Systematic Review Article

Lower fixed retainers: bonded on all teeth or only on canines? *A systematic review*

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ABSTRACT

Objective: To evaluate the stability after orthodontic treatment between two types of lower fixed retainers: those bonded onto all anterior teeth or those bonded only onto the canines.

Materials and Methods: The following electronic databases were consulted: PubMed, Scopus, Web of Science, Cochrane Library, Lilacs, OpenGrey, ClinicalTrials, and Google Scholar. No restriction of language or year were applied. After selection of studies, risk-of-bias evaluation and qualitative synthesis of the included studies were performed using The Cochrane Collaboration's tool for randomized studies and the "Risk of Bias in Non-randomized Studies of Interventions" (ROBINS-I) tool for nonrandomized studies, and a summary of the overall strength of evidence was presented using the "Grading of recommendations, assessment, development and evaluation" tool.

Results: Among the 180 studies retrieved from the searches, five were included in this review. Three of them showed a low risk of bias, while two presented a high risk of bias. With regard to stability, two studies reported better stability for retainers bonded to all six teeth, while the other three showed no difference. The retainer bonded to all teeth presented a higher breakage rate in one study.

Conclusions: Stability seems better with lower fixed retainers bonded on all anterior teeth. The breakage rate may not change according to the bonding. However, studies with greater methodological soundness are necessary to reach a more reliable conclusion. (*Angle Orthod.* 2020;90:125–143.)

KEY WORDS: Orthodontic retainers; Long-term effects; Orthodontic appliances

INTRODUCTION

After orthodontic movement, teeth tend to return to the direction from which they were originally moved[1] as a result of traction of the elastic fibers of the gingiva and the imbalance among forces between the lips and tongue.[2] After finishing treatment, time is needed for the reorganization of alveolar bone and periodontium.[3] Orthodontic retainers are ideally suited to maintain tooth alignment after treatment.[4]

In the lower arch, fixed retainers in the anterior segment are a valid option for managing the significant relapse rate in this area.[5] Recent evidence[6,7] indicated that retainers are essential for long-term stability. However, there are still questions regarding the efficacy of the different types of retainers available.[8]

The 3 × 3 fixed retainer, bonded using the direct technique, is a commonly used type of retainer in the lower arch. This is likely attributable to the accessibility and cost-effectiveness of the technique.[9] This type of retainer can be bonded either to the lingual surface of the lower canines only or to all six of the lower teeth, on the lingual surface of the incisors and canines.[4,9] In addition to stability, another concern associated with fixed retainers has been the possibility of increased levels of dental plaque and calculus as a result of poor

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dental hygiene due to the difficulty of brushing and flossing the area around the retainer.[10]

Several systematic reviews[11–14] and original studies[15,16] investigated the benefits and damage associated with fixed and removable retainers. Those studies focused on stability and clinical performance of both types of retainers, considering the different materials and design of the appliances.[11–16]

Despite the fact that the influence of design and bonding technique for lower fixed retainers was discussed in original studies,[15,16] no systematic review has addressed this question. A previous systematic review[11] evaluated the difference between fixed orthodontic retainers bonded to all teeth and those bonded only to the canines, but only the periodontal condition and bonding failures were presented; results regarding the stability of dental alignment were not reported. This systematic review aimed to evaluate the difference in stability between lower fixed retainers bonded on all six anterior teeth (lower incisors and canines) and those bonded only to the canines. Additionally, breakage rates were also evaluated.

MATERIALS AND METHODS

Protocol and Registration

The protocol of this systematic review was registered in the PROSPERO database (International Prospective Register of Systematic Reviews–PROSPERO; http://www.crd.york.ac.uk/PROSPERO) under the code CRD42016050719. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)[17] guidelines were followed in this review.

Eligibility Criteria

The PICO/PECO strategy was applied. Prospective and retrospective studies performed in adults and adolescents (P), using lower fixed retainers bonded only on canines (I/E) compared to retainers bonded to all anterior teeth (lower incisors and canines), were evaluated with regard to stability (O). Animal studies, technical articles, case reports, literature reviews, and noncontrolled studies were excluded.

Search Strategy and Study Selection

Searches in the following databases were performed through June 2019: PubMed, Scopus, Web of Science, The Cochrane Library, LILACS, and ClinicalTrials. The gray literature was consulted through OpenGrey and Google Scholar. No language or year restriction was applied. The predefined search strategies presented a combination of Mesh and free terms related to orthodontic retainers and were adapted to each database (Appendix 1).

After searches were conducted, the results were imported into a reference manager software (EndNote web, Clarivate Analytics, Philadelphia, Pa). Duplicated results were excluded by automatic and manual assessment.

The selection process was performed in two phases. In the first phase, the title and abstracts that did not follow the established eligibility criteria were excluded. In the second phase, articles remaining from phase I were assessed by full text. Among the selected studies resulting from this process, reference lists were also evaluated to retrieve new articles following the eligibility criteria. All steps of the selection process were conducted independently by two reviewers (ALCSB and LBM) and checked by a third reviewer (SMAM) in case of disagreement.

Data Extraction and Risk of Bias

The results extracted from included articles were evaluated qualitatively. The country, year of publication, study design, sample characteristics, methods of evaluation, results, and statistical analysis were obtained from the included studies. In the event of an absence of information among the articles, the authors were contacted by e-mail. In an attempt to contact authors, one e-mail was sent once every week for five consecutive weeks for each study.

The risk of bias was assessed through two tools: The Cochrane Collaboration's tool for assessing the risk of bias[18] applied in randomized controlled studies and the "Risk of Bias in Non-randomized Studies of Interventions" (ROBINS-I) tool[19] in nonrandomized studies. In The Cochrane Collaboration's tool for assessing risk of bias[18] tool, seven domains were included: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other bias. The performance bias and the detection bias were not considered in this evaluation. For each domain, the risk of bias was judged as "low risk," "high risk," or "unclear risk."

The ROBINS-I tool[19] was used in nonrandomized studies. This checklist presents three main evaluation domains: preintervention, during intervention, and postintervention. After the individualization of the main criteria, the risk of bias was assessed for each domain and classified as "low," "moderate," "serious," "critical," or "no information."

Level of Evidence

A summary of the overall strength of evidence was presented using the "Grading of recommendations,

Table 1. Risk of Bias (RoB) of the Included Studies, According to the ROBINS-I Tool[19]

	Domains							
	Preintervention		At Intervention	Postintervention				
Author	Bias Due to Confounding	Bias in Selecting Participants for the Study	Bias in Classifying Interventions	Bias Due to Deviations From Intended Intervention	Bias Due to Missing Data	Bias in Measuring Outcomes	Bias in Selecting Reported Result	Overall RoB Judgment
Al-Nimri et al.[23]	Low	Low	Low	Low	Low	Low	Low	Low
Steinnes et al.[24]	Low	Low	Low	Low	Low	Low	Low	Low
Schutz-Frazon et al.[25]	Low	Low	Critical	Moderate	Low	Low	Low	Serious

assessment, development and evaluation" (GRADE) tool.[20] Included studies were evaluated according to their design, study quality, consistency, and directness. Evaluation of stability and frequency of breakage were performed.

RESULTS

Selection and Characteristics of Included Studies

A total of 180 citations were retrieved from databases. After exclusion of 63 duplicated results, 117 title/abstracts were evaluated. Among those, 111 studies were excluded: two were opinion articles, two were systematic reviews that did not assess the bonding of retainers, 12 studies did not evaluate stability of retainers, 32 did not compare the two types of bonding among retainers, and 63 studies did not assess orthodontic lower retainers (Appendix 2). Six studies were reviewed by full text,[21–26] and one was excluded because of the absence of stability evaluation.[26] Five studies were included in this review[21–25] and subjected to qualitative and risk-of-bias assessment (Figure 1; Table 1). Among the included articles, two were randomized trials[21,22] and three were nonrandomized clinical trials[23–25] (Table 2).

A meta-analysis was not possible to achieve as part of this systematic review as a result of methodological heterogeneity. The included studies used a different wire thickness, so comparisons among them were not feasible.

Results from Individual Studies

Stormann and Ehmer[22] and Al-Nimri et al.[23] reported better stability for the retainer bonded on all lower anterior teeth. The other three studies[21,24,25] showed no differences between the two types of retainers in the frequency of breakage or in the stability of treatment.

Two of the studies included[21,22] were randomized clinical trials with a follow-up period ranging from 2[22] to 3[21] years. The sample sizes ranged from 49[21] to 98[22] patients, and only adolescents and young adults were included. The other articles included in this review[23–25] were nonrandomized studies. The sample size varied from 62 to 69 patients, and the follow-up time was between 1 and 9 years. The average patient age was from 12 to 25 years among the studies.[23–25]

The method used to compare the two types of retainers was the Irregularity Index proposed by Little.[27] One of the studies[24] also used the PAR index.[28] To evaluate breakage, the mean number of broken appliances was compared among groups descriptively[21,25] or by statistical analysis[22,23] (Table 2).

Risk of Bias

For the Artun et al.[21] study, there was an unclear risk of bias on the domains random sequence generation (selection bias) and allocation concealment (selection bias). The authors were contacted to clarify the randomization process but they were unable to provide further information (Appendix 3). For the domains of incomplete outcome data (attrition bias) and other bias there was a high risk due to a reported dropout of patients during follow up and the absence of the primary evaluator during follow up. The domains blinding of participants and personnel (performance bias) and blinding of outcome assessment (detection bias) were not evaluated because of the nature of the intervention (Figure 2).

The study from Stormann and Ehmer[22] presented a low risk of bias for all domains considered. The article thoroughly described the randomization process, reported all the results, and seemed to be free from other sources of bias (Figure 2).

Among the nonrandomized studies, two[23,24] of them presented a low risk of bias in all domains. The other study[25] was classified as having a moderate risk of bias, due to the retrospective definition of some aspects of the assignments of intervention.

Level of Evidence

The GRADE evaluation highlights the results reported by the included studies, suggesting that there was better stability when lower retainers bonded on all anterior teeth were used compared to retainers bonded only to canines. A higher rate of breakage was

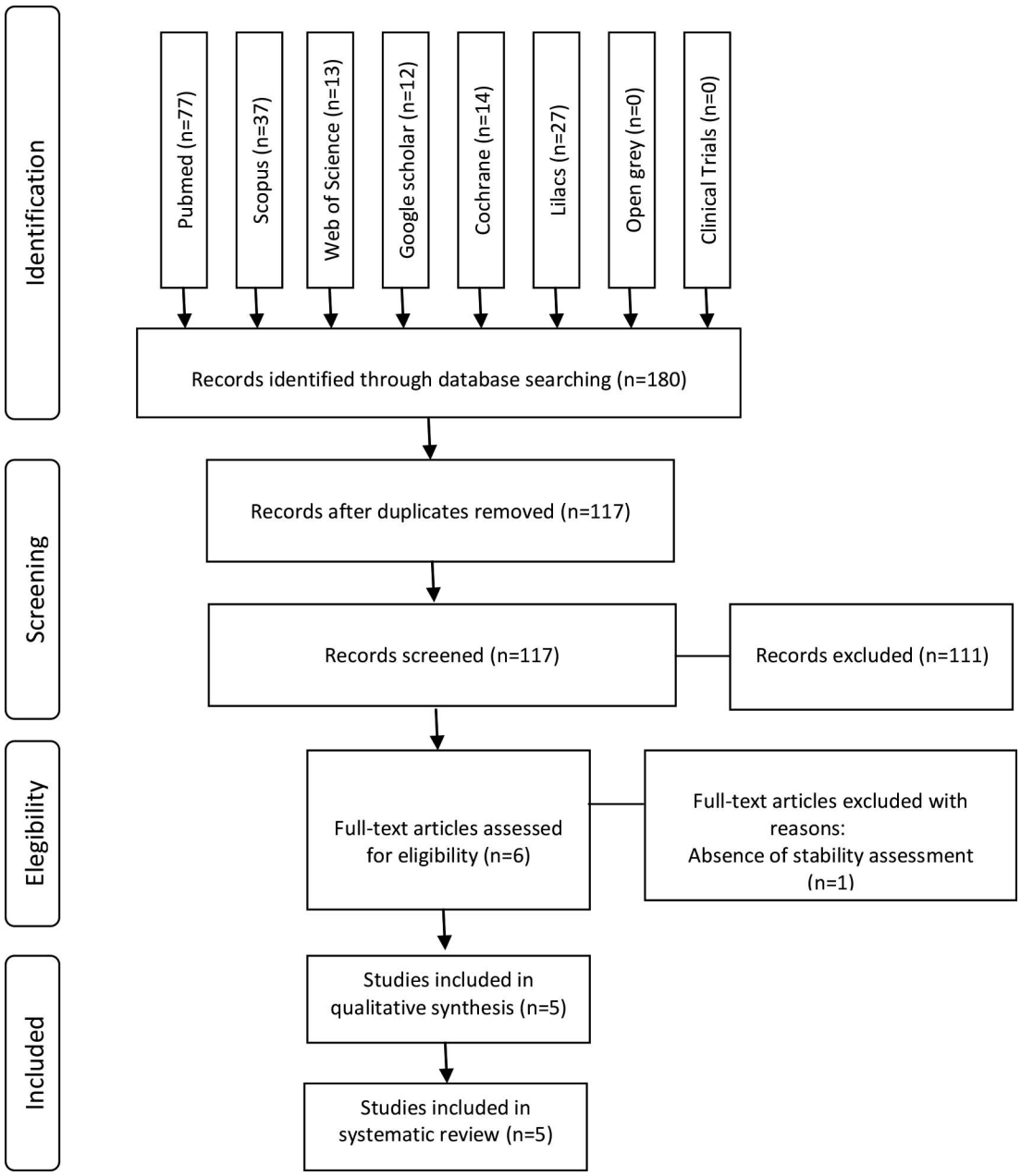

Figure 1. Flowchart with the number of records identified and removed at each stage of the review according to the PRISMA statement.

reported for retainers bonded on all teeth; however, the strength of these results should be carefully considered because of the risk of bias and type of the included studies (Table 3).

DISCUSSION

Summary of Evidence

Among the five studies included in this review, differences were found between the performance of lower fixed retainers bonded to all lower anterior teeth and those bonded to canines only. Stormann and Ehmer[22] and Al-Nimri et al.[23] reported lower relapse rates when lower retainers were bonded to all teeth (canines and incisors). Artun et al.,[21] Steinnes et al.,[24] and Schutz-Frazon et al.[25] reported no difference between the two types of retainers evaluated. Regarding the risk of bias, two studies were classified as high risk[21,25] and the other studies as low risk.[22–24]

The better results that were reported for retainers bonded to all lower anterior teeth may be attributed to the reduced protrusive forces produced by the tongue during the retention phase. The lower retainers bonded

Table 2. Summary of Characteristics and Results of the Included Studies[a]

Author/Country/ Year/Study Design		Artun et al.[21]/United States/1997/RCT	Stormann and Ehmer[22]/ Germany/2002/RCT	Al-Nimri et al.[23]/Jordan/ 2009/Non-RCT	Steinnes et al.[24]/ Norway/2017/ Non-RCT	Schutz-Frazon et al.[25]/ Sweden /2017/ Non-RCT
Sample	Source	Department of Orthodontics, University of Washington, Seattle, Wash	Department of Orthodontics, University of Münster, Germany	Department of Orthodontics, Jordan University of Science and Technology, Jordan	Public Dental Service Competence Centre of Northern Norway, Tromsø, Norway	Department of Orthodontics, Institute for Postgraduate Dental Education, Jonkoping, Sweden
	n	49 n = 11: thick plain wire (0.032 inch) bonded only to the canines n = 13: thick spiral wire (0.032 inch) bonded only to the canines n = 11: thin (0.205-inch) flexible spiral wire bonded to each tooth in the segment n = 14: removable retainers	98 n = 36: twisted wire (0.0215 inch) bonded to each tooth in the segment n = 30: twisted wire (0.0195 inch) bonded to each tooth in the segment n = 32: canine-and-canine prefabricated retainer	62 n = 31: multistrand lower retainers bonded to all six teeth n = 31 plain wire retainers bonded only in canines	60 lower fixed retainers: bonded to all six teeth or only canines	64 n = 28: plain wire (0.028 inch) retainers bonded only in canines n = 36: multistrand (0.0195 inch) lower retainers bonded in all six teeth
	Age	Adults and adolescents	13–17 y	19.97–20.23 y	25 y	12. –13.2 y
	Follow-up, y	3	2	1	8	9
Assessment	Stability	Irregularity Index	Irregularity Index	Irregularity Index	Irregularity Index and PAR index	Irregularity Index
Results	Stability	No difference between groups on the alignment of incisors ($P = .18$)	The relapse rate was higher among retainers bonded only in canines ($P < .001$)	The retainers bonded only to canines presented a higher than those bonded in all six teeth ($P = .002$)	No difference among groups ($P = .62$)	No difference among groups ($P = .05$)
	Breakages	27.3% of retainers bonded to all teeth 20.4% of retainers bonded only in canines: 30.4% in twisted archwire and 9.1% in plain archwire	The retainers bonded in all six teeth (0.0215) presented a higher rate of breakages (53%), followed by the 0.0195 retainers (29%). The retainers bonded only to the canines presented a rate of 18%; $P < .001$	No difference among groups ($P > .05$)	—	No difference among groups ($P > .05$)

[a] RCT indicates randomized controlled trial; Non-RCT, non–randomized controlled trial.

only on the canines could result in protrusion of the incisors that were not bonded.[29]

The stability of tooth position during fixed orthodontic retention can also be influenced by other factors, such as breakage of the retainer,[26,30] tooth rotation,[31,32] increased intercanine distance,[32] the diameter of retainer wire,[26,32] and the follow-up duration.[6,7] The occurrence of breakage during follow up between the two retainer designs was found to be different in only one study.[22] That study reported a high rate of breakage for retainers bonded on all anterior teeth.[22] Even though the breakage of fixed retainers was previously associated with poor stability,[26,30] in this specific study,[22] no relapse on orthodontic treatment was reported.

Another factor previously shown to influence the stability of orthodontic treatment was the presence of tooth rotations corrected during treatment.[31,32] A high Irregularity Index (80%) was associated with relapse of tooth rotations in two included studies.[22,23] The return of rotations seemed to be related to the amount of rotation before treatment.[31,32] An increase in intercanine distance during treatment has also been shown to be a cause of relapse of the crowding of anterior lower teeth.[32] In this review, no changes in intercanine distance were detected in the studies.[22,23]

The wire thickness of the retainers used was different in the various studies included in this review.[21–25] Canine-to-canine retainers can be made with stainless-steel twisted archwires or plain stainless-steel archwires.[9] The twisted archwires have been

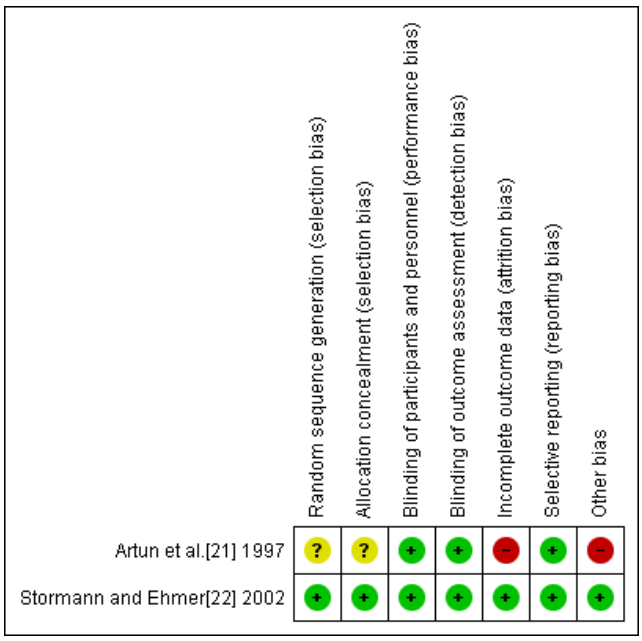

Figure 2. Risk of bias of the randomized studies according to The Cochrane Collaboration's tool.

described as very elastic and highly resilient,[33] allowing for physiological movement of the teeth, in addition to having a design that offers great mechanical retention of the material.[5] One study[21] included in this review suggested that twisted archwires were more effective in tooth alignment maintenance. This result was in agreement with the findings of another study,[31] which reported less adverse effects[31] as compared to those associated with retainers made of plain stainless-steel bonded only on canines.[34] It is suggested that the use of twisted archwires is a safer alternative to prevent unexpected movements during the retention phase.[34]

Limitations

The variation in follow-up time may have been a factor contributing to the differences found between the studies. Artun et al.,[21] Steinnes et al.,[24] and Schutz-Frazon et al.[25] observed that there was no difference in stability between the two types of retainers, those bonded to all teeth or those bonded only to canines, at 3, 8, and 9 years of follow up, respectively. However, all of the included studies[21–25] identified that the retainers bonded to all teeth resulted in adequate stability, comparing for 3, 2, 1, 8, or 9 years, respectively. In the long term, this stability seemed to remain regardless of the type of retainer. There was evidence that restraint stability was effective in the long term[6,7] and that the highest relapse rate occurred during the first 2 years.[6]

Regarding the sample size, none of the studies[21–25] performed a power calculation to determine the appropriate sample size. The absence of sample calculations was previously reported as a common characteristic in orthodontic journals.[35] The use of nonstatistical factors to assess sample size may

Table 3. Grading of Recommendation, Assessment, Development, and Evaluation (GRADE) instrument[20]

Certainty Assessment							Summary of Findings				
							Study Event Rates, No. (%)%			Anticipated Absolute Effects	
No. of Participants (Studies) FollowUp	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Certainty of Evidence	With Bonded Only in Canines	With Lower Fixed Retainers Bonded in All Teeth	Relative Effect (95% CI)	Risk with Bonded Only in Canines	Risk Difference with Lower Fixed Retainers Bonded in All Teeth
Absence of relapse on stability (follow up: range 2–3 y)											
133 (2 RCTs)	Serious[a]	Not serious	Not serious	Not serious	None	⊕⊕⊕○ Moderate	70/77 (90.9)	48/56 (85.7)	Not estimable	Not pooled	Not pooled
Absence of relapse on stability (follow up: range 1–9 y)											
186 (3 observational studies)	Serious[b]	Not serious	Serious[c]	Not serious	None	⊕⊕○○ Low	47/78 (60.3)	77/108 (71.3)	Not estimable	Not pooled	Not pooled
No. of breakages (follow up: range 1–9 y)											
259 (4 observational studies)	Serious[a,b]	Not serious	Not serious	Not serious	None	⊕⊕⊕○ Moderate	30/115 (26.1)	58/144 (40.3)	Not estimable	Not pooled	Not pooled

a. Artun et al. reported an unclear risk of Bias on the domains Random sequence generation (selection bias) and Allocation concealment (selection bias)
b. Schutz-Frasson et al. was classified as a moderae risk of bias, due to the retrospective definition of some aspects of the assignments of intervention
c. Al-Nimri et al. presents the stability as a secondary outcome
d. CI indicates confidence interval; RCT, randomized controlled trial.

compromise the validity of the results and the conclusions found.[36] However, in the studies included, the samples used appeared to be large enough.

Among the randomized trials included in this review, a high risk of bias was detected in one study[21] and a low risk was found[22] in another study. Among the three nonrandomized studies, two were classified as low risk[23,24] and one[25] as high risk.

Randomization in controlled clinical studies is an essential step ensuring reliability of the sample allocation and, consequently, influencing the validity of the results.[37] Thus, even with a low risk of bias from the evaluation of a suitable tool for nonrandomized studies,[19] two studies included in this review[23,25] were still less robust due to the absence of a randomized design.

In the fields of random sequence generation and allocation concealment, an uncertain risk was identified in one study[21] due to the absence of precise information regarding the method of randomization. An attempt to contact the authors was conducted, but the author was not able to clarify the method used. It is essential to perform adequate allocation concealment to reduce selection bias for confounding factors and to improve the internal validity of the study and influence the clinical outcome.[37]

Regarding the field of incomplete outcome data, the study by Artun et al.[21] was classified as high risk of bias since patients were abandoned as a result of bonding failure, causing an uneven distribution among genders, age, and gingival state. The loss of these patients may have impaired evaluation of the final results since it can generate failures in the homogeneity of the evaluated groups. In the other risks of bias domain in the same study it was identified that the principal investigator was not available for all contention maintenance and routine clinical practice and that absence of the primary evaluator may have represented a systematic error within the sample.[21] A failure of the executed measurements assessment may have implications in the dimensioning of the size of the sample examined, generating a lack of reliability of the obtained data.[35]

Overall, the studies have suggested there was better stability and a higher rate of breakage in lower retainers bonded on all anterior teeth, with a certainty varying from very low to moderate. Even though the results suggested better outcomes from retainers bonded to all lower anterior teeth, the clinical decision made for individual patients may involve subjective factors, such as the professional training of the provider and the patient's compliance/acceptance. Inclusion of these variables in further studies may help in developing a more reliable conclusion.

CONCLUSIONS

- The current evidence may point to better stability of dental alignment when lower fixed orthodontic retainers are bonded to all anterior teeth.
- However, as uncertainty is moderate, more reliable research on the topic is needed to clarify some of the contradictions among the studies included.

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APPENDIX 1 Database and Search Strategies

Database	Search Strategy
PubMed	#1 ((((((((((((((((Orthodontic Patients[Title/Abstract]) OR Patients with bonded retainer [Title/Abstract]) OR Patients with orthodontic retainers [Title/Abstract]) OR Patients after orthodontic treatment [Title/Abstract]) OR Patients of the finishing phase of orthodontic treatment [Title/Abstract]) OR Patients adults [Title/Abstract]) OR Young patients [Title/Abstract]) OR Orthodontic appliance [MeSH Terms]) OR Orthodontic appliance [Title/Abstract]) OR Appliance, Orthodontic [Title/Abstract]) OR Appliances, Orthodontic [Title/Abstract]) OR Orthodontic, Appliances [Title/Abstract]) OR Fixed orthodontic appliance [Title/Abstract]) OR Fixed appliance [Title/Abstract]) OR Orthodontic treatment [Title/Abstract])) AND #2 (((((((((((((((((((((((((((((((((Canine to canine retainer [Title/Abstract]) OR Bonded only to the canines [Title/Abstract]) OR Bonded to the canines only [Title/Abstract]) OR Bonded orthodontic canine to canine retainers [Title/Abstract]) OR Bonded orthodontic canine to canine retainer [Title/Abstract]) OR Bonded to two teeth [Title/Abstract]) OR Bonded from canine to canine [Title/Abstract]) OR (Canine [Title/Abstract] AND canine retainer [Title/Abstract])) OR (Canine [Title/Abstract] AND canine retainers [Title/Abstract])) OR Canine-and-canine retainer [Title/Abstract]) OR Canine-and-canine retainers [Title/Abstract]) OR Canine-to-canine retainers [Title/Abstract]) OR Canine-to-canine retainer [Title/Abstract]) OR Canine to canine retainers [Title/Abstract]) OR Canine to canine lingual retainer [Title/Abstract]) OR Canine to canine lingual retainers [Title/Abstract]) OR Canine-to-canine lingual retainers [Title/Abstract]) OR Canine-to-canine lingual retainer [Title/Abstract]) OR Canine-to-canine lingual retainers bonded to two [Title/Abstract]) OR Canine-to-canine lingual retainer bonded to two [Title/Abstract]) OR Lower canine-to-canine retainer [Title/Abstract]) OR Lower canine-to-canine retainers [Title/Abstract]) OR Lower canine to canine retainer [Title/Abstract]) OR Lower canine to canine retainers [Title/Abstract]) OR Orthodontic mandibular canine-to-canine retainers [Title/Abstract]) OR Orthodontic mandibular canine-to-canine retainer [Title/Abstract]) OR Retainers canine-to-canine [Title/Abstract]) OR Retainer canine-to-canine [Title/Abstract]) OR Retainer canine-and-canine [Title/Abstract]) OR Retainers canine-and-canine [Title/Abstract]) OR Types of mandibular canine-to-canine retainers [Title/Abstract])) AND #3 ((Orthodontic Retainers [MeSH Terms]) OR Orthodontic Retainers [Title/Abstract]) OR Retainers, Orthodontic [Title/Abstract]) OR Orthodontic, Retainer [Title/Abstract]) OR Retainer, Orthodontic [Title/Abstract]) OR Bonded to all mandibular anterior teeth [Title/Abstract]) OR Bonded to six teeth [Title/Abstract]) OR Bonded to each tooth [Title/Abstract]) OR (Bonded to incisors [Title/Abstract] AND canines [Title/Abstract])) OR Bonded retainers [Title/Abstract]) OR Bonded retainer [Title/Abstract]) OR Bonded lingual retainers [Title/Abstract]) OR Bonded lingual retainer [Title/Abstract]) OR Bonded mandibular retainers [Title/Abstract]) OR Bonded mandibular retainer [Title/Abstract]) OR Bonding a retainer [Title/Abstract]) OR Bonding a retainers [Title/Abstract]) OR Bonded to all six anterior teeth [Title/Abstract]) OR Direct bonded lingual retainers [Title/Abstract]) OR Direct bonded lingual retainer [Title/Abstract]) OR Direct bonded lingual retainers [Title/Abstract]) OR Direct bonding of retainer [Title/Abstract]) OR Direct bonding of retainers [Title/Abstract]) OR Fixed retainers [Title/Abstract]) OR Fixed retainer [Title/Abstract]) OR Fixed lingual retainers [Title/Abstract]) OR Fixed lingual retainer [Title/Abstract]) OR Fixed lingual retention [Title/Abstract]) OR Fixed mandibular retainer [Title/Abstract]) OR Fixed mandibular retainers [Title/Abstract]) OR Lingual retainers [Title/Abstract]) OR Lingual retainer [Title/Abstract]) OR Lingual retainers bonded to six teeth [Title/Abstract]) OR Lingual retainer bonded to six teeth [Title/Abstract]) OR Mandibular bonded retainers [Title/Abstract]) OR Mandibular bonded retainer [Title/Abstract]) OR Mandibular retainers [Title/Abstract]) OR Mandibular retainer [Title/Abstract]) OR Mandibular anterior teeth retained [Title/Abstract]) OR Orthodontic fixed retainer [Title/Abstract]) OR Orthodontic fixed retainers [Title/Abstract]) OR Orthodontic retainer [Title/Abstract]) OR Retainer bonded to six teeth [Title/Abstract]) OR Retainers bonded to six teeth [Title/Abstract]) Final search: #1 AND #2 AND #3

APPENDIX 1 Continued

Database	Search Strategy
Scopus	((TITLE-ABS-KEY (“Orthodontic Patients”) OR TITLE-ABS-KEY (“Patients with bonded retainer”) OR TITLE-ABS-KEY (“Patients with orthodontic retainers”) OR TITLE-ABS-KEY (“Patients after orthodontic treatment”) OR TITLE-ABS-KEY (“Patients of the finishing phase of orthodontic treatment”) OR TITLE-ABS-KEY (“Patients adults”) OR TITLE-ABS-KEY (“Young patients”) OR TITLE-ABS-KEY (“Orthodontic appliance”) OR TITLE-ABS-KEY (“Fixed orthodontic appliance”) OR TITLE-ABS-KEY (“Fixed appliance”) OR TITLE-ABS-KEY (“Orthodontic treatment”))) AND (((TITLE-ABS-KEY (“Canine to canine retainer”) OR TITLE-ABS-KEY (“Bonded only to the canines”) OR TITLE-ABS-KEY (“Bonded to the canines only”) OR TITLE-ABS-KEY (“Bonded orthodontic canine to canine retainers”) OR TITLE-ABS-KEY (“Bonded orthodontic canine to canine retainer”) OR TITLE-ABS-KEY (“Bonded to two teeth”) OR TITLE-ABS-KEY (“Bonded from canine to canine”) OR TITLE-ABS-KEY (“Canine and canine retainer”) OR TITLE-ABS-KEY (“Canine and canine retainers”) OR TITLE-ABS-KEY (“Canine-and-canine retainer”) OR TITLE-ABS-KEY (“Canine-and-canine retainers”) OR TITLE-ABS-KEY (“Canine-to-canine retainers”) OR TITLE-ABS-KEY (“Canine-to-canine retainer”) OR TITLE-ABS-KEY (“Canine to canine retainers”) OR TITLE-ABS-KEY (“Canine to canine lingual retainer”) OR TITLE-ABS-KEY (“Canine to canine lingual retainers”)))))) OR ((TITLE-ABS-KEY (“Canine-to-canine lingual retainers”) OR TITLE-ABS-KEY (“Canine-to-canine lingual retainer”) OR TITLE-ABS-KEY (“Canine-to-canine lingual retainers bonded to two”) OR TITLE-ABS-KEY (“Canine-to-canine lingual retainer bonded to two”) OR TITLE-ABS-KEY (“Lower canine-to-canine retainer”) OR TITLE-ABS-KEY (“Lower canine-to-canine retainers”) OR TITLE-ABS-KEY (“Lower canine to canine retainer”) OR TITLE-ABS-KEY (“Lower canine to canine retainers”) OR TITLE-ABS-KEY (“Orthodontic mandibular canine-to-canine retainers”) OR TITLE-ABS-KEY (“Orthodontic mandibular canine-to-canine retainer”) OR TITLE-ABS-KEY (“Retainers canine-to-canine”) OR TITLE-ABS-KEY (“Retainer canine-to-canine”) OR TITLE-ABS-KEY (“Retainer canine-and-canine”) OR TITLE-ABS-KEY (“Retainers canine-and-canine”) OR TITLE-ABS-KEY (“Types of mandibular canine-to-canine retainers”))))))) AND ((((((((TITLE-ABS-KEY (“Orthodontic Retainers”) OR TITLE-ABS-KEY (“Bonded to all mandibular anterior teeth”) OR TITLE-ABS-KEY (“Bonded to six teeth”) OR TITLE-ABS-KEY (“Bonded to each tooth”) OR TITLE-ABS-KEY (“Bonded to incisors and canines”) OR TITLE-ABS-KEY (“Bonded retainers”) OR TITLE-ABS-KEY (“Bonded retainer”) OR TITLE-ABS-KEY (“Bonded lingual retainers”) OR TITLE-ABS-KEY (“Bonded lingual retainer”) OR TITLE-ABS-KEY (“Bonded mandibular retainers”) OR TITLE-ABS-KEY (“Bonded mandibular retainer”) OR TITLE-ABS-KEY (“Bonding a retainer”) OR TITLE-ABS-KEY (“Bonding a retainers”) OR TITLE-ABS-KEY (“Bonded to all six anterior teeth”) OR TITLE-ABS-KEY (“Direct bonded lingual retainers”) OR TITLE-ABS-KEY (“Direct bonded lingual retainer”) OR TITLE-ABS-KEY (“Direct bonding of retainer”) OR TITLE-ABS-KEY (“Direct bonding of retainers”) OR TITLE-ABS-KEY (“Fixed retainers”) OR TITLE-ABS-KEY (“Fixed retainer”))))) OR ((TITLE-ABS-KEY (“Fixed lingual retainers”) OR TITLE-ABS-KEY (“Fixed lingual retainer”) OR TITLE-ABS-KEY (“Fixed lingual retention”) OR TITLE-ABS-KEY (“Fixed mandibular retainer”) OR TITLE-ABS-KEY (“Fixed mandibular retainers”) OR TITLE-ABS-KEY (“Lingual retainers”) OR TITLE-ABS-KEY (“Lingual retainer”) OR TITLE-ABS-KEY (“Lingual retainers bonded to six teeth”) OR TITLE-ABS-KEY (“Lingual retainer bonded to six teeth”) OR TITLE-ABS-KEY (“Mandibular bonded retainers”) OR TITLE-ABS-KEY (“Mandibular bonded retainer”) OR TITLE-ABS-KEY (“Mandibular retainers”) OR TITLE-ABS-KEY (“Mandibular retainer”) OR TITLE-ABS-KEY (“Mandibular anterior teeth retained”) OR TITLE-ABS-KEY (“Orthodontic fixed retainer”) OR TITLE-ABS-KEY (“Orthodontic fixed retainers”) OR TITLE-ABS-KEY (“Orthodontic retainer”) OR TITLE-ABS-KEY (“Retainer bonded to six teeth”) OR TITLE-ABS-KEY (“Retainers bonded to six teeth”))))))

APPENDIX 1 Continued

Database	Search Strategy
Web of Science	#1 Tópico: (“Orthodontic Patients”) OR Tópico: (“Patients with bonded retainer”) OR Tópico: (“Patients with orthodontic retainers”) OR Tópico: (“Patients after orthodontic treatment”) OR Tópico: (“Patients of the finishing phase of orthodontic treatment”) OR Tópico: (“Patients adults”) OR Tópico: (“Young patients”) OR Tópico: (“Orthodontic appliance”) OR Tópico: (“Fixed orthodontic appliance”) OR Tópico: (“Fixed appliance”) OR Tópico: (“Orthodontic treatment”) #2 Tópico: (“Canine to canine retainer”) OR Tópico: (“Bonded only to the canines”) OR Tópico: (“Bonded to the canines only”) OR Tópico: (“Bonded orthodontic canine to canine retainers”) OR Tópico: (“Bonded orthodontic canine to canine retainer”) OR Tópico: (“Bonded to two teeth”) OR Tópico: (“Bonded from canine to canine”) OR Tópico: (“Canine and canine retainer”) OR Tópico: (“Canine and canine retainers”) OR Tópico: (“Canine-and-canine retainer”) OR Tópico: (“Canine-and-canine retainers”) OR Tópico: (“Canine-to-canine retainers”) OR Tópico: (“Canine-to-canine retainer”) OR Tópico: (“Canine to canine retainers”) OR Tópico: (“Canine to canine lingual retainer”) OR Tópico: (“Canine to canine lingual retainers”) Tópico: (“Canine-to-canine lingual retainers”) OR Tópico: (“Canine-to-canine lingual retainer”) OR Tópico: (“Canine-to-canine lingual retainers bonded to two”) OR Tópico: (“Canine-to-canine lingual retainer bonded to two”) OR Tópico: (“Lower canine-to-canine retainer”) OR Tópico: (“Lower canine-to-canine retainers”) OR Tópico: (“Lower canine to canine retainer”) OR Tópico: (“Lower canine to canine retainers”) OR Tópico: (“Orthodontic mandibular canine-to-canine retainers”) OR Tópico: (“Orthodontic mandibular canine-to-canine retainer”) OR Tópico: (“Retainers canine-to-canine”) OR Tópico: (“Retainer canine-to-canine”) OR Tópico: (“Retainer canine-and-canine”) OR Tópico: (“Retainers canine-and-canine”) OR Tópico: (“Types of mandibular canine-to-canine retainers”) #3 Tópico: (“Orthodontic Retainers”) OR Tópico: (“Bonded to all mandibular anterior teeth”) OR Tópico: (“Bonded to six teeth”) OR Tópico: (“Bonded to each tooth”) OR Tópico: (“Bonded to incisors and canines”) OR Tópico: (“Bonded retainers”) OR Tópico: (“Bonded retainer”) OR Tópico: (“Bonded lingual retainers”) OR Tópico: (“Bonded lingual retainer”) OR Tópico: (“Bonded mandibular retainers”) OR Tópico: (“Bonded mandibular retainer”) OR Tópico: (“Bonding a retainer”) OR Tópico: (“Bonding a retainers”) OR Tópico: (“Bonded to all six anterior teeth”) OR Tópico:(“Direct bonded lingual retainers”) OR Tópico: (“Direct bonded lingual retainer”) OR Tópico: (“Direct bonding of retainer”) OR Tópico: (“Direct bonding of retainers”) OR Tópico: (“Fixed retainers”) OR Tópico: (“Fixed retainer”) Tópico: (“Fixed lingual retainers”) OR Tópico: (“Fixed lingual retainer”) OR Tópico: (“Fixed lingual retention”) OR Tópico: (“Fixed mandibular retainer”) OR Tópico: (“Fixed mandibular retainers”) OR Tópico: (“Lingual retainers”) OR Tópico: (“Lingual retainer”) OR Tópico: (“Lingual retainers bonded to six teeth”) OR Tópico: (“Lingual retainer bonded to six teeth”) OR Tópico: (“Mandibular bonded retainers”) OR Tópico: (“Mandibular bonded retainer”) OR Tópico: (“Mandibular retainers”) OR Tópico: (“Mandibular retainer”) OR Tópico: (“Mandibular anterior teeth retained”) OR Tópico: (“Orthodontic fixed retainer”) OR Tópico: (“Orthodontic fixed retainers”) OR Tópico: (“Orthodontic retainer”) OR Tópico: (“Retainer bonded to six teeth”) OR Tópico: (“Retainers bonded to six teeth”) Final search: #1 AND #2 AND #3
The Cochrane Library	’“Orthodontic Patients” OR “Patients with bonded retainer” OR “Patients with orthodontic retainers” OR “Patients after orthodontic treatment” OR “Patients of the finishing phase of orthodontic treatment” OR “Patients adults” OR “Young patients” OR “Orthodontic appliance” OR “Fixed orthodontic appliance” OR “Fixed appliance” OR “Orthodontic treatment” in Title, Abstract, Keywords and “Canine to canine retainer” OR “Bonded only to the canines” OR “Bonded to the canines only” OR “Bonded orthodontic canine to canine retainers” OR “Bonded orthodontic canine to canine retainer” OR “Bonded to two teeth” OR “Bonded from canine to canine” OR “Canine and canine retainer” OR “Canine and canine retainers” OR “Canine-and-canine retainer” OR “Canine-and-canine retainers” OR “Canine-to-canine retainers” OR “Canine-to-canine retainer” OR “Canine to canine retainers” OR “Canine to canine lingual retainer” OR “Canine to canine lingual retainers” OR “Canine-to-canine lingual retainers” OR “Canine-to-canine lingual retainer” OR “Canine-to-canine lingual retainers bonded to two” OR “Canine-to-canine lingual retainer bonded to two” OR “Lower canine-to-canine retainer” OR “Lower canine-to-canine retainers” OR “Lower canine to canine retainer” OR “Lower canine to canine retainers” OR “Orthodontic mandibular canine-to-canine retainers” OR “Orthodontic mandibular canine-to-canine retainer” OR “Retainers canine-to-canine” OR “Retainer canine-to-canine” OR “Retainer canine-and-canine” OR “Retainers canine-and-canine” “Types of mandibular canine-to-canine retainers” in Title, Abstract, Keywords and “Orthodontic Retainers” OR “Bonded to all mandibular anterior teeth” OR “Bonded to six teeth” OR “Bonded to each tooth” OR “Bonded to incisors and canines” OR “Bonded retainers” OR “Bonded retainer” OR “Bonded lingual retainers” OR “Bonded lingual retainer” OR “Bonded mandibular retainers” OR “Bonded mandibular retainer” OR “Bonding a retainer” OR “Bonding a retainers” OR “Bonded to all six anterior teeth” OR “Direct bonded lingual retainers” OR “Direct bonded lingual retainer” OR “Direct bonding of retainer” OR “Direct bonding of retainers” OR “Fixed retainers” OR “Fixed retainer” OR “Fixed lingual retainers” OR “Fixed lingual retainer” OR “Fixed lingual retention” OR “Fixed mandibular retainer” OR “Fixed mandibular retainers” OR “Lingual retainers” OR “Lingual retainer” OR “Lingual retainers bonded to six teeth” OR “Lingual retainer bonded to six teeth” OR “Mandibular bonded retainers” OR “Mandibular bonded retainer” OR “Mandibular retainers” OR “Mandibular retainer” OR “Mandibular anterior teeth retained” OR “Orthodontic fixed retainer” OR “Orthodontic fixed retainers” OR “Orthodontic retainer” OR “Retainer bonded to six teeth” OR “Retainers bonded to six teeth” in Title, Abstract, Keywords in Trials’

APPENDIX 1 Continued

Database	Search Strategy
Lilacs	(tw:(“Orthodontic Patients” OR “Patients with bonded retainer” OR “Patients with orthodontic retainers” OR “Patients after orthodontic treatment” OR “Patients of the finishing phase of orthodontic treatment” OR “Patients adults” OR “Young patients” OR “Orthodontic appliance” OR “Fixed orthodontic appliance” OR “Fixed appliance” OR “Orthodontic treatment”)) AND (tw:(“Canine to canine retainer” OR “Bonded only to the canines” OR “Bonded to the canines only” OR “Bonded orthodontic canine to canine retainers” OR “Bonded to two teeth” OR “Bonded from canine to canine” OR “Canine-and-canine retainer” OR “Canine-and-canine retainers” OR “Canine-to-canine retainers” OR “Canine to canine lingual retainer” OR “Canine-to-canine lingual retainers” OR “Canine-to-canine lingual retainers bonded to two” OR “Lower canine-to-canine retainer” OR “Orthodontic mandibular canine-to-canine retainers” OR “Retainers canine-to-canine” OR “Retainers canine-and-canine” OR “Types of mandibular canine-to-canine retainers”)) AND (tw:(“Orthodontic Retainers” OR “Orthodontic Retainer” OR “Bonded to all mandibular anterior teeth” OR “Bonded to six teeth” OR “Bonded to each tooth” OR “Bonded to incisors and canines” OR “Bonded retainers” OR “Bonded lingual retainers” OR “Bonded mandibular retainers” OR “Bonding a retainer” OR “Bonded to all six anterior teeth” OR “Direct bonded lingual retainers” OR “Direct bonding of retainer” OR “Fixed retainers” OR “Fixed lingual retainers” OR “Fixed lingual retention” OR “Fixed mandibular retainer” OR “Lingual retainers” OR “Lingual retainers bonded to six teeth” OR “Mandibular bonded retainers” OR “Mandibular retainers” OR “Mandibular anterior teeth retained” OR “Orthodontic fixed retainer” OR “Retainer bonded to six teeth”))
Clinical Trials	#1: “Orthodontic patient” AND “Canine to canine retainer” AND “Orthodontic Retainers" #2: “Orthodontic patients” AND “Canine to canine retainer” AND “Bonded to six teeth"
OpenGrey	#1: “Orthodontic patients” AND “Canine to canine retainer” AND “Bonded to six teeth" #2: “Orthodontic patients” AND “Canine to canine retainer” AND “Orthodontic Retainers"
Google Scholar	#1: “Orthodontic patients” AND “Canine to canine retainer” AND “Orthodontic retainers”

APPENDIX 2 References Excluded from Title-Abstract Evaluation

Reasons	Reference
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Have not compared the two types of bonding among retainers	Bjering R, Sandvik L, Midtb M, Vandevska-Radunovic V. Stability of anterior tooth alignment 10 years out of retention. *J Orofac Orthop*. 2017;78:275–283.
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APPENDIX 2 Continued

Reasons	Reference
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APPENDIX 2 Continued

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APPENDIX 3:

All attempts to contact any authors and their fate