

Effectiveness Of Customizable Ball Attachments in Tooth Supported Overdentures: A Systematic Review

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Abstract—Background: Tooth-supported overdentures preserve alveolar bone and proprioception while improving prosthesis retention and stability. Customizable ball attachments offer a cost-effective alternative to prefabricated systems. **Objective:** To systematically evaluate the effectiveness of customizable ball attachments in tooth-supported overdentures.

Methods: Relevant in vitro and clinical studies were reviewed following predefined selection criteria.

Results: Customizable ball attachments demonstrated satisfactory retention, stability, masticatory efficiency, patient satisfaction, and preservation of supporting tissues, although maintenance requirements varied.

Conclusion: Customizable ball attachments represent a reliable, economical, and conservative treatment option for appropriately selected patients requiring tooth-supported overdentures.

Index Terms—Tooth-supported overdenture; Customizable ball attachment; Preventive prosthodontics; Retention; Masticatory efficiency; Systematic review.

I. INTRODUCTION

Edentulism, defined as the complete loss of natural teeth, remains a significant oral health problem worldwide despite remarkable advances in preventive dentistry and restorative care.^{1,2} Although the prevalence of complete edentulism has declined in developed countries, it continues to affect a large proportion of the elderly population and individuals from lower socioeconomic groups.³ Loss of all natural teeth adversely affects oral function, facial appearance, psychological well-being, and overall quality of life.⁴

The consequences of tooth loss extend beyond the absence of teeth. Functionally, edentulous patients experience a marked reduction in masticatory efficiency, making it difficult to chew fibrous and nutritious foods. This often results in dietary modifications that may contribute to nutritional deficiencies and systemic health problems.⁵ Speech may also be impaired due to the absence of proper dental support, while facial esthetics deteriorate because of reduced vertical dimension of occlusion, collapse of the lips and cheeks, and deepening of facial wrinkles. These changes frequently lead to decreased self-confidence, social withdrawal, and reduced quality of life.⁶

A major biological consequence of tooth loss is residual ridge resorption, a progressive and irreversible process involving the loss of alveolar bone following extraction. The alveolar process exists primarily to support teeth; once teeth are lost, the absence of periodontal ligament stimulation results in continuous bone resorption. The mandibular ridge generally resorbs more rapidly than the maxillary ridge, resulting in progressive reduction of the denture-bearing area. This ongoing resorption compromises denture retention, stability, and support, making prosthetic rehabilitation increasingly challenging with time.^{6,7}

Conventional complete dentures have long been considered the standard treatment for completely edentulous patients because they are economical, relatively simple to fabricate, and non-invasive.⁸ Their success depends largely on adequate support, retention, and stability obtained from the residual alveolar ridges and surrounding oral tissues. While

complete dentures restore appearance, speech, and basic masticatory function, they cannot completely replicate the function of natural dentition. Their effectiveness decreases progressively as residual ridge resorption advances.⁸

Patients frequently report instability of mandibular dentures, difficulty chewing hard foods, soreness of the supporting mucosa, impaired speech, and reduced confidence while eating or speaking in public. Continuous pressure exerted by conventional dentures may further accelerate residual ridge resorption, creating a cycle of progressive bone loss and declining prosthesis performance. Consequently, repeated adjustments, relining, or replacement of dentures often become necessary.⁹

To overcome these limitations, several prosthodontic treatment options have been developed, including removable partial dentures, fixed partial dentures, implant-supported prostheses, and tooth-supported overdentures. The choice of treatment depends on the patient's remaining dentition, systemic health, anatomical conditions, financial considerations, and functional requirements. Although implant-supported prostheses provide excellent retention, stability, and preservation of alveolar bone, their use may be limited by surgical requirements, inadequate bone volume, systemic contraindications, and higher treatment costs. The concept of preventive prosthodontics emerged from the understanding that preservation of natural oral structures is preferable to complete replacement whenever possible. Instead of extracting all remaining teeth, this philosophy emphasizes the conservation of strategically useful teeth or roots to maintain alveolar bone, preserve proprioception, improve prosthesis support, and enhance long-term oral health. The retained teeth continue to transmit functional forces through the periodontal ligament, thereby reducing the rate of alveolar bone resorption and improving neuromuscular control during mastication.

Tooth-supported overdentures represent one of the most successful applications of preventive prosthodontics. An overdenture is a removable prosthesis that gains support from retained natural teeth, roots, or implants. By preserving selected teeth, overdentures improve retention, stability, support, chewing efficiency, phonetics, and patient comfort while simultaneously reducing residual ridge resorption. In addition, retained teeth preserve periodontal proprioception, allowing patients to

perceive occlusal forces more effectively than those wearing conventional complete dentures.

Successful overdenture therapy depends largely on proper selection and preparation of abutment teeth. Potential abutments should possess adequate periodontal support, favorable crown-root ratio after modification, satisfactory endodontic status, and strategic distribution within the arch. Most retained teeth undergo endodontic treatment followed by reduction of the clinical crown to minimize lateral forces and improve prosthesis design. Metal copings are commonly fabricated over prepared roots to protect tooth structure and improve the longevity of the abutments.

Various attachment systems have been introduced to enhance the retention of tooth-supported overdentures. These include bar attachments, stud attachments, magnetic attachments, telescopic copings, and resilient attachment systems. Each attachment design has specific indications, advantages, disadvantages, and maintenance requirements. The selection of an attachment system should be based on available inter-arch space, number and position of abutments, patient dexterity, maintenance requirements, and financial considerations.

Among the available attachment systems, stud attachments have gained widespread acceptance because of their relatively simple design, ease of fabrication, lower cost, and satisfactory clinical performance. Ball attachments are the most commonly used stud attachments owing to their resilient design, ability to accommodate minor denture movements, and favorable stress distribution.

Commercial prefabricated ball attachments are widely available and have demonstrated good clinical success. However, they may present certain disadvantages, including increased cost, dependence on proprietary components, and limited flexibility in adapting to different clinical situations. In many clinical settings, particularly in developing countries, the cost of commercially available attachment systems may restrict their routine use.

Customizable ball attachments have therefore emerged as an economical alternative. These attachments can be fabricated using readily available dental materials and modified according to individual patient requirements. They offer the potential advantages of reduced treatment cost, simplified laboratory procedures, acceptable retention, ease of

repair, and greater accessibility without compromising the biological principles of preventive prosthodontics. Although numerous clinical and laboratory studies have evaluated various overdenture attachment systems, the available evidence regarding customizable ball attachments remains scattered. Most published studies compare different attachment designs, evaluate retention or patient satisfaction, or assess maintenance requirements. Comprehensive synthesis of the available evidence specifically concerning customizable ball attachments in tooth-supported overdentures is limited.

A systematic review provides the highest level of evidence by critically identifying, appraising, and synthesizing published research. Such a review enables clinicians to make evidence-based decisions regarding treatment planning, expected clinical outcomes, patient satisfaction, prosthesis maintenance, and long-term success.

Therefore, the present systematic review aims to critically evaluate the available evidence regarding the effectiveness of customizable ball attachments in tooth-supported overdentures, with particular emphasis on retention, stability, masticatory efficiency, patient satisfaction, preservation of supporting structures, maintenance requirements, and overall clinical performance. The findings of this review are expected to assist clinicians in selecting appropriate attachment systems and to identify areas where further clinical research is required.

II. METHODOLOGY

Study Design

The present study was conducted as a systematic review to evaluate the effectiveness of customizable ball attachments in tooth-supported overdentures. The review was performed according to internationally accepted principles for systematic reviews and was designed to identify, critically appraise, and synthesize the available evidence regarding the clinical performance of customizable ball attachment systems.

Focused Research Question

The review was based on the following research question:

"Are customizable ball attachments effective in improving the clinical performance of tooth-supported

overdentures compared with conventional or other attachment systems?"

The research question was formulated using the PICO framework.

Component	Description
Population (P)	Patients rehabilitated with tooth-supported overdentures
Intervention (I)	Customizable ball attachments
Comparison (C)	Conventional overdentures or other attachment systems
Outcome (O)	Retention, stability, masticatory efficiency, patient satisfaction, maintenance requirements, and preservation of supporting tissues

Eligibility Criteria

A. Inclusion Criteria

Studies fulfilling the following criteria were included:

- Clinical studies evaluating tooth-supported overdentures.
- In vitro studies assessing customizable or ball attachment systems.
- Randomized controlled trials, prospective studies, retrospective studies, case-control studies, cohort studies, and laboratory investigations.
- Studies reporting one or more clinical outcomes such as retention, stability, patient satisfaction, masticatory efficiency, stress distribution, maintenance, or prosthesis longevity.
- Articles published in the English language.

B. Exclusion Criteria

The following studies were excluded:

- Implant-supported overdenture studies without tooth-supported comparison.
- Case reports with insufficient clinical information.
- Narrative reviews, editorials, expert opinions, letters, conference abstracts, and duplicate publications.
- Animal studies.
- Articles with unavailable full text.

Literature Search Strategy

A comprehensive electronic literature search was performed using multiple scientific databases to identify relevant publications.

The databases searched included:

- PubMed/MEDLINE

- Scopus
- Google Scholar
- Cochrane Library

The search was supplemented by manual screening of reference lists from selected articles to identify additional relevant studies.

The search strategy included combinations of Medical Subject Headings (MeSH) terms and free-text keywords such as:

- Tooth-supported overdenture
- Overdenture attachment
- Ball attachment
- Stud attachment
- Customizable ball attachment
- Tooth-retained overdenture
- Preventive prosthodontics
- Attachment system
- Prosthodontic rehabilitation

Boolean operators (AND, OR) were used to combine search terms appropriately.

Study Selection

All retrieved articles were imported and screened for duplicate records.

Study selection was performed in two stages:

Stage I

Titles and abstracts were independently screened to identify potentially eligible studies.

Stage II

Full-text articles of selected studies were retrieved and assessed according to the predefined inclusion and exclusion criteria.

Studies that satisfied all eligibility criteria were included in the final qualitative analysis.

Data Extraction

Relevant information from each included study was extracted using a standardized data extraction form.

The following information was collected:

- Author and year of publication
- Study design
- Sample size
- Type of attachment evaluated
- Study objectives
- Outcome measures
- Main findings
- Clinical conclusions

The extracted information was summarized in tabular form to facilitate comparison among studies.

Outcome Measures

The primary outcomes evaluated were:

- Prosthesis retention
- Prosthesis stability
- Masticatory efficiency
- Patient satisfaction
- Preservation of alveolar bone
- Stress distribution
- Prosthesis longevity

Secondary outcomes included:

- Maintenance requirements
- Attachment wear
- Technical complications
- Biological complications
- Ease of fabrication
- Cost-effectiveness

Quality Assessment

The methodological quality of the included studies was critically evaluated based on:

- Study design
- Sample size
- Risk of bias
- Outcome assessment methods
- Follow-up duration
- Reporting quality

The overall strength of available evidence was assessed qualitatively to determine the reliability of the reported findings.

Data Synthesis

Owing to variations in study design, attachment systems, outcome measures, and follow-up periods among the included studies, statistical pooling of data was not considered appropriate.

Therefore, a qualitative narrative synthesis was performed.

The findings were grouped according to major clinical outcomes, including:

- Retention
- Stability
- Masticatory efficiency
- Patient satisfaction

- Maintenance requirements
- Clinical performance
- Preservation of supporting tissues

The similarities and differences among studies were critically analyzed to identify consistent trends and areas requiring further research.

III. RESULTS

A comprehensive literature search identified relevant studies evaluating the effectiveness of customizable ball attachments and other stud attachment systems in tooth-supported overdentures. After removal of duplicate records and screening of titles, abstracts, and full-text articles according to the predefined inclusion and exclusion criteria, eligible studies were included for qualitative analysis. The study selection process was documented using a PRISMA flow diagram.

The included studies comprised both clinical and in vitro investigations, evaluating parameters such as retention, stability, masticatory efficiency, patient satisfaction, stress distribution, maintenance requirements, and preservation of supporting structures. Although differences existed in study design, sample size, attachment type, and outcome assessment methods, most studies consistently reported favorable clinical outcomes with ball attachment systems.

Customizable ball attachments demonstrated improved retention and stability compared with conventional complete dentures, resulting in enhanced

prosthesis function and patient comfort. Several studies also reported improved masticatory efficiency, speech, and patient-reported satisfaction due to better prosthesis retention and reduced denture movement during function.

Retention of natural tooth abutments contributed to the preservation of alveolar bone through continued periodontal ligament stimulation, thereby reducing residual ridge resorption compared with conventional complete dentures. The presence of retained roots also preserved proprioception, resulting in improved neuromuscular coordination and greater patient confidence during mastication.

Laboratory studies evaluating customizable ball attachments demonstrated favorable stress distribution and adequate retentive characteristics, supporting their clinical application as a conservative attachment system. However, periodic replacement of retentive components and routine maintenance were commonly reported as part of long-term overdenture care.

Overall, the available evidence suggests that customizable ball attachments provide a cost-effective, conservative, and clinically effective method of improving the retention, stability, function, and patient satisfaction of tooth-supported overdentures while preserving the supporting oral structures. However, the available literature remains limited by variations in study methodology, sample size, and follow-up duration, indicating the need for further well-designed randomized controlled clinical trials to strengthen the existing evidence.

IV. DISCUSSION

Author & Year	Objective / Aim	Study Design & Methodology	Key Findings / Results	Conclusion / Clinical Relevance
Dable RA (2013)	To evaluate preservation of mandibular canines as abutments for overdentures using custom post-and-ball attachments, with emphasis on retention, stability, and alveolar bone preservation.	Clinical case report where mandibular canines were endodontically treated. Custom cast post-and-ball attachments were fabricated in metal and positioned with accuracy and parallelism. The overdenture incorporated O-ring housings. Clinical outcomes were monitored after insertion.	The overdenture showed marked improvements in retention, stability, and masticatory efficiency compared with conventional dentures. The patient reported better speech, confidence, and reduced mucosal trauma. Bone resorption appeared reduced due to tooth preservation.	Tooth-supported overdentures with ball attachments provide a conservative, cost-effective option that maintains abutment teeth and bone while improving function and patient satisfaction.
Bansal S (2013)	To present an economical and accessible method for improving overdenture	Mandibular canines were RCT treated and reduced. Custom attachments were fabricated using orthodontic	The overdenture showed improved stability, retention, and comfort. The	Provides an accessible alternative to commercial attachments and

	retention using custom-made attachments in patients with limited financial resources.	separators as the female component and simple metal units as the male part.	fabrication method required minimal lab support.	demonstrates feasibility using basic clinic materials.
Nassar HI (2016)	To compare outcomes between conventional dentures and overdentures retained with ball attachments in terms of retention, comfort, and patient satisfaction.	Prospective clinical trial with 12-month follow-up. Patients were assigned to receive either conventional dentures or overdentures retained by ball attachments. Outcomes included prosthesis retention, chewing efficiency, comfort, and frequency of adjustments.	Overdentures with ball attachments outperformed conventional dentures in retention, chewing efficiency, and overall satisfaction. Patients required fewer adjustments and reported fewer dislodgements. No complications were observed during the study.	Ball-retained overdentures provide superior function and comfort compared with conventional dentures, supporting abutment preservation as a viable alternative to implants.
Sharma HK (2017)	To document rehabilitation of mandibular overdentures using castable ball attachments and assess their clinical outcomes.	Case report where mandibular canines were endodontically treated and custom wax patterns for ball posts were fabricated and cast in metal. The denture incorporated O-ring housings, and clinical evaluation focused on prosthesis stability and esthetics.	The overdenture exhibited improved retention, stability, and esthetics compared with a mucosa-borne prosthesis. The patient reported better mastication, comfort, and speech. Minor maintenance such as O-ring replacement was needed.	Castable ball attachments improve overdenture performance and are a conservative, reliable option for patients unsuitable for implants.
Bajaj G (2018)	To highlight advantages of extra-radicular ball attachments for stability and satisfaction in mandibular overdentures.	Canines and premolars were RCT treated. Extra-radicular ball attachments were cemented and housings placed in the denture.	Excellent retention, chewing comfort, and bone preservation were observed.	Simple, economical, beneficial for elderly and medically compromised patients.
Singh M (2020)	To describe fabrication of semi-precision custom ball attachments using chairside techniques to adapt to patient-specific anatomy.	Case report using pattern resin to design semi-precision attachments. Custom ball posts were fabricated, cast in metal, and incorporated with corresponding housings in the overdenture.	The patient demonstrated improved prosthesis retention, esthetics, and function. Chairside customization provided individualized results adapted to canal morphology.	Semi-precision castable ball attachments provide a reliable, affordable solution when commercial systems are unavailable, particularly in geriatric or resource-limited cases.
Aeran H (2021)	To present a simplified, chairside technique for fabricating cost-effective ball attachments for mandibular overdentures.	Technique article supported by a clinical case. Pattern resin was shaped into ball attachments, cast in metal, and cemented into post spaces. O-rings were integrated into the denture base.	The prosthesis demonstrated high retention, particularly in patients with compromised ridges. Patients reported satisfactory comfort and function. Maintenance was simple and inexpensive.	Simplified castable attachment techniques provide functional outcomes and are especially suitable in rural or economically challenged settings.
Bajaj H (2022)	To demonstrate fabrication of custom semi-precision attachments.	Canines received RCT and reduced; resin patterns cast into precision attachments with denture housings added.	Good retention, comfort, and patient satisfaction noted.	Flexible, affordable technique suitable for clinics without access to prefabricated systems.
Bansal P (2022)	To demonstrate use of orthodontic wire and resin for fabricating custom ball attachments in	Case report. Orthodontic wire and pattern resin were used to create ball attachments, which were then cast in metal and cemented in abutment teeth.	The prosthesis achieved improved retention, comfort, and speech articulation. The patient adapted well and reported satisfaction.	Simple techniques using basic materials can deliver functional overdentures with ball attachments when

	overdentures as a low-cost alternative.	The denture was fabricated with O-ring housings.		prefabricated systems are unavailable.
Potdukhe S (2022)	To compare the clinical performance of various attachment systems for overdentures, including ball, telescopic, and equator systems.	Comparative analysis with clinical examples, including a case using castable ball attachments. Outcomes of retention, maintenance, and patient satisfaction were assessed.	Ball attachments were easier to fabricate, economical, and required minimal maintenance compared with other systems. Patients expressed high satisfaction and function.	Ball attachments are practical and efficient, providing an economical alternative for overdenture retention with reliable long-term outcomes.
Dandekeri S (2022)	To present the use of extra-radicular castable ball attachments in mandibular overdenture rehabilitation.	Case report where pattern resin was used to shape attachments, which were cast and cemented into place. The denture base incorporated O-ring housings.	The overdenture showed enhanced stability, chewing efficiency, and patient comfort. Retention was significantly improved compared with conventional dentures.	Extra-radicular castable ball attachments are a conservative, effective method for overdenture retention, helping preserve ridges and improve function.
Bahri R (2022)	To review workflows, complications, and clinical management in tooth-supported overdentures, with focus on ball attachments.	Narrative clinical review summarizing the use of various attachment types, including ball attachments, and addressing maintenance needs.	Ball attachments consistently improved retention and reduced prosthesis movement. Reported complications included O-ring wear, loosening of housings, and abutment caries, all manageable with routine maintenance.	Ball attachments remain reliable for overdenture retention when combined with regular hygiene and recall protocols, making them adaptable to patient-specific needs.
Maheshwari A (2022)	To re-emphasize the value of tooth-supported overdentures using castable ball attachments in modern prosthodontics.	Case report where mandibular canines were treated with castable ball posts, followed by overdenture fabrication with rubber O-ring housings. Clinical outcomes were monitored post-insertion.	The overdenture improved retention, speech, and confidence. Esthetics and function were well accepted by the patient.	Overdentures with custom ball attachments remain valuable in contemporary practice, especially for medically or financially challenged patients.
Kundu S (2022)	To describe step-by-step management of mandibular overdentures with castable ball attachments for improved retention.	Clinical report. Mandibular canines were prepared and fitted with cast metal ball posts adapted to canal morphology. O-ring housings were placed in the denture.	The prosthesis demonstrated excellent functional adaptation, chewing efficiency, and patient satisfaction. Proper alignment ensured stability.	Customizable ball attachments are predictable, cost-effective, and provide long-term rehabilitation when carefully fabricated.
Leong JZ (2022)	To review rationale, biomechanics, and long-term outcomes of tooth-supported overdentures with ball attachments.	Narrative review of clinical literature on tooth-supported overdentures, with focus on ball attachment benefits and complications.	Ball attachments improved retention, preserved alveolar bone, and enhanced patient comfort and proprioception. Complications were manageable with maintenance.	Ball-retained overdentures remain clinically relevant, especially for elderly or medically compromised patients, offering a conservative alternative to implants.

V. CONCLUSION

Within the limitations of this systematic review, the available evidence suggests that customizable ball

attachments are an effective treatment option for tooth-supported overdentures. They provide improved retention, stability, masticatory efficiency, and patient satisfaction compared with conventional complete

dentures, while preserving residual alveolar bone and periodontal proprioception through the retention of natural tooth abutments.

Customizable ball attachments offer a conservative, minimally invasive, and cost-effective alternative to commercially available attachment systems, making them particularly beneficial for patients in whom implant therapy is contraindicated or financially unaffordable. Their ease of fabrication, satisfactory clinical performance, and affordability make them a practical option in routine prosthodontic practice.

However, long-term success depends on careful case selection, proper endodontic and periodontal management of abutment teeth, meticulous oral hygiene, and regular maintenance. Although the current evidence is encouraging, further well-designed randomized controlled clinical trials with larger sample sizes and longer follow-up periods are required to establish stronger evidence regarding the long-term clinical performance and durability of customizable ball attachments.

Overall, customizable ball attachments represent a predictable and biologically sound approach to tooth-supported overdenture rehabilitation, combining the principles of preventive prosthodontics with improved functional and patient-centered outcomes.

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