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Review Article

Comparison of Memotain Retainers to Conventional Fixed Retainers: A Systematic Review

Vikrant Lambate [1], Priya Manimegalan [2], M. Gunasekaran [3], Arul Prakash Kaveri [3], Shekhar K. Asarsa [4], Sharath Kasturi [5]

[1]Postgraduate Resident, Orthodontics and Dentofacial Orthopedics, Mahatma Gandhi Missions (MGM) Dental College and Hospital, Kamothe, Navi Mumbai, [2]Consultant Orthodontist, Private Practitioner, Bangalore, [3]Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (DU), Salem, Tamil Nadu, India, [4]Tutor, Department of Orthodontics and Dentofacial Orthopaedics, Siddhpur Dental College And Hospital, Dethali, Patan, Gujarat, [5]Consultant Orthodontist, Private Practitioner, Nellore.

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ABSTRACT

Objective: This systematic review assesses and compares the use of fixed retainers manufactured by CAD CAM and conventional methods in patients undergoing orthodontic treatment.

Methodology: Data from the selected studies were collected using customised data collection forms. Primary analysis involved assessing the stability of orthodontic treatment over time through measurements taken from dental casts and assessing the impact on periodontal health. Secondary aspects involved an evaluation of the rates at which retainers failed and gathered valuable insights from outcomes reported by patients.

Results: Seven randomised controlled trials (RCTs) were included involving 601 participants. During the initial 6 months, no notable variations in the distance between canine teeth or the length of the dental arch were noted when comparing CAD/CAM retainers with conventional retainers. Nevertheless, it's noteworthy that CAD/CAM retainers exhibited superior performance compared to stainless steel retainers (single strand). Significant differences in Little's irregularity index, was evident at 3-month and 6-month intervals. Distinctions with limited clinical significance were noted in multi-stranded stainless-steel retainers at 6-month follow-up assessment. Regarding oral health aspects, CAD/CAM retainers displayed lower plaque index scores compared to traditional retainers. In terms of durability, most retainers demonstrated comparable failure rates. In one study, CAD/CAM retainers were associated with a greater rate of failure, which resulted in the premature termination of that specific study.

Conclusion: CAD/CAM fixed retainers offer a promising alternative to traditional options and may promote better periodontal health due to lower plaque index scores. Nevertheless, to assess their effectiveness and long-term durability, more studies are needed, particularly regarding failure rates. In the absence of comprehensive evidence, the utilisation of customisation of CAD/CAM retainers is advisable for individual clinical cases.

Keywords: Orthodontic retainers; Computer-aided design; Computer-aided manufacturing; Retention

Address for Correspondence:
Dr Vikrant Lambate,
Postgraduate Resident, Department of Orthodontics,
Mahatma Gandhi Missions (MGM) Dental College and Hospital
Kamothe, Navi Mumbai, Indian
Email: vikrantlambate@gmail.com

INTRODUCTION

Sustaining the outcomes of orthodontic treatments and thwarting the possibility of relapse presents a substantial challenge within the field. One notable concern is that over time, teeth may gradually shift back towards their original positions, especially concerning the lower front teeth, largely due to age-related changes.[1] To counteract this phenomenon, experts recommend the implementation of long-term retention strategies. Among these strategies, bonded retainers are commonly utilised for extended retention periods. However, they are not without their set of potential complications, including the risk of retainer failure, detrimental impacts on gingival health, and the occurrence of undesirable tooth movements. [2,3]

Retainer failures can be attributed to a range of factors, including instances where the composite material separates from the enamel surface,[4] bond failures between the orthodontic wire and composite,[5] or even fractures in the retainer structure itself.[6] Notably, research into an incomplete understanding of the precise mechanics behind tooth movement while wearing bonded retainers is still ongoing.[7]

Custom-made nitinol fixed retainers made using CAD-CAM technologies are now a key component of overcoming these orthodontic issues. Increased precision, increased predictability, and an incredibly exact fit on the tooth surface are just a few of the advantages that these retainers have to offer.[8,9] Notably, two specific fixed retainers, viz., Memotain® and Ortho-FlexTech™, have risen to prominence as innovative alternatives to the conventional retainers commonly employed. [10,11]

Despite these promising advancements and the evolution of sophisticated retention methods, the quest to determine the most effective long-term retention approach remains shrouded in uncertainty. The field is plagued by a conspicuous absence of high-quality and definitive evidence that conclusively establishes the superior method for long-term retention. Even RCTs aimed at comparing fixed and removable retainers have failed to deliver unequivocal support for one approach over the other.[12]

Hence, the principal objective of this systematic review is to exhaustively evaluate and make a detailed comparison between the effectiveness of Memotain® retainers and conventional fixed retainers.

MATERIALS AND METHODOLOGY

This systematic review adhered to the guidelines outlined in the Cochrane Handbook for Systematic Review of Interventions, ensuring reliability and transparency in research results. The review protocol was registered in PROSPERO under ID: CRD42023486522. Every aspect of the research process, including study selection, data extraction, and analysis, was meticulously documented according to PRISMA guidelines.

Furthermore, the review followed the PRISMA extension statement for network meta-analyses, which offers additional guidance for transparently conducting and reporting complex analyses comparing multiple interventions simultaneously. This extension ensures precision and clarity in reporting network meta-analyses of healthcare interventions.

Focused Question

Are Memotain retainers better in preserving stable tooth alignment over the long term and patient satisfaction in orthodontic retention than traditional fixed retainers?

Search Approach

Our approach involved a comprehensive investigation to locate pertinent studies utilising a variety of online databases, including but not limited to MEDLINE, Web of Science, EMBASE, Scopus, Cochrane's CENTRAL, and Google Scholar. This search encompassed articles available from the inception of these databases up to May 2023. Our search encompassed articles from January 2000 to February 2023. We also conducted a detailed review of the bibliographies of relevant primary research papers and systematic reviews to ensure comprehensive literature coverage. We specifically focused on identifying RCTs.

To identify articles, we conducted an exhaustive search across databases, including MEDLINE/PubMed, Cochrane, and EMBASE. We collected articles published between 2000 and 2023 without imposing any language or publication year restrictions. During this search, we used Medical Subject Headings (MeSH) terms such as "orthodontic retainers," "computer-aided design," "computer-aided manufacturing", "retention", and "Memotain Retainers."

Our selection and exclusion process strictly adhered to the criteria outlined in the PRISMA Checklist. The research team thoroughly reviewed the full texts of the studies and individually assessed them against the predefined inclusion criteria. We consistently followed the PRISMA statement guidelines and faithfully executed the predetermined search strategy. Furthermore, we examined the included studies manually to ensure a thorough examination of the existing literature. A descriptive summary of data selection has been put forth in the PRISMA Flowchart, i.e. PRISMA 2009 Flow Diagram [Figure 1].

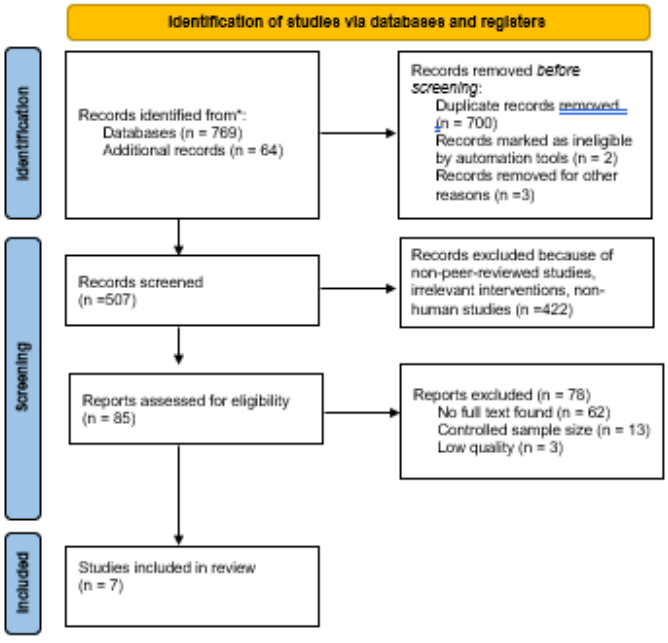

Figure 1: PRISMA Checklist

Inclusion criteria

- Peer-reviewed randomised controlled trials (RCTs)
- Human participants of all ages and genders
- Studies involving orthodontic treatment with either Memotain or conventional fixed retainers

- Studies comparing the effectiveness of Memotain retainers to conventional fixed retainers in orthodontic retention
- Outcome measures related to tooth alignment stability, patient satisfaction, and clinically meaningful or patient-reported outcomes

Exclusion Criteria

- Review articles, meta-analyses, case reports, opinion pieces, and conference abstracts.
- Participants with severe medical or dental conditions that may confound retention outcomes
- Studies not directly comparing Memotain and conventional fixed retainers
- Studies lacking relevant outcome data
- Unpublished or non-peer-reviewed studies

The determination of inclusion and exclusion criteria was guided by the aspects of Participants, Interventions, Comparisons, Outcomes, and Study design (PICOS) [Table 1].

Table 1: PICOS Criteria

POPULATION	Patients requiring lingual fixed retainers after orthodontic treatment
INTERVENTION	CAD/CAM fixed retainers
COMPARISON	Conventional fixed retainers
OUTCOME	Stability, periodontal indices, failure rates, and patient-reported outcomes
STUDY DESIGN	Randomized Clinical Trials

Screening and Selection

The search and screening process involved two researchers collaborating closely with an κ coefficient of 0.83, indicating a substantial level of consensus between them. The process followed a structured framework comprising four stages. Initially, irrelevant citations were promptly excluded in Stage 1. Moving to Stage 2, one reviewer meticulously assessed titles and abstracts against predefined inclusion criteria, excluding articles falling outside the scope while scrutinising unclear ones with input from a second reviewer.

Stage 3 involved rigorous evaluation by two independent reviewers to confirm alignment with eligibility criteria, excluding articles with inappropriate study designs or deficient outcome measurements. Finally, Stage 4 entailed a comprehensive examination of selected articles, with relevant data extraction and critical appraisal of clinical methodologies, focusing on interventions and outcomes investigated within each study.

Data Extraction

Data extraction commenced with the primary author and underwent further review and refinement by the second author. For each full-text article meeting the predetermined inclusion criteria, independent data extraction was conducted using a standardised format facilitated by Microsoft Office Excel 2013 software. The gathered data were systematically structured into separate sections encompassing authorship and publication year, study design, participant demographics (including age range), intervention specifics, comparator elements, and outcomes. [Table 2].

Table 2: Details of the studies included in this systematic review

Sr. No.	1	2	3	4	5	6	7
Author	Adanur-Atmaca et al	Alrawas et al	Gelin et al	Gera et al	Jowett et al	Kartal et al	Shim et al
Year	2021	2020	2020	2022	2022	2020	2021
Title	Effects of different lingual retainers on periodontal health and stability	Comparing the effects of CAD/CAM nickel-titanium lingual retainers on teeth stability and periodontal health with conventional fixed and removable retainers: A randomized clinical trial	Innovative customized CAD/CAM nickel-titanium lingual retainer versus standard stainless-steel lingual retainer: A randomized controlled trial.	Stability, survival, and patient satisfaction with CAD/CAM versus conventional multistranded fixed retainers in orthodontic patients: a 6-month follow-up of a two-centre randomized controlled clinical trial.	CAD/CAM nitinol bonded retainer versus a chairside rectangular-chain bonded retainer: A multicentre randomised controlled trial.	Comparative evaluation of periodontal effects and survival rates of Memotain and five-stranded bonded retainers	Comparative assessment of relapse and failure between CAD/CAM stainless steel and standard stainless steel fixed retainers in orthodontic retention patients.
Population	132 orthodontic patients (92 female, 40 male)	Sixty orthodontic participants	62 orthodontic patients	181 orthodontic patients	68 patients	52 orthodontic patients	46 patients
Type of the Study	Single-centre parallel design prospective randomized clinical trial	Prospective randomized clinical trial	Randomized controlled trials	Randomized controlled trial	Multi centered Randomized controlled trial	Randomized controlled trial	Randomized controlled trial
Mean age of patients	16.0 years	20 years	17 years	16 years	Not mentioned	15-18 years	14-16 years
Parameters	Stability (LII, ICD, AL); periodontal (PI, GI, and CI)	Stability (LII, ICD, IMD, and ADAL); periodontal (PI, GI, BOP, and PD)	Stability (LII, ICD, IPD, IMD, ADAL, and AL); periodontal (PI, GI, BOP, and MR); radiographic (IMPA); failure; patient satisfaction	Stability (LII, ICD, IPD, IMD, and AL); failure (survival time and type), satisfaction (cleaning, speech and comfort)	Stability (LII and ICD); failure (survival time and type), satisfaction (cleaning, speech, and comfort)	Periodontal (PI, PD, BOP, and MR); survival	Stability (LII and ICD); failure
Intervention	CAD/CAM, Dead-soft wire (SS), 5-strand stainless steel wire (MS), connected bonding pad	CAD/CAM, multi-stranded stainless steel (MS), single-strand nickel free titanium (SS), vacuum-formed removable retainer	CAD/CAM, 6-strand stainless-steel (MS)	CAD/CAM, 6-strand stainless steel (MS)	CAD/CAM, traditional OrthoFlexTech (RC)	CAD/CAM, five-strand (MS)	CAD/CAM, lab, traditional ortho FlexTech (RC)

Comparison	All measurements were performed at each time point (debonding and 3, 6, 9, and 12 months).	Digital impressions were taken for all participants at three different time intervals: baseline, 3 and 6 months.	Radiological measurements such as the incisor mandibular plane angle were recorded at baseline and at 3, 6, 9 and 12 months	Post-treatment stability, retainer failures and patient satisfaction were assessed at baseline, 3 months and 6 months	Measurements were carried out on study models taken at debonding and after six months. Patient satisfaction questionnaires were completed at six months following debonding.	Patients were examined at the following time points: 1 week, 1 month, 3 months and 6 months	Intraoral scans were obtained at placement of fixed retainers, 3 and 6-month visit and measured for Intercanine width and Little's Irregularity Index.
Results/Outcome	The group and time interaction significantly affected Little's irregularity index values, indicating notable differences in tooth alignment stability over time between the groups	No statistical significance was found between the CAD/CAM retainer and other retainers regarding the clinical failure rate	no significant differences in stability, periodontal health, or failure rates between CAD/CAM and stainless-steel retainers, though CAD/CAM retainers had higher patient satisfaction.	There was no evidence of a statistically significant difference in LII, upper and lower arch lengths and widths (inter-canine, Interpremolar, and inter-molar distances) between baseline and 6 months, except for the LII in the CAD/CAM group	Higher risk of failure in the maxillary arch when compared to upper Ortho-FlexTech™ bonded retainers after six months.	Patients were examined at 1 week, 1 month, 3 months, and 6 months showing no significant differences in stability, periodontal health, or failure rates between retainer types.	CAD/CAM fixed retainers demonstrated less relapse compared to lab-based and traditional chairside retainers, with fewer failures than lab-based retainers, highlighting their superior stability.
Duration	1 year	6 months	1 year	6 months	6 months	6 months	6 months

The data forms were instrumental in gathering essential information encompassing a wide range of details. These included the publication date of the study, the study's design, its duration, the size of the sample, the distribution of participants by gender, age demographics, specific details about the treatment plan, particulars regarding malocclusion characteristics, intricate information about CAD/CAM design specifications, the types of wires employed (both CAD/CAM and manually placed), the status of bonded dentition, the bonding agent used, a comprehensive description of the bonding procedure, the techniques utilised for measuring outcomes, and the diverse range of assessed outcomes. These encompassed aspects like the treatment outcome and its stability, the health of the periodontium and its measurements, rates of retainer failure, and feedback from patients regarding their satisfaction.

Assessment of Risk of Bias

Using the Cochrane Risk of Bias 2.0 (RoB 2) tool, two of our review authors, MG and PS, individually assessed the risk of potential bias in each of the included studies. This assessment considered seven key criteria. These criteria were classified into three categories: low risk, medium risk, and high risk, following Cochrane's handbook guidelines [Table 3].

RESULTS

Search and Selection

Our main goal was to compare CAD/CAM retainers to conventional retainers. The absence of direct comparisons between all types of retainers doesn't introduce bias into the head-to-head comparisons but could affect the unbiased ranking of retainers.

In a systematic review involving seven studies and 574 patients, the comparison between CAD/CAM retainers and alternative methods revealed significant differences. Single-stranded stainless-steel retainers showed notable variations compared to Ni-Ti CAD/CAM (Memotain) retainers, with significant distinctions at 3 months (mean difference: 0.18 mm) and 6 months (mean difference: 0.27 mm). Multi-stranded stainless-steel retainers had no difference from CAD/CAM retainers at 3 months but did exhibit a significant difference at 6 months (mean difference: 0.09 mm). However, there were no distinctions between SS CAD/CAM and conventional retainers and no variations between rectangular chain (Orthoflex) and Ni-Ti CAD/CAM retainers throughout the study.[10,11]

Risk of Bias across the Studies

Gera et al.'s study had a low risk of bias, providing strong support for their findings. In contrast, the other six studies had concerns in critical areas.[13] For example, Gelin et al.'s study lacked transparency in randomisation reporting, potentially introducing bias.[14] Participant and personnel blinding was often impractical, but a study by Jowett et al. achieved participant blinding.[15] Most studies had low attrition bias, except for studies by Gelin et al. and Shim et al., which had substantial participant dropouts.[14,16] Outcome evaluator blinding faced challenges due to retainer variability, but a study by Jowett et al. used a new approach for blinding.[15] Reporting and selective reporting biases were minimised in studies by Gelin et al. and Gera et al. through pre-registration and comprehensive outcome reporting.[13,14] In summary, the Cochrane RoB 2 tool revealed varying bias levels across studies, underscoring the need to consider these factors when interpreting the systematic review's findings [Table 3].

Table 3: Risk of Bias Assessment of Included Studies

Domain	Adanur-Atmaca et al, 2021	Alrawas et al, 2020	Gelin et al., 2020	Gera et al., 2022	Jowett et al., 2022	Kartal et al., 2020	Shim et al., 2021
Random sequence generation	1	1	2	1	1	1	1
Allocation concealment	1	1	1	1	1	1	1
Blinding of Participants and Personnel	1	1	2	1	1	1	2
Blinding of outcome assessment	1	2	1	1	1	2	1
Incomplete outcome data	2	1	1	1	2	2	1
Selective reporting	2	1	1	1	2	2	2
Other bias	1	2	2	1	1	1	2
Total	9	9	10	7	9	10	10

DISCUSSION

1. Incisor Cumulative Displacement (ICD)

We designed our systematic review based on retainer type efficiency by choosing the stability indicator: Incisor Cumulative Displacement (ICD). We found that no statistically significant difference exists between CAD/CAM retainers and other retainer types; hence, CAD/CAM retainers are equivalent to conventional practices in terms of stability. Interestingly, the outcome of ranking the retention methods by their effectiveness when the Rücker et al. method is applied shows no superiority among the retention methods, and this further supports the idea that CAD/CAM and conventional methods offer similar stability outcomes.[17]

2. Changes in Gingiva and Periodontal Health

The periodontal indices like Gingival Index (GI) and Plaque Index (PI) did not vary significantly among the retainer types, indicating that selectivity in retainer type does not have a practically significant impact on gingival health. However, CAD/CAM retainers had lower PI scores than all other retainer types, which might indicate an advantage in plaque control. The clinical significance of this is anybody's guess, however. Adanur-Atmaca's research extends the same argument and reveals the lesser formation of calculus in the patients with CAD/CAM fixed retainers than in conventional retainers.[11] In other periodontal clinical assessments like Bleeding on Probing (BOP), Probing Depth (PD), and Marginal Recession (MR), there is no significant difference between CAD/CAM and traditional fixed retainers, thus stating that both of them have effects similar to that in gingival health and tissue response.

3. Failure Rates and Retention Durability

The failure rates were also discussed, and the average failure rate was approximately 25% for multi-strand and Ni-Ti CAD/CAM retainers. A trend toward lowered failure rates by the rectangular chain retainers was reported, but comparisons are challenging given the heterogeneity in the methodologies of the studies. Shim et al reported a significant difference in failure rates: A 14% failure rate was recorded in rectangular chain retainers, whereas in the case of CAD/CAM retainers, it was about 25%.[16] Jowett et al. also found a significant difference as the failure rate for CAD/CAM retainers was 50%, while for rectangular chain retainers, it was 15%.[15] These results suggest that rectangular chain retainers are associated with a relatively lower failure rate compared to CAD/CAM retainers, although a direct comparison was difficult to make.

4. Patient Satisfaction and Cephalometric Changes

The results for patient satisfaction varied between the studies. However, it was reported that except for the CAD/CAM retainer, which provided improved comfort during the tooth-cleaning process as per Gera et al., no significant differences in terms of satisfaction levels were reported between the groups for the conventional and CAD/CAM retainers.[13] Interestingly, Gelin et al. made no significant findings concerning differences in cephalometric changes, for instance, IMPA (Incisor Mandibular Plane Angle) or the inter-incisor angle, between the retention groups; this would suggest that the type of retention does not significantly influence overall craniofacial alignment.[14]

Recommendations of the Study

Based on this systematic review, future studies should preferably have more extended sample sizes to confirm the robustness of findings. Indeed, for maxillary retainers, which were underrepresented in the present paper, further studies are necessary. Longitudinal data are also crucial in determining the durability and effectiveness of different retention methods that persist over an extended period. Another important source of variability was found in studies across retention protocols, patient characteristics, and practitioner skill levels. Potential confounding variables may have impacted the outcomes. Thus, further research with a more consistent methodology would help clarify the relative efficacies of retention strategies. Future studies should also include comprehensive patient-reported outcomes for the assessment of clinical outcomes in addition to perceived satisfaction and comfort with retention types. Finally, cost-benefit analyses should also be conducted to benefit from a more comprehensive assessment of the general value of each retention method.

Limitation of Systematic Review

Although this review was rather broad in scope, there were still some limitations. The studies on maxillary retainers were very limited, thus limiting the generalizability of our findings. Another limitation was that there were no long-term follow-up data available; thus, the durability of retention methods in relation to longer periods could not be evaluated. Different protocols were undertaken in the studies, and variations of different implementations of retention, patient characteristics and oral hygiene practices prevented direct comparisons of different retainer types. The low sample size in some of the studies limits this research from being able to find statistically significant differences across retention methods, and future studies should address this limitation to draw more conclusive results.

CONCLUSION

In our thorough investigation, we meticulously compared two distinct types of fixed retainers within orthodontic treatment. Our focus was to assess their impact on treatment outcomes consistency, periodontal health, and retainer failures. After exhaustive analysis, we found minimal differences in Incisor Cumulative Displacement (ICD) and Apical Labial (AL) changes between the two retainer types. CAD/CAM retainers showed a slight advantage in Lower Incisor Inclination (LII), but this advantage lacked clinical significance.

Moreover, CAD/CAM retainers displayed a modest reduction in the Plaque Index (PI), suggesting potential benefits for oral hygiene maintenance. However, Gingival Index (GI) outcomes were comparable between the two, indicating CAD/CAM retainers as a viable alternative.

Despite minor differences in certain aspects, such as ICD and AL changes, the clinical impact remained minimal in the orthodontic treatment. CAD/CAM retainers showed a slight advantage in LII and reduced PI, reinforcing their viability as an alternative option.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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