

Implant Supported Overdenture Attachment Systems: A Systematic Review With Meta-Analysis

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Abstract

Aim: This systematic review aimed to compare different attachment systems used in implant-supported overdentures by assessing outcomes such as prosthodontic maintenance and complications, peri-implant tissue changes, retention, and patient satisfaction for the optimal selection of an attachment system.

Settings and Design: This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Materials and Methods: A comprehensive electronic literature search was conducted through PubMed, The Cochrane Central Register of Controlled Trials (CENTRAL), and Science Direct. Additionally, individual journals and reference lists of selected studies were manually searched. The review included randomized controlled clinical trials and crossover clinical trials from 2015 to 2022 with a follow-up period of over one year. The risk of bias in the included studies was assessed using The Cochrane Collaboration's tool.

Statistical Analysis Used: Statistical meta-analysis was performed using Review Manager (RevMan) [computer program]. Version 5.4. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2020.

Results: Five studies met the inclusion criteria, exhibited a low risk of bias, and had follow-up periods exceeding one year. Of the four outcomes, meta-analysis was conducted for prosthodontic maintenance and peri-implant tissue changes. Due to limited data availability, retention and patient satisfaction were reviewed systematically without meta-analysis. The meta-analysis results for ball versus magnet attachment showed statistically significant differences in prosthodontic complications and maintenance, with ball attachments reporting fewer complications than locator attachments.

Conclusion: The current review concludes that bar attachments offer the highest retention. The telescopic attachment system not only demonstrated the highest patient satisfaction but also resulted in the least peri-implant mucosal changes. The ball attachment system is a suitable option for limited inter-arch space and parallel implant placement.

Keywords— “O” ring attachment, ball and bar, implant supported overdenture, locator attachment, overdenture attachments

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I. Introduction

Edentulism is a debilitating and permanent condition that remains significant and prevalent among the elderly population. [1] Adapting to complete dentures is complex and requires consideration from various perspectives. The primary treatment options for completely edentulous patients include conventional removable complete dentures or implant-supported fixed or removable prostheses. [2] Conventional complete dentures often pose challenges in chewing and speaking due to poor retention, stability, support, and other factors. [3]

The use of dental implants to replace natural teeth has become a standard practice in restorative and surgical dentistry. Implants provide excellent support for both fixed and removable prostheses, significantly improving functional efficiency compared to conventional removable complete and partial dentures and restoring patient aesthetics. [4]

Rehabilitation with dental implants is considered a successful option for edentulous arches, suggesting that any edentulous area is a potential site for implants. [5]

Implant overdentures have become the preferred choice for completely edentulous arch rehabilitation. Generally, overdenture attachment systems are classified into four main categories: ball or stud, bar and clip, magnet type, and telescopic attachments.^[6, 7] Each system includes a retainer comprising a metal receptacle (the female or matrix) and a closely fitting part (the male or patrix), with one component embedded in the undersurface of the prosthesis and the other connected to the implant.^[8] Different overdenture attachment systems encounter various prosthetic maintenance issues and complications, such as matrix loosening, detachment of the matrix, denture fractures, the need for relining and rebasing, and the fracture of components like bars and crowns.^[9] The retention provided by these attachment systems varies, and excessive retention can sometimes hinder the insertion and removal of the prosthesis. Additionally, peri-implant tissue conditions, including plaque and calculus deposition, gingivitis, probing depth, and marginal bone loss, are notable complications linked to different attachment systems. Patient satisfaction is a critical factor, influenced by the maintenance, stability, retention, and proper functioning of the prosthesis. These factors collectively determine the success of the prostheses. [10] Numerous studies compare factors such as prosthodontic maintenance and complications, retention, effects on peri-implant tissue conditions, patient satisfaction, and masticatory efficiency, effectiveness, and the cost-effectiveness of the various overdenture attachment systems for maxillary mandibular implant overdenture.

Thus, the primary objective of this systematic review and meta-analysis was to compare studies from 2015 to 2022, focusing on the various outcomes of newly marketed overdenture attachment systems. The aim was to address the PICOTS question: “In completely edentulous mandibular arches rehabilitated with late implant placement and delayed loading protocols, do prosthodontic complications, retention, peri-implant tissue changes, and patient satisfaction vary with different implant overdenture attachment systems?”

II. Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.^[11, 12] The review included randomized controlled clinical trials (RCTs) and crossover clinical trials with a minimum follow-up period of one year. These studies focused on attachment systems for two or more implant-supported mandibular overdentures and reported on various outcomes such as prosthodontic maintenance/complications, patient satisfaction, prosthesis retention, and peri-implant tissue evaluation.

The PICOTS format provided by the Centre for Evidence-Based Medicine for systematic literature search to answer the research question was formulated as below,

P - POPULATION: Patients having completely edentulous mandibular arch.

I - INTERVENTION: Late implant placement (minimum two implants in inter foramina region) and delayed loading with implant-supported overdenture.

C - COMPARISON: Various overdenture attachment systems like ball attachment, bar attachment, magnet attachment, telescopic type of attachment.

O - OUTCOME: 1. Prosthodontic maintenance and complications 2. Retention 3. Effect on peri-implant tissue condition and 4. Patient’s satisfaction.

T - TIME - Studies published from 2015 to 2022, with the minimum follow-up of 1 year.

S - STUDY DESIGN: Prospective RCT and crossed over clinical trial.

A. Search strategy

An electronic literature search was independently conducted by two investigators (PS, PM) from January 2015 to December 2022, using MEDLINE (PubMed), the Cochrane central register of controlled trials (central) and Science direct databases for articles in English language published in journals of dentistry using following search terms: “implant overdenture AND mandibular arch,” “mandibular implant overdenture AND overdenture attachment systems,” “implant overdenture attachments NOT maxillary implant overdenture,” “implant overdenture attachment systems NOT single implant overdenture,” “mandibular implant overdenture AND implant overdenture attachment systems NOT maxillary implant overdenture NOT single implant overdenture,” “mandibular implant overdenture attachments AND prosthodontic complication/maintenance,” “mandibular implant overdenture attachments AND retention,” “mandibular implant overdenture attachments AND patient’s satisfaction,” “mandibular implant overdenture attachments AND peri-implant tissue condition.” The following journals were also searched manually: The Journal of the Indian Prosthodontic Society, The Journal of Prosthetic Dentistry, International Journal of Prosthodontics, The Journal of Advanced Prosthodontics, International Journal of Oral and Maxillofacial Implants, Clinical Oral Implants Research, Journal of Oral Implantology, British Dental Journal, Journal of Oral Rehabilitation, Journal of Dental Research

B. Study Selection and Intervention

Inclusion criteria

Articles that met the following inclusion criteria were included in this systematic review:

1. RCTs and cross-over clinical trials published only in the English language
2. Mandibular complete edentulous arch
3. Overdenture retained with two or more interforaminal implants
4. Late implant placement delayed loading protocol
5. Studies included from 2015 to 2022
6. Overdenture attachments placed on root-form endosseous implants
7. Follow-up period of a minimum of 1 year.

Exclusion criteria

Studies meeting the following criteria were excluded:

1. Rehabilitation of partially edentulous arches with implant-supported overdentures
2. Studies with follow-up of <1 year
3. Immediate implant placement with immediate loading
4. Studies including overdenture implant attachment in the maxillary arch.
5. Nonclinical studies, reviews, papers without abstracts, case reports/series, letters to editors, and technical notes
6. Single implant-supported overdentures.

Data extraction and collection

The full-text copies of all potential articles were independently evaluated by two authors (PS, PM). The data were recorded as per the following criteria.

1. Name of the author
2. Publication year
3. Type of implant placement
4. Number of implant placement
5. Area of implant placement
6. Implant with delayed loading
7. Overdenture for mandibular arch
8. Type of attachments for overdenture
9. Outcome assessment
10. Follow-up period
11. Type of study (RCT and crossover clinical trial).

Assessment of risk of bias in included studies.

Four investigators (SP, SH, PS, UH) independently assessed the risk of bias for each study using the standard guideline outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011).^[13] There were no disagreements for the assessment of the risk of bias in the present study.

The Cochrane collaboration's tool, for author's judgments, were categorized on the study methods as "Low risk," "High risk," or "Unclear risk" of bias-related for following domains:

1. Random sequence generation (checking for possible selection bias)
2. Allocation concealment (checking for possible selection bias)
3. Blinding of participants and personnel (checking for possible performance bias)
4. Blinding of outcome assessment (checking for possible detection bias)
5. Incomplete outcome data (checking for possible attrition bias due to the amount, nature and handling of incomplete outcome data)
6. Selective reporting (checking for reporting bias)
7. Other bias (checking for bias due to problems not covered by the previously mentioned domains).

Meta-analysis

A randomized controlled trial (RCT) compared ball attachments and locator attachments in terms of prosthodontic maintenance, patient preference, biological complications, and oral health-related quality of life.^[19] This study provided data specifically for the analysis of prosthodontic maintenance. Upon analyzing the data from this single trial regarding prosthodontic success, it was found that ball attachments reported fewer complications compared to locator attachments (RR = 0.55, CI = 95%, P = 0.03, Heterogeneity = not applicable, single study, 48 patients, 24 events of prosthodontic complications)

III. Discussion

Implant overdentures can be an optimal choice for completely edentulous patients who are unable to opt for fixed implant prostheses due to compromised posterior bone quality, anatomical limitations, higher treatment costs, and systemic medical conditions.^[21-23] For the completely edentulous mandible, the McGill consensus

recommends a two-implant-supported overdenture as the first treatment choice. ^[24] The selection of attachment type depends on several factors, including bone height, bone width, inter-arch space, and the degree of retention required, the patient's economic condition, prosthetic expectations, and clinician preference. ^[25, 26]

The minimum space required for rehabilitation between the mandibular incisal edge and mucosa is 13–14 mm for bar attachments, 13–14 mm for telescopic attachments, 10–12 mm for ball attachments, 8.5 mm for locator attachments, and 8.5 mm for magnet attachments. ^[27, 28] Ball attachments can tolerate implant angulations of 10 degrees or less, ^[29, 30] while locator attachments can compensate for angulations up to 40 degrees. ^[4] The parallelism of implants is crucial when using telescopic attachments, but bar attachments can manage non-parallelism using angulated abutments. ^[30]

However, implant-supported overdentures are associated with frequent follow-up visits, prosthetic failures, overdenture attachment loosening, and peri-implant soft and hard tissue complications. ^[31-33] These complications may vary depending on the attachment type. Therefore, this systematic review and meta-analysis aimed to evaluate how different mandibular implant overdenture attachment systems vary in terms of retention, prosthodontic maintenance, their effect on peri-implant tissue health, and overall patient satisfaction. This meta-analysis included a RCT and crossover clinical trial with follow-up of more than 1 year, showing a low risk of bias published in MEDLINE (PubMed), Cochrane, Science direct databases. The attachment systems utilized by the included studies were ball, bar-clip, locator, telescopic and magnet overdenture attachments.

Ball attachments were documented as the most frequently used attachments in the included studies. Two studies compared ball attachments with locator attachments, reporting that ball attachments were perceived by patients to be more retentive. ^[15, 20] An in vitro study indicated that locator attachments had the least retention (33.5 ± 9.77 N) compared to ball (40.3 ± 15.83 N) and bar attachments (46.9 ± 13.9 N). ^[34] When compared to bar attachments, ball attachments demonstrated similar stability (18–20 N) as measured by a force gauge, regardless of the number of implants used. ^[16]

It was documented that ball attachments required more prosthetic maintenance compared to locator, magnet, and telescopic attachments. ^[18, 20] However, Kleis et al. found that locator attachments necessitated more frequent follow-up visits. ^[19] This finding aligns with a systematic review by Miler AM et al., which concluded that the nylon ring of the male component of locator attachments required frequent replacements. ^[35]

Optimal peri-implant tissue health was maintained with ball and telescopic attachment systems. ^[16, 17] The highest level of patient satisfaction was achieved with telescopic attachments, followed by ball and bar attachments. ^[16, 17] Naert et al. compared splinted bar attachments with unsplinted ball and magnet attachments, finding that the bar variety caused greater mucosal changes, while the other group experienced more prosthetic complications. ^[36] The results for mucosal changes found in a similar study by Varshney et al. aligned with the aforementioned study. ^[37] A systematic review and meta-analysis by Chaware and Thakkar compared reports for both maxillary and mandibular arches. In contrast, the focus of this current systematic review and meta-analysis was to evaluate randomized controlled trials and crossover studies conducted exclusively on mandibular overdenture cases. This study specifically included studies with longer follow-up periods. Furthermore, the current meta-analysis employed the Cochrane Collaboration Tool for assessing risk of bias, which was not accurately represented by Chaware and Thakkar. ^[38] York demonstrated that patient satisfaction and quality of life significantly improved with mandibular implant-supported overdentures compared to conventional dentures. ^[39] The findings from this systematic review and meta-analysis will aid in the judicious selection, predictable functioning, and maximum longevity of prostheses chosen for oral cavity rehabilitation.

Summary Of Evidence Table

Summary of the included studies and the results is summarized in Table 2.

IV. Conclusion

Among the various treatment options for rehabilitating the edentulous mandible, implant-supported overdentures are documented to be less invasive and more economical than fixed implant prostheses. The bar attachment system, requiring minimal prosthetic follow-up, was identified as the best retention system when there was sufficient inter-ridge distance and good hygiene maintenance. The bar attachment was the most retentive for implants placed in nonparallel alignment, while the ball attachment system was most favorable for axially parallel implant placement. The telescopic attachment system exhibited the least mucosal changes and favorable force distribution. However, when considering patient satisfaction, unsplinted attachment systems were preferred, with the telescopic attachment system achieving the highest satisfaction levels. The current analysis concluded that there is a need for standardized studies to specifically investigate the same parameters across different attachment types.