O-Ring and Bar-Clip: A Comparative Analysis of Retention in Overdenture Prostheses – A Systematic Review

Keywords

Retention
Overdenture
Attachment System
Bar-Clip
O-Ring

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Received: 06.05.2024
Accepted: 03.10.2024

doi: 10.1922/EJPRD_2727Araujo08

ABSTRACT

Introduction: Mandibular implant-supported overdentures (IODs) show higher retention than conventional complete dentures. However, there is no consensus on the best attachment to ensure resistance to vertical displacement. The most used are o-ring and bar-clip. This systematic review answered "Which type of attachment for overdenture prosthesis provides higher retention: o-ring or bar-clip? Methods: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was followed and registered in the International Prospective Register of Systematic Reviews (PROSPERO). The search was applied to 5 databases and grey literature. The selection process occurred in two blinded steps by the reviewers following the eligibility criteria: a randomized clinical trial comparing retention between o-ring and bar-clip in IODs. The risk of bias was analyzed by RoB II. Results: 206 articles were found, and after removing the duplicates 136 were evaluated by title and abstract of which 24 were selected for full reading, 5 met the eligibility criteria, and all had a high risk of bias. The bar-clip provided higher retention than o-ring in four studies. Conclusions: The bar-clip system provides a higher retention rate than the o-ring. In addition, the selection of attachment systems is dependent on the patient's anatomical-functional and economic conditions.

INTRODUCTION

Edentulism interferes with quality of life, compromising oral health, masticatory and muscle function, and social life.[1-3] This scenario still prevails worldwide, and elderly patients with systemic, morphological, and economic limitations lack treatment alternatives because even with advances in implant dentistry and surgical techniques, full-mouth fixed rehabilitation is unfeasible.[4] Thus, overdenture prostheses (IODs) are advantageous because they require fewer implants, simpler and less invasive surgery, and less expensive treatment, with a high survival rate and favorable prognosis.[2,5-7]

Over the last 30 years, the use of implant-supported overdentures (IODs) has proven to be effective, with survival rates of 95.3%, depending on the type of attachment used.[2,7,8] The advantages of IODs compared to conventional complete dentures are better retention and stability, greater masticatory efficiency, reduced ridge bone resorption, and better aesthetic and functional outcomes for the patient.[2,9] As disadvantages, they have high complication rates associated with loss of retention over time.[1,10]

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Ramadan and Mohamed[11] infer that the retentive force of IODs should be greater than 20 N to avoid displacement by oblique forces, which influences patient satisfaction, decreased functionality, and consequent treatment success.[11-13]

IODs can be retained by attachment systems, o-ring, bar-clip, magnetic, locator, and double-crown, of which the first two are the most used.[10,14,15] These are selected based on the amount of retention desired, the morphology of the mandible, bone quantity and quality, interarch distance, maxillo-mandibular relationship, parafunctional habits and level of oral hygiene of the patient, facility of use for adhesion, and cost.[14,16-18]

The o-ring presents advantages such as easy cleaning and low cost, however, its low resistance to wear makes it suitable for periodic changes.[16,19,20] It is noteworthy that this requires parallel insertion of the implant, otherwise, it affects the adaptation of the patient by hindering the insertion and removal of the prosthesis, and even causing the fracture of the pillar by stress concentration.[16,19,21]

The bar-clip presents the advantages of being splinted with improved stress distribution and decreased force on the implant, to be indicated in rehabilitation with immediate loading.[14,19] The disadvantages are technical sensitivity, high cost, and hygienic difficulties due to the bar being installed close to the mucosa, which can lead to inflammation and gingival hyperplasia.[14,16]

The o-ring and bar-clip systems are the most commonly used, but there is still no consensus in the literature as to which is best for the long-term success of rehabilitative treatment. Therefore, this systematic review aimed to answer the question "Which type of attachment for overdenture prosthesis provides greater retention: o-ring or bar-clip?" in order to contribute to clinicians and researchers in decision making and material development. The null hypothesis was that there would be no significant differences in retention between the o-ring and bar-clip.

METHODS

This systematic review followed the guidelines of the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA 2020)[22] and was registered in PROSPERO (CRD42023413578). The acronym PICOS was structured according to the research question "Which type of attachment for overdenture prosthesis provides greater retention: o-ring or bar-clip?" P = overdenture prosthesis; I = bar-clip and o-ring attachment systems; C = bar-clip and o-ring attachment systems; O = retention of the overdenture prosthesis; S = randomized clinical trial.

The personalized search strategy was applied to the Embase, PubMed, Scopus, Science Direct, and Web of Science databases on November 24th, 2022, without the restriction of time and language, furthermore, the search in the non-peer-reviewed literature such as Google Scholar and ProQuest (Supplementary Table 1).

For inclusion in this systematic review, only randomized clinical studies comparing the retention of bar-clip and o-ring systems in IODs were considered. Studies were excluded if they: 1) Lacked information on the attachment retention evaluation method; 2) Were conference abstracts; 3) Did not compare bar-clip and o-ring systems; 4) Evaluated retention after complications; 5) Compared the o-ring system with a different attachment system other than the bar-clip; 6) Were not randomized clinical trials.

The article selection process was carried out in two stages. In the first step, reviewers B.L.P.A, C.A.S.C, and J.D.C.T evaluated the title and abstract of the articles found after applying the search strategy in the Rayyan web application according to the eligibility criteria, to select the articles to be read in full. In the second step, B.L.P.A, C.A.S.C, and J.D.C.T independently assessed the articles selected for full reading according to the eligibility criteria. Doubts regarding the inclusion or not of the article were resolved in a consensus meeting with coordinator A.C.R.

The data were tabulated in a Word spreadsheet according to the criteria: author and year, groups, prosthesis placement (mandibular, maxillary, or both), retention assessment method, results, and conclusion *(Table 1)*.

The risk of bias of the studies was performed using the revised Cochrane risk-of-bias tool for randomized trials (RoB II).[23]

RESULTS

When applying the personalized search strategy, 206 articles were found, and after removing the duplicates, 136 were analyzed by title and abstract; of these, 24 were selected to be read in full, of which 5 met the eligibility criteria and 19 were excluded the reason in detail in Supplementary Table 2. It should be noted that no article was included from the reference list and the grey literature. *(Figure 1)*.

The characteristics of the 5 included studies were summarized in Table 1. The retention of mandibular overdentures retained by the o-ring and bar-clip systems was evaluated using a dynamometer[7,24-26] or a device developed by the authors.[27] Naert *et al*.[24] found that bar-clip had a higher retention capacity (60-70%) than o-ring (<10%) when following up for 2 years. Naert *et al*.[25] found that bar-clip had a higher retention capacity (1379 N) than o-ring (883 N) when following up for 3 years. Naert *et al*.[26] found that bar-clip had a higher retention capacity (1240 N) than G2 (567 N) when following up for 3 years. Van Kampen *et al*.[27] found that the bar-clip had a higher retention capacity (29.8 N) than the o-ring (28.0 N) when following up for 3 months. However, Naert *et al*.[7] found that the o-ring had a higher retention capacity (1,327 g) than the bar-clip (1,067 g) when following up for 10 years.

The heterogeneity of the studies regarding the device for evaluation of the retention force and brand of attachments prevented meta-analysis.

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Table 1. Characteristics of the included studies.

Author, year	Groups	Prosthesis placement (mandibular, maxillary, or both)	Method for evaluating retention	Results	O-ring and bar-clip brand	Conclusion
Naert et al., 1994[24]	G1 =12 patients treated with bar-clips. G2 = 12 patients treated with o-ring.	Mandibular	Dynamometer with a maximum capacity of 20 N (1 kgf = 9,807 N).	The studies showed that G1 had a higher retention capacity (60-70%) than G2 (<10%) when following up for 2 years. Mean and standard deviation values were not expressed.	Bar-clip: egg-shaped Dolder bar; O-ring: Nobelpharma AB.	The bar-clip retention system provided the best retention results.
Naert et al., 1997[25]	G1 =12 patients treated with bar-clips. G2 = 12 patients treated with o-ring.	Mandibular	Dynamometer with a maximum capacity of 20 N (1 kgf = 9,807 N).	The studies showed that G1 had a higher retention capacity (1379 N) than G2 (883 N) when following up for 3 years. Baseline (mean): G1 = 1677 N; G2 = 655 N After 3 years (mean): G1 = 1379 N; G2= 883 N Decreased retention G1 = 298 N Increased retention G2 = 228 N	Bar-clip: egg-shaped Dolder bar; O-ring: Nobel Biocare.	The bar-clip retention system provided the best retention results.
Naert I. et al.,1999[26]	G1 =12 patients treated with bar-clips. G2 = 12 patients treated with o-ring.	Mandibular	Dynamometer with a maximum capacity of 20 N (1 kgf = 9,807 N).	The studies showed that G1 had a higher retention capacity (1240 N) than G2 (567 N) when following up for 3 years. Baseline (mean): G1 = 1677 N; G2 = 655 N After 5 years (mean): G1 = 1240 N; G2= 567 N Decrease retention: G1 = 437 N; G2 = 88 N	Bar-clip: egg-shaped Dolder bar; O-ring: Nobel Biocare.	The bar-clip retention system provided the best retention results.
Van Kampen et al., 2003[15]	G1 =6 patients treated with bar-clips. G2 = 6 patients treated with o-ring.	Mandibular	A device developed that allowed to apply an increasing vertical force on the overdenture.	The studies showed that G1 had a higher retention capacity (29.8 N) than G2 (28.0 N) when following up for 3 months. Baseline (mean): G1 = 32.9 N; G2 = 31.4 N After 3 months (mean): G1 = 29.8 N; G2= 28.0 N Decrease retention: G1 = 3.1 N; G2 = 3.4 N	Bar-clip: round bar in conjunction with a metal omega-shaped IMZ clip, Friadent; O-ring: ball-socket attachment, Frialit-2, Friadent.	The bar-clip retention system provided the best retention results.
Naert et al., 200[47]	G1 =12 patients treated with bar-clips. G2 = 12 patients treated with o-ring.	Mandibular	Dynamometer with a maximum capacity of 2,000 g.	The studies showed that G2 had a higher retention capacity (1,327 g) than G1 (1,067 g) when following up for 10 years. Baseline (mean): G1=2000 g; G2 = 600 g After 10 years (mean): G1 = 1.067 g; G2 =1.327 g Decreased retention G1 = 993 N Increased retention G2 = 727 N	Bar-clip: egg-shaped Dolder bar; O-ring: Nobel Biocare.	The o-ring retention system provided better retention results in the tenth year.

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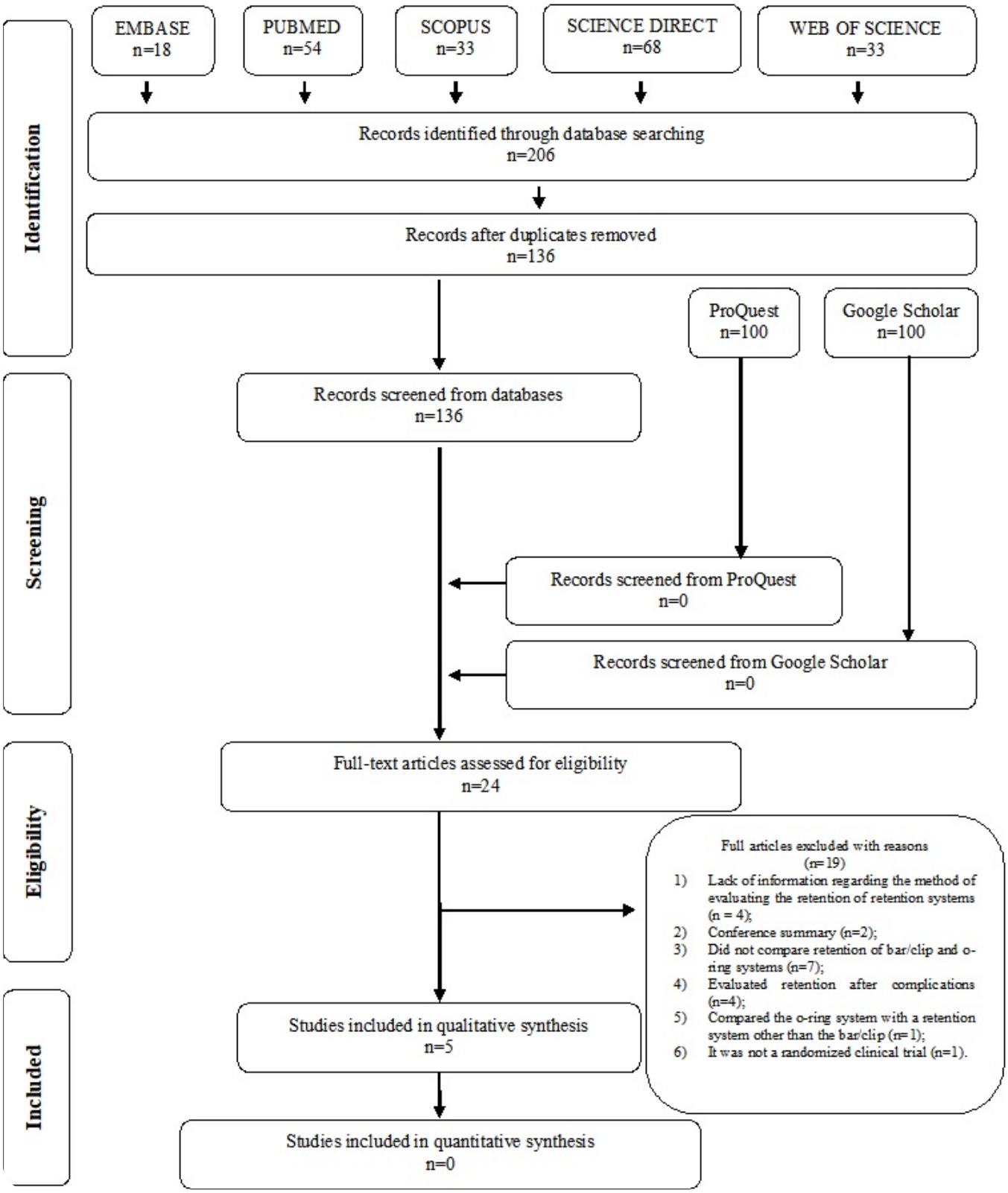

Figure 1: Flow of information through different phases of systematic review.

As shown in Figure 2 the result of the risk of bias analysis using the RoB II tool. Domain D1, which analyzes the bias arising from the randomization process, presented a high risk of bias in all studies since the way it was performed was not informed. Hence, there is no possibility of knowing if there was a selection bias when performing the randomization.

On the other hand, domains D2, D4, and D5, which respectively analyze biases of intended interventions, measurement of the outcome, and selection of the reported result, presented some concerns attributed to the awareness of the attachment used (bar-clip or o-ring) by the measurer and patient, which makes it impossible to blind the data.

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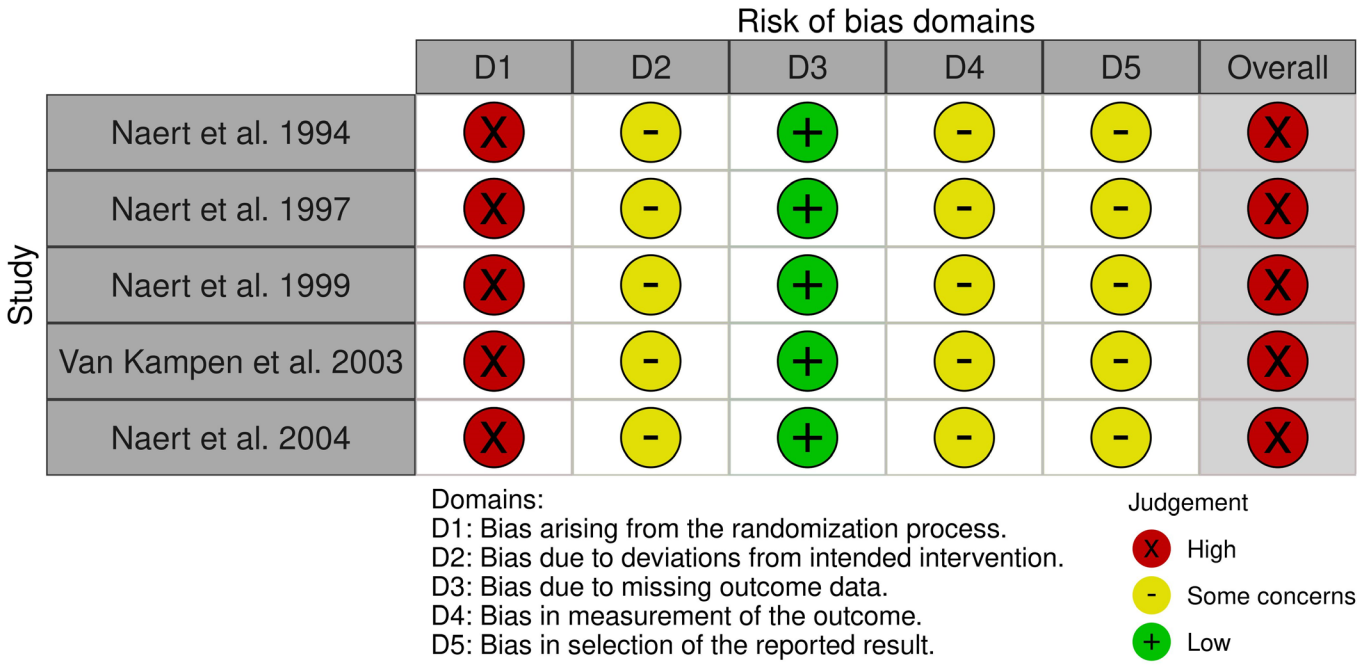

Figure 2: Result of the risk of bias analysis using the RoB II tool.

DISCUSSION

Retention is a determinant in the function and survival of oral rehabilitations with IODs and patient satisfaction, and it is directly related to the attachment selected. It should ensure a retentive force greater than 20 N to prevent displacement of the prosthesis by oblique forces, improve masticatory performance, and facilitate cleaning.[28,29] According to the literature, the most commonly used types of attachments are o-ring and bar-clip with no consensus on which is best for retention,[14] a fact that motivated this systematic review with randomized clinical trials to avoid selection and condition biases. The qualitative analysis found that of the five studies included[7,24-27] in four[24-27] the bar-clip system showed higher retention rates and hence rejected the null hypothesis. Retention force can be measured by objective methods, oral devices such as the dynamometer,[7,24-26] and subjective, patient satisfaction questionnaires.[12,27] In this review, all studies used objectivity, which allowed the results found to be more reliable and avoid biases regarding subjectivity.

Four studies demonstrated that the bar-clip was preferable over the o-ring by inducing greater retention,[24-27] a finding reported in previous studies,[25,30] and causing lower screw loosening rates being 0% vs ≈ 40% in the o-ring.[7] These results can be justified by the biomechanics of this retention system, allowing greater stability of the prosthesis provided by the bar-clip design, favoring the uniform distribution of occlusal forces, providing a larger contact area with the prosthesis for firmer fixation, and using materials that are more durable and resistant to wear, thereby contributing to superior long-term retention.[7,24-27,30]

Nevertheless, the limitation of the bar-clip is that the composing material of the clip is polymeric and suffers distortions attributed to degradation by eating habits, chemical, and mechanical hygienic methods, and frequency of insertion and removal of the prosthetic device that induces loss of retention and need of replacement.[7,25,27,31,32] Regular appointments with the dental surgeon are instructed for maintenance and preservation of the optimal condition of the overdenture and its components.

Naert *et al.*[7] contrary to previous studies, reported better retention rates for the o-ring, suggesting that it allows for complete settlement of the IODs base to the denture bearing area unlike the bar-clip, in which the bar acted as a bulkhead to adaptation. It should be stressed that a conflict of interest may have interfered with this result possibly attributed to the o-ring being funded by a different company than the other studies.[24-27]

The average duration of the bar-clip system tends to be longer, 12 to 18 months, compared to the o-ring system, which lasts six to nine months.[17,34,20,32,33] The biomechanics of this system can justify this greater durability, as its design provides a greater contact area with the prosthesis, which favors a more uniform distribution of forces to reduce the incidence of damaging forces that affect its durability.[17,34] This inference is corroborated by the study by Savabi *et al.*,[17] in which after five years of monitoring the bar-clip system, the retentive force reduced to 44% of the initial value. It is reiterated that the wear rate of the accessory and the number of maintenance visits required to replace it depend on the materials used in the clips and the specific characteristics of the patient, which if they present malocclusion and parafunctional habits tend to reduce.[17,34,20,32,33]

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In contrast, the o-ring system generally presents faster wear and a lower retention rate attributed to its smaller contact area and consequent lower prosthesis stability with a higher incidence of destructive forces, which means it needs to be replaced every six to nine months.[20,32,33] It is noteworthy that the loss of retention is one factor that increases the cost and patient dissatisfaction.[20,32,33] Table 1 illustrates this fact and depicts the increase in retention with the substitution. It must be noted that the included articles reported that these were replaced upon patient request due to loss of retention, unlike the plastic clip of the bar-clip system that showed lower rates of replacement.[24-27]

It is reiterated that the choice of the fixation system for overdentures is influenced by factors related to the anatomical, functional, and social conditions of the patient.[14,16-18] Among the anatomical factors, the quantity and quality of available bone are highlighted, as adequate bone volume and density are crucial for the effective anchorage of the fixation components and consequent stability of the prosthesis.[14,16-18] The interarch distance and maxillomandibular relationship also play significant roles in determining spatial constraints and aligning the overdenture with the underlying support structures.[14,16-18] Parafunctional habits are another factor that can impact the wear and longevity of different fixation systems, thus requiring a thorough patient anamnesis and complementary treatments, such as the use of interocclusal devices to reduce harm to the stomatognathic system and treatment complications.[14,16-18] Socioeconomic factors also influence the decision, as different fixation systems vary in cost and complexity, which can affect financial viability.[14,16-18] Therefore, when planning oral rehabilitation with overdentures, the clinician must have a comprehensive and correlative view of the patient's oral, functional, and social conditions, as well as the characteristics, advantages, and disadvantages of each retention system to ensure the performance and durability of the rehabilitative treatment.[14,16-18]

The included studies presented a high risk of bias, however, this should not be seen as a negative factor to the results found, because when comparing attachment systems for overdentures, it is impossible to blind these interventions from the patient and the clinician who installed them. Accordingly, the bias reiterates the importance of finding an effective method for the rehabilitation of elderly patients who are unable to use fixed prostheses on implants either due to systemic and/or socioeconomic factors, since the professionals specializing in this group should be instructed on the requirement of survival of these rehabilitations to increase the functionality of the prostheses, patient satisfaction, and prevention of deleterious muscle and joint diseases.

As a limitation, this review presents heterogeneity regarding the time of analysis, 3 months,[27] 2 years,[24] 3 years,[25,26] and 10 years,[7] which prevent an equal comparison of results, in addition to the restricted sample size, 6 patients[27] and 12 patients,[7,24-26] which may generate overestimation of results.

The critical analysis of the included literature has allowed inferring that the bar-clip system presents higher retention rates than the o-ring and motivates further research on this subject, given the low number of articles included and the non-publication for more than 20 years.

CONCLUSIONS

Based on the critical analysis of the literature, the following conclusion was drawn:

The bar-clip system provides better retention rates than the o-ring. Furthermore, the choice depends on the anatomical and functional conditions, quantity and quality of available bone, interarch distance, maxillo-mandibular relationship, parafunctional habits, and socioeconomic situation.

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Supplementary Table 1. Search Strategy.

Database	Search	Found
PubMed November 24th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	54
Scopus November 24th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	33
Web of Science November 24th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	33
Embase November 24th, 2022	(overdenture OR 'Implant-supported overdenture') AND ('attachment system' OR attachment OR 'retention system') AND ('bar-clip' OR 'barclip' OR 'splinted attachment') AND ('o-ring' OR ball OR 'ball attachment') AND ('overdenture retention' OR retention)	18
Science Direct November 24th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	68
	Grey Literature	
Google Scholar November 24th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	100
ProQuest November 4th, 2022	(overdenture OR "Implant-supported overdenture") AND ("attachment system" OR attachment OR "retention system") AND ("bar-clip" OR "barclip" OR "splinted attachment") AND ("o-ring" OR ball OR "ball attachment") AND ("overdenture retention" OR retention)	100

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Supplementary Table 2. Excluded Articles and the Reason.

Author, Year	Exclusion Reason
MericsKe-Stern and Dent 1990	1
Närhi et al. 2001	1
Walton et al. 2002	1
Walton 2003	2
Cune et al. 2005	2
Van Der Bilt et al. 2006	3
Karabuda et al. 2008	4
Cune et al. 2010	3
Burns et. al. 2011	3
Bilhan et al. 2011	1
Krennmair et al. 2012	5
Viswambaran et al. 2015	3
Sampaio-Fernandes et al. 2016	4
Park et al. 2019	4
Varshney et al. 2019 (a)	3
Chrcanovic et al. 2020	4
Dillenburg et al. 2021	3
Nejatidanesh et al. 2022	3
Varshney et al. 2019 (b)	6

1. **Absence of information regarding the method of attachment retention evaluation (n = 4);**
2. **Conference abstract (n=2);**
3. **Did not compare bar-clip and o-ring (n=7);**
4. **Evaluated retention after complications (n=4);**
5. **Compared the o-ring system with another attachment system other than the bar-clip (n=1);**
6. **Was not a randomized clinical trial (n=1);**

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