retainers in the maxillary arch ($p = 0.016$) and in the mandibular arch ($p = 0.036$) for adult patients, compared to different practice settings. However, the influence of practice setting on the use of bonded retainers in adolescents was insignificant ($p > 0.05$).

4. Based on the clinicians' age and experience

The results (Table 2) showed that the age of participants had a negligible effect on the prescribed retention protocol ($p > 0.05$), except that younger age groups (less than 30 years of age) were more likely to prescribe a combination of lower Hawley and bonded retainers for their adult patients (14.7%, $p < 0.01$).

Orthodontists aged 30-39 years were more likely to combine Hawley and bonded retainers in the mandibular arch for adolescent patients (14.1%, $p = 0.006$) in comparison with older age groups. Moreover, participants older than 60 years preferred to use lower bonded retainers in adolescents (56%, $p = 0.026$).

With regards to clinical experience, orthodontists having less than 5 years of clinical experience, highly preferred the use of a combined lower Hawley and bonded retainer for their adult and adolescent patients in comparison with other groups, $p = 0.011$ and $p = 0.007$ respectively (Table 2). On the other hand, the influence of clinical experience was not statistically significant for other retention protocols ($p > 0.05$).

Patient and Clinician Related Factors

When the participants were asked to choose factors influencing their choice of a retainer, compliance of the patients (56.2%)

Table 1. Retention protocols in the maxilla and mandible in both adult and adolescents according to the gender and the practice setting

Patients	Type of retainer	Overall	Gender		Practice setting		
			Male n=296 (%)	Female n=256 (%)	Postgraduate students n=138 (%)	Private practice n=256 (%)	Mixed settings (university/hospital and private) n=161 (%)
Maxillary arch in adults	Bonded retainer	100 (18%)	56 (18.9%)	54 (20.8%)	30 (21.7%)	38 (14.8%)	42 (26.1%)*
	Hawley retainer	113 (20%)	56 (18.9%)	57 (22%)	36 (26.1%)	31 (12.1%)	46 (28.6%***)
	Thermoplastic retainer	263 (47%)	145 (49%)	118 (45.6%)	68 (49.3%)	114 (44.5%)	81 (50.3%)
	Thermoplastic and bonded retainer	220 (39.6%)	124 (41.9%)	96 (37.1%)	46 (33.3%)	109 (42.6%)	65 (40.4%)
	Hawley and bonded retainer	85 (15%)	37 (12.5%)	48 (18.5%)*	23 (16.7%)	35 (13.7%)	27 (16.8%)
Mandibular arch in adults	Bonded retainer	249 (45%)	131 (44.3%)	118 (45.6%)	64 (46.4%)	101 (39.5%)	84 (52.2%)*
	Hawley retainer	60 (11%)	33 (11.1%)	27 (10.4%)	15 (10.9%)	14 (5.5%)	31 (19.3%***)
	Thermoplastic retainer	172 (31%)	85 (28.7%)	87 (33.6)	49 (35.5%)	63 (24.6%)	60 (37.3%)*
	Thermoplastic and bonded retainer	241 (43%)	130 (43.9%)	111 (42.9%)	58 (42%)	122 (47.7%)	61 (37.9%)
	Hawley and bonded retainer	53 (9.5%)	24 (8.1%)	29 (11.2%)	16 (11.6%)	19 (7.4%)	18 (11.2%)
Maxillary arch in adolescents	Bonded retainer	78 (14%)	43 (14.5%)	35 (13.5%)	24 (17.4%)	27 (10.5%)	27 (16.8%)
	Hawley retainer	186 (33.5%)	88 (29.7%)	98 (37.8%)*	65 (47.1%)	54 (21.1%)	67 (41.6%***)
	Thermoplastic retainer	235 (42%)	132 (44.6%)	103 (39.8%)	55 (39.9%)	106 (41.4%)	74 (46%)
	Thermoplastic and bonded retainer	171 (31%)	93 (31.4%)	78 (30.1%)	34 (24.6%)	93 (36.3%)	44 (27.3%)*
	Hawley and bonded retainer	110 (19.8%)	54 (18.2%)	56 (21.6%)	29 (21%)	45 (17.6%)	36 (22.4%)
Mandibular arch in adolescents	Bonded retainer	226 (40.7%)	122 (41.2%)	104 (40.2%)	53 (38.4%)	95 (37.1%)	78 (48.4%)
	Hawley retainer	103 (18.5%)	50 (16.9%)	53 (20.5%)	39 (28.3%)	21 (8.2%)	43 (26.7%***)
	Thermoplastic retainer	149 (26.8%)	76 (25.7%)	73 (28.2%)	40 (29%)	58 (22.7%)	51 (31.7%)
	Thermoplastic and bonded retainer	183 (33%)	105 (35.5%)	78 (30.1%)	37 (26.8%)	105 (41%)	41 (25.5%**)
	Hawley and bonded retainer	61 (11%)	29 (9.8%)	32 (12.4%)	17 (12.3%)	25 (9.8%)	19 (11.8%)

Statistically significant: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
n, number of participants

Table 2. Retention protocols in the maxilla and mandible in both adult and adolescents according to the age and the clinical experience

Patients	Type of retainer	Age					Clinical experience				
		Less than 30 years	30-39 years	40-49 years	50-59 years	More than 60 years	Less than 5 years	5-10 years	11-15 years	16-20 years	More than 20 years
		n=102 (%)	n=241 (%)	n=126 (%)	n=61 (%)	n=25 (%)	n=192 (%)	n=150 (%)	n=83 (%)	n=49 (%)	n=81 (%)
Maxillary arch in adults	Bonded retainer	31 (30.4%)	37 (15.4%)	25 (19.8%)	12 (19.7%)	5 (20%)	43 (22.4%)	30 (20%)	11 (13.3%)	9 (18.4%)	17 (21%)
	Hawley retainer	27 (26.5%)	42 (17.4%)	23 (18.3%)	13 (21.3%)	8 (32%)	46 (24%)	28 (18.7%)	13 (15.7%)	2 (4.1%)	24 (29.6%)
	Thermoplastic retainer	49 (48%)	117 (48.5%)	57 (45.2%)	29 (47.5%)	11 (44%)	97 (50.5%)	64 (42.7%)	44 (53%)	23 (46.9%)	35 (43.2%)
	Thermoplastic and bonded retainer	36 (35.3%)	100 (41.5%)	56 (44.4%)	20 (32.8%)	8 (32%)	70 (36.5%)	66 (44%)	37 (44.6%)	20 (40.8%)	27 (33.3%)
	Hawley and bonded retainer	20 (19.6%)	32 (13.3%)	18 (14.3%)	9 (14.8%)	6 (24%)	31 (16.1%)	22 (14.7%)	9 (10.8%)	9 (18.4%)	14 (17.3%)
Mandibular arch in adults	Bonded retainer	53 (52%)	97 (40.2%)	54 (42.9%)	31 (50.8%)	14 (56%)	87 (45.3%)	63 (42%)	35 (42.2%)	20 (40.8%)	44 (54.3%)
	Hawley retainer	10 (9.8%)	22 (9.1%)	17 (13.5%)	6 (9.8%)	5 (20%)	22 (11.5%)	15 (10%)	9 (10.8%)	1 (2%)	13 (16%)
	Thermoplastic retainer	36 (35.3%)	73 (30.3%)	37 (29.4%)	19 (31.1%)	7 (28%)	65 (33.9%)	48 (32%)	22 (26.5%)	15 (30.6%)	22 (27.2%)
	Thermoplastic and bonded retainer	41 (40.2%)	115 (47.7%)	57 (45.2%)	21 (34.4%)	7 (28%)	80 (41.7%)	72 (48%)	38 (45.8%)	26 (53.1%)	25 (30.9%)
	Hawley and bonded retainer	15 (14.7%)	26 (10.8%)	7 (5.6%)	3 (4.9%)	2 (8%)*	26 (13.5%)	14 (9.3%)	6 (7.2%)	2 (4.1%)	5 (6.2%)*
Maxillary arch in adolescents	Bonded retainer	20 (19.6%)	24 (10%)	24 (19%)	6 (9.8%)	4 (6%)	29 (15.1%)	16 (10.7%)	10 (12%)	11 (22.4%)	12 (14.8%)
	Hawley retainer	40 (39.2%)	79 (32.8%)	37 (29.4%)	21 (34.4%)	9 (36%)	74 (38.5%)	48 (32%)	21 (25.3%)	10 (20.4%)	33 (40.7%)
	Thermoplastic retainer	36 (35.3%)	103 (42.7%)	53 (42.1%)	35 (57.4%)	8 (32%)	76 (39.6%)	66 (44%)	33 (39.8%)	24 (49%)	36 (44.4%)
	Thermoplastic and bonded retainer	30 (29.4%)	83 (34.4%)	41 (32.5%)	11 (18%)	6 (24%)	54 (28.1%)	57 (38%)	27 (32.5)	17 (34.7%)	16 (19.8%)
	Hawley and bonded retainer	22 (21.6%)	49 (20.3%)	26 (20.6%)	9 (14.8%)	4 (16%)	47 (24.5%)	26 (17.3%)	18 (21.7%)	4 (8.2%)	15 (18.5%)
Mandibular arch in adolescents	Bonded retainer	36 (35.3%)	93 (38.6%)	53 (42.1%)	30 (49.2%)	14 (56%)*	71 (37%)	59 (39.3%)	36 (43.4%)	19 (38.8%)	41 (50.6%)
	Hawley retainer	27 (26.5%)	40 (16.6%)	22 (17.5%)	9 (14.8%)	5 (20%)	45 (23.4%)	28 (18.7%)	8 (9.6%)	5 (10.2%)	17 (21%)
	Thermoplastic retainer	24 (23.5%)	65 (27%)	35 (27.8%)	20 (32.8%)	5 (20%)	52 (27.1%)	41 (27.3%)	19 (22.9%)	16 (32.7%)	21 (25.9%)
	Thermoplastic and bonded retainer	31 (30.4%)	91 (37.8%)	43 (34.1%)	13 (21.3%)	5 (20%)	59 (30.7%)	58 (38.7%)	32 (38.6%)	17 (34.7%)	17 (21%)
	Hawley and bonded retainer	14 (13.7%)	34 (14.1%)	8 (6.3%)	4 (6.6%)	1 (4%)**	31 (16.1%)	14 (9.3%)	7 (8.4%)	3 (6.1%)	6 (7.4%)**

Statistically significant: *p<0.05; **p<0.01; ***p<0.001
n, number of participants

and status of oral hygiene (54.2%) were the most influencing clinician and patient-related factors.

Malocclusion and Treatment Factors

Pre-treatment spacing, degree of rotation and pre-treatment crowding were the most influencing malocclusion related-factors on the choice of retainers, 77.7%, 73.5% and 70.8%, respectively. Notably, the influence of third molars received the lowest score (8.5%). With regards to treatment-related factors, 64.1% of the total sample thought the amount of expansion achieved during treatment was the most influential factor for their preferred choice of retainer type. The degree of interdigitation after treatment was chosen by half of the participants (50.1%) as being a factor. Only 18.6% of the cohort thought the amount of extrusion of posterior teeth would be an influencing factor on their choice of retainer after treatment. Appendix 2 shows a detailed report of the participants' responses.

The Adjunctive Procedures and the Benefit of Guidelines

46.4% of the respondents do not routinely use adjunctive retention procedures such as the circumferential supracrestal fiberotomy (CSF) or interproximal reduction (IPR) (Appendix 3). However, 39.7% of the cohort prescribe CSF to enhance retention of de-rotated teeth, while 31.3% of the participants considered IPR in the presence of pre-treatment labial segment crowding to optimise post-treatment retention. The results demonstrated that there is a consensus (92.8%) regarding the association between a thick labial frenum and a median diastema. Most respondents (94.2%) applied the blanching test for its diagnosis, while 39.5% relied on the radiographical assessment. Most participants believed in the thick labial frenum being an aetiological factor for a median diastema and recommended labial frenectomy to minimise relapse, either before commencing orthodontic treatment (7.7%), during treatment but before complete diastema closure (42%), or after active orthodontic treatment (44.5%). Furthermore, 84.7% of the participants recommended the use of a bonded retainer as a post-treatment retention protocol for maintaining diastema closure, but only 12.6% preferred a removable retainer (4.1% for the Hawley retainer and 8.5% for thermoplastic retainer).

Approximately, two-thirds (68.6%) of the participants agreed that professional guidelines on retention would be useful, 24.7% thought it would be partially helpful, and only 5% thought such guidelines would have no benefit.

DISCUSSION

The present survey has shed some light on the retention regimes employed by orthodontic clinicians worldwide, which may help orthodontists improve their retention protocols in the absence of uniform clinical guidelines. Despite their importance, existing guidelines are out of date, and their quality was rated inadequate, especially in terms of their development, editorial independence, stakeholder agreement, and record of applicability, as judged by the AGREE instrument (Appraisal of

Guidelines, Research, and Evaluation).¹⁷

This study showed that thermoplastic retainers were the most commonly prescribed retainers in the maxillary arch in adult and adolescent patients, a finding similar to those of previous studies in the UK,⁹ Australia/New Zealand,¹⁰ Ireland,¹⁹ Canada,²³ and Malaysia.²⁴ On the other hand, studies from other parts of the globe showed different outcomes. For instance, the Hawley retainer was the most common retention appliance in the maxillary arch in the USA^{21,25} and Saudi Arabia,²⁰ while fixed retainers were commonly adopted by clinicians from the Netherlands,¹⁸ and Norwegian and Danish clinicians^{11,26} were in favor of a combination of removable and fixed retainers, indicating the influence of the training center on the choice of retention appliance. It is noteworthy that over recent years and in many countries, there has been a shift from Hawley to clear thermoplastic retainers.^{8,18,21,27} Present evidence²⁸ shows that thermoplastic retainers are more cost-effective and well accepted by patients when compared with Hawley retainers. However, the effectiveness of thermoplastic retainers over Hawley retainers for maxillary arch stability is inconclusive.^{29,30} Moreover, in this study, most clinicians favored bonded retainers in the mandibular arch, which is in agreement with most previous studies.^{8,10,11,18,20,25} Additionally, some previous studies have reported using thermoplastic retainers²⁴ or a combination of removable and fixed retainers.⁷

In the present study, female clinicians were more inclined towards the use of Hawley retainers alone in the maxillary arch in adolescents (37.8%) or in combination with bonded retainers in adults (18.5%), similar to the findings of previous studies.^{11,31} Clinicians in private practices favored thermoplastic retainers in the maxillary arch and a combination of thermoplastic and bonded retainers in the mandibular arch. These findings are consistent with UK⁹ and Ireland¹⁹ based retention surveys. For orthodontists working in mixed practice settings, the use of upper thermoplastic and lower bonded retainers were most common, in contrast with an Ireland-based survey¹⁹ in which thermoplastic retainers were mostly used in both maxillary and mandibular arches. This discrepancy could be due to the fact that the latter study¹⁹ included respondents from public practices as well as the influence of the orthodontic training background on the choice of retention appliance.

In the current study, upper thermoplastic retainers in adults, Hawley retainers in adolescents, and lower bonded retainers, were preferred options for patients treated in mixed settings (university, hospital and private). Previous studies from Ireland and the UK^{9,19} showed that thermoplastic retainers were most commonly used in both jaws in hospital-based practices. This trend can be explained by the fact that almost all of our participants in mixed-based practices were postgraduate students who were working under supervision.⁷ The participants' age had negligible influence on retainer choice, with older orthodontists leaning more towards lower bonded retainers. Similar opinions were given by UK orthodontists in a previous study.⁹

It is well established that clinical experience of orthodontists is an important factor that can affect the retention protocol.⁸ In our study, orthodontic clinicians with less than 5 years of clinical experience highly preferred using a combined lower Hawley retainer and bonded retainer. This could be due to the carry-over learning effect of their previous clinical training during residency.⁷ However, a recent study showed no correlations between different retention modalities and orthodontic experience.³¹

In this study, malocclusion-related factors were more important than patient- and treatment-related factors. The spacing and de-crowding were equally important variables in selecting the retainers, while the influence of third molars was the least importance. Similar opinions were given by orthodontists in previous studies.^{7,18,31} The most important patient-related factors for the choice of retainers were compliance of the patients and their oral hygiene status, similar to the findings of previous studies.^{7,11,18} Expansion achieved during treatment and the degree of interdigitation at the end of treatment were the most important treatment-related factors that influenced retainer choice. In previous studies, interdigitation after treatment,¹⁸ expansion and extraction,^{7,18-20} and final occlusal outcomes^{11,18} were opined to be the most important treatment factors in determining the retention plan.

Adjunct procedures like IPR and CSF are widely reported to prevent relapse.^{4,32} In the present study, one third of the cohort prescribed CSF to enhance retention of de-rotated teeth, while a quarter of the participants considered IPR to be beneficial in preventing potential post-treatment lower labial segment relapse. In a Saudi Arabia-based survey,²⁰ 28% of orthodontists performed IPR, while 19.1% used CSF as an adjunct procedure to optimise post-treatment retention.

Since a thick labial frenum is one of the causative factors for a median diastema, it is an established fact that these patients are at high risk of post-treatment relapse.³³ In the present survey, most clinicians acknowledged this association and therefore recommended a labial frenectomy before complete diastema closure or after active orthodontic treatment, followed by placing a bonded retainer. This is in agreement with the findings of previous studies.^{18,31} Regarding the need for retention guidelines, the majority of the participants agreed that such guidelines would be beneficial, which is in agreement with several previous studies.^{7,11,18}

Some studies have reported a higher response rate in their survey studies mainly by implementing telephonic reminders^{8,18} or paper-based postal services.^{9,19} In the present study, the response rate was low, which is common in electronic-based surveys in the field of orthodontic retention.^{20,21} As the present survey was global and conducted during the coronavirus disease-2019 pandemic, it was not practical for the authors to have pre-contacts and personalized contacts with most of the participants. Moreover, in survey-based studies, response representativeness is more important than response rate.²²

All previous survey studies on retention protocols^{7,8,18,23} were mostly limited to specialist orthodontists, or were regional and thus lacking favorable representativeness of working orthodontic clinicians, in comparison with the present study. However, higher response rate from different continents may or may not change the significance of the results, but it may increase the generalizability of the findings.

Study Limitations

The strength of this survey lies in the fact that it involved validated questionnaires answered by orthodontists and residents of different ages and experience levels from across the globe, thus increasing representativeness rate and minimizing the level of bias. The authors acknowledge that the participation in this study was uneven, and therefore this factor needs to be taken into consideration when interpreting the findings.

CONCLUSION

This study showed that the most common retention appliance was thermoplastic retainer in the maxillary arch and bonded retainer in the mandibular arch for both adults and adolescents. This is similar to the adopted adolescent retention protocol in private practices except that the lower bonded retainer is usually combined with thermoplastic retainer. Female orthodontists commonly used Hawley retainer alone or combined with bonded retainer. The age of participants has negligible effect on the prescribed retention protocol except that younger age groups who are more likely to prescribe a combination of lower Hawley and bonded retainers for their adult. The pre-treatment spacing and crowding were the most influencing malocclusion-related factors. Moreover, the uneven participation in this survey should be taken into consideration during interpreting the results.

Ethics

Ethics Committee Approval: The approval was granted by the Ethical Committee of ITTEFAQ Hospital (registration number: RCDD-IHT-04-2020, date: 21.09.2020).

Informed Consent: At the commencement of the survey, details about the study objectives and the researcher team were provided to the participants.

Author Contributions: Concept - M.A.; Design - M.A., S.M.; Supervision - M.A.; Data Collection and/or Processing - M.A., S.M.; Analysis and/or Interpretation - S.M.; Literature Review - H.K., M.B.W.; Writing - M.A., S.M., H.K., F.A., E.E.A., M.B.W.; Critical Review - H.K., F.A., E.E.A., M.B.W.

Declaration of Interests: All authors declare that they have no conflict of interest.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments: FA would like to thank Prince Sattam bin Abdulaziz University for their support.

REFERENCES

1. Riedel R, Graber T, Swain B. Current orthodontic concepts and techniques. Philadelphia: WB Saunders Co; 1969. [CrossRef]
2. Fleming PS, Dibiasi AT, Lee RT. Arch form and dimensional changes in orthodontics. *Prog Orthod.* 2008;9(2):66-73. [CrossRef]
3. Thilander B. Orthodontic relapse versus natural development. *Am J Orthod Dentofacial Orthop.* 2000;117(5):562-563. [CrossRef]
4. Littlewood SJ, Kandasamy S, Huang G. Retention and relapse in clinical practice. *Aust Dent J.* 2017;62(Suppl 1):51-57. [CrossRef]
5. Al-Moghrabi D, Johal A, O'Rourke N, et al. Effects of fixed vs removable orthodontic retainers on stability and periodontal health: 4-year follow-up of a randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2018;154(2):167-174.e1. [CrossRef]
6. Kaklamanos EG, Kourakou M, Kloukos D, Doulis I, Kavvadia S. Performance of clear vacuum-formed thermoplastic retainers depending on retention protocol: a systematic review. *Odontology.* 2017;105(2):237-247. [CrossRef]
7. Andriekute A, Vasiliauskas A, Sidlauskas A. A survey of protocols and trends in orthodontic retention. *Prog Orthod.* 2017;18(1):31. [CrossRef]
8. Padmos JAD, Fudalej PS, Renkema AM. Epidemiologic study of orthodontic retention procedures. *Am J Orthod Dentofacial Orthop.* 2018;153(4):496-504. [CrossRef]
9. Singh P, Grammati S, Kirschen R. Orthodontic retention patterns in the United Kingdom. *J Orthod.* 2009;36(2):115-121. [CrossRef]
10. Wong PM, Freer TJ. A comprehensive survey of retention procedures in Australia and New Zealand. *Aust Orthod J.* 2004;20(2):99-106. [CrossRef]
11. Vandevska-Radunovic V, Espeland L, Stenvik A. Retention: type, duration and need for common guidelines. A survey of Norwegian orthodontists. *Orthodontics (Chic.).* 2013;14(1):e110-117. [CrossRef]
12. Sheridan JJ, LeDoux W, McMinn R. Essix retainers: fabrication and supervision for permanent retention. *J Clin Orthod.* 1993;27(1):37-45. [CrossRef]
13. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces. *Cochrane Database Syst Rev.* 2016;2016(1):CD002283. [CrossRef]
14. Johnston C, Burden D, Morris D. Clinical guidelines: Orthodontic retention. 2008. [CrossRef]
15. Lewis BR, Snyder CA, Rainer Jr RK. An empirical assessment of the information resource management construct. *JMIS.* 1995;12(1):199-223. [CrossRef]
16. Lawshe CH. A quantitative approach to content validity. *Pers Psychol.* 1975;28(4):563-575. [CrossRef]
17. Tejani T, Mubeen S, Seehra J, Cobourne MT. An exploratory quality assessment of orthodontic clinical guidelines using the AGREE II instrument. *Eur J Orthod.* 2017;39(6):654-659. [CrossRef]
18. Renkema AM, Sips ET, Bronkhorst E, Kuijpers-Jagtman AM. A survey on orthodontic retention procedures in The Netherlands. *Eur J Orthod.* 2009;31(4):432-437. [CrossRef]
19. Meade MJ, Millett D. Retention protocols and use of vacuum-formed retainers among specialist orthodontists. *J Orthod.* 2013;40(4):318-325. [CrossRef]
20. Al-Jewair TS, Hamidaddin MA, Alotaibi HM, et al. Retention practices and factors affecting retainer choice among orthodontists in Saudi Arabia. *Saudi Med J.* 2016;37(8):895-901. [CrossRef]
21. Pratt MC, Kluemper GT, Hartsfield JK Jr, Fardo D, Nash DA. Evaluation of retention protocols among members of the American Association of Orthodontists in the United States. *Am J Orthod Dentofacial Orthop.* 2011;140(4):520-526. [CrossRef]
22. Cook C, Heath F, Thompson RL. A meta-analysis of response rates in web- or internet-based surveys. *EPM.* 2000;60(6):821-836. [CrossRef]
23. Carneiro NCR, Nóbrega MTC, Meade MJ, Flores-Mir C. Retention decisions and protocols among orthodontists practicing in Canada: A cross-sectional survey. *Am J Orthod Dentofacial Orthop.* 2022;162(1):51-57. [CrossRef]
24. Ab Rahman N, Low TF, Idris NS. A survey on retention practice among orthodontists in Malaysia. *Korean J Orthod.* 2016;46(1):36-41. [CrossRef]
25. Valiathan M, Hughes E. Results of a survey-based study to identify common retention practices in the United States. *Am J Orthod Dentofacial Orthop.* 2010;137(2):170-177; discussion 7. [CrossRef]
26. Hamran T, Čirgić E, Aiyar A, Vandevska-Radunovic V. Survey on retention procedures and use of thermoplastic retainers among orthodontists in Norway, Sweden, and Denmark. *J World Fed Orthod.* 2022;11(4):114-119. [CrossRef]
27. Keim RG, Vogels Iii DS, Vogels PB. 2020 JCO study of orthodontic diagnosis and treatment procedures part 1: results and trends. *J Clin Orthod.* 2020;54(10):581-610. [CrossRef]
28. Mollov ND, Lindauer SJ, Best AM, Shroff B, Tufekci E. Patient attitudes toward retention and perceptions of treatment success. *Angle Orthod.* 2010;80(4):468-473. [CrossRef]
29. Rowland H, Hichens L, Williams A, et al. The effectiveness of Hawley and vacuum-formed retainers: a single-center randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2007;132(6):730-737. [CrossRef]
30. 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(3):404-409. [CrossRef]
31. Padmos J, Mei L, Wouters C, Renkema AM. Orthodontic retention procedures in New Zealand: A survey to benefit clinical practice guideline development. *J World Fed Orthod.* 2019;8(1):24-30. [CrossRef]
32. Edman Tynelius G, Bondemark L, Lilja-Karlander E. Evaluation of orthodontic treatment after 1 year of retention—a randomized controlled trial. *Eur J Orthod.* 2010;32(5):542-547. [CrossRef]
33. Rajani ER, Biswas PP, Emmatty R. Prevalence of variations in morphology and attachment of maxillary labial frenum in various skeletal patterns - A cross-sectional study. *J Indian Soc Periodontol.* 2018;22(3):257-262. [CrossRef]

Click the link to access Appendix Tables 1-3:

<http://glns.co/9k5bq>