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Review Article

An overview of implant overdenture attachment systems

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ABSTRACT

Implant-retained overdentures have revolutionized dental prosthetics, addressing the limitations of traditional removable dentures. These overdentures rely on attachment systems to anchor them to dental implants or abutments, improving stability, retention, and functionality. Common attachment systems include locator attachments, bar attachments, magnets, Hader clips, ERA attachments, telescopic crowns, and OT equator attachments. Each offers unique benefits and retention levels. Implant survival rates are influenced by various factors, including attachment type, but overall, attachment choice may not be the primary determinant of implant success. Attachment systems that evenly distribute forces, like bar attachments, contribute to implant stability. Marginal bone loss can affect implant stability and is influenced by attachment systems. Precision attachments, such as telescopic crowns, have shown reduced marginal bone loss in practice. Soft tissue complications, including inflammation and mucositis, vary by attachment but can be managed with proper oral hygiene. Retention, crucial for function, varies with attachment type and implant number. More implants generally improve retention, although it may decrease over time. Bar attachments typically provide superior retention. Maintenance is essential, with some debate over whether bar or stud designs entail more upkeep. Patient satisfaction is high with both bar and ball attachments, while magnets may pose retention issues. The choice of attachment depends on patient needs and clinical factors, with regular follow-up and maintenance essential for long-term success.

Keywords: Implant-retained overdentures, Attachment systems, Implant survival, Retention, Stress distribution, Complications, Patient satisfaction

INTRODUCTION

While partly edentate individuals have greatly benefited from dental implants, the most significant advancements in therapy have been seen for totally edentulous individuals with atrophy of mandibles and/or maxillae. When denture retention is exceedingly challenging or unattainable, placing two or more implants to provide retention and support to an overdenture offers superior results in terms of patient satisfaction and function. The McGill consensus dictates that patients with complete edentulism should not receive prosthetic rehabilitation with a conventional denture. Instead, the option to be considered initially should be the insertion of two implants and the administration of an implant-retained overdenture.[1,2] In individuals who are fully edentate, implants and attachments can be used to make overdentures more stable and retentive. To deliver a retentive force to implant-supported overdentures, several different types of attachments have been introduced. Various manufacturing firms all over the world offer a wide variety of attachments. These attachments are primarily categorized into splinted anchorage systems, like the bar type, and un-splinted anchorage systems, like the ball type.[3] The most often used attachment systems include the bar, ball, magnet, and several individual mechanical attachments that resemble the ball type in terms of dimensions and functionality.[4] Un-splinted anchorage attachments have been adopted in many overdentures because not only do they require less space within the prosthesis, but they are also easy to clean, economical, and less technique sensitive. The numerous attachments can be bewildering for a dentist who is not experienced in the field. This issue is made worse by the fact that, rather than being based on information and scientific results, the decision of which attachment to utilize is primarily based on the practitioner's clinical experience and personal preference.

The purpose of this article is to provide an overview of the different attachments used routinely in implant-retained overdentures and address their effect on treatment outcomes such as implant survival rate, marginal bone loss, soft tissue complications, retention, stress distribution, space requirements, maintenance complications, and patient satisfaction.

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on October 1, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed implant overdenture attachment systems. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

The development of implant-retained overdentures has revolutionized the field of prosthodontics by addressing some of the shortcomings associated with traditional removable dentures. The attachment system, a critical element of implant-retained overdentures, plays a pivotal role in anchoring the overdenture to dental implants or abutments, thereby enhancing stability, retention, and functional performance.[5] They are integral to the success of implant-retained overdentures as they offer numerous advantages, including enhanced prosthesis stability, improved retention, and optimized chewing efficiency.[6] Furthermore, attachment systems mitigate issues commonly associated with conventional removable dentures, such as slippage, discomfort, and reduced masticatory function. These systems encompass a diverse array of mechanisms designed to secure the overdenture to dental implants or abutments. Common attachment systems include locator attachments (ball and socket attachments), bar attachments (bar overdentures), magnets, Hader clips, ball and bar attachments (era attachments), and telescopic crowns (Telescopic attachments).[7]

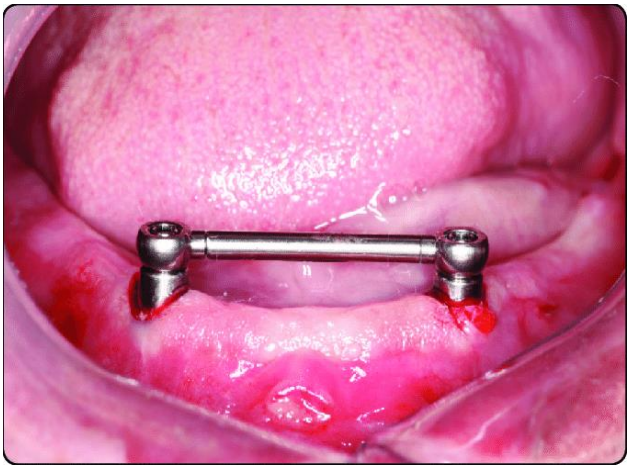

Figure 1: Mandibular overdenture retained to the implants with prefabricated (SFI bar) bar attachment.[8]

Locator attachments are a versatile attachment system consisting of two components: a male attachment (the "ball") affixed to the implant and a female attachment (the "socket") embedded in the overdenture.[9] This ball and socket mechanism allows for rotational movement, improving the stability of the overdenture while providing some degree of flexibility. Locator attachments are available at various retention levels, allowing customization to meet the specific needs of each patient. Their durability and ease of maintenance make them a popular choice among both clinicians and patients. Bar attachments represent a robust attachment system

commonly used when multiple dental implants are positioned in a straight line along the dental arch.[4] They involve a metal bar securely attached to dental implants. The overdenture is then affixed to the bar using clips, magnets, or other retention mechanisms. This system offers the advantage of distributing occlusal forces evenly across the implants, resulting in excellent stability and support for the overdenture.

Figure 2: Ball attachment cylinders.[10]

Magnetic attachment systems rely on the force of magnets to connect the implant and the overdenture.[11] This magnetic force provides secure retention and allows the overdenture to easily "snap" into place. Magnets are particularly patient-friendly, as they are relatively easy for individuals to use and maintain. This makes them a suitable option, especially for patients with dexterity issues. Hader clips are a straightforward attachment system employing a clip mechanism to secure the overdenture to the implants.[12] They are recognized for their durability and longevity. However, it's important to note that Hader clips may require periodic maintenance to ensure their continued effectiveness. This attachment system is often chosen for its cost-effectiveness. ERA attachments combine the features of both ball attachments and bar attachments, offering stability, even force distribution, and some degree of movement for the overdenture. They are particularly valuable in cases where patients require enhanced retention and stability. ERA attachments provide a balanced combination of attributes from both attachment types, contributing to their versatility in implant-retained overdenture treatments.[13] Telescopic crowns consist of two integral components: an inner crown affixed to the implant and an outer crown integrated into the overdenture.[14] These crowns slide together to form a secure and stable attachment system with minimal lateral movement. Telescopic crowns are often selected for their aesthetic appeal and functional benefits, particularly in cases where esthetics are of primary concern. OT Equator attachments represent a low-profile, resilient solution for implant-retained overdentures.[15] They are meticulously designed to minimize the vertical space required for attachment systems, making them suitable for cases with limited interarch space. OT Equator attachments are valued for their ability to offer stability while maintaining a discreet appearance, addressing both functional and aesthetic considerations.

Figure 3: Inner telescopic crowns in a mandibular overdenture with telescopic attachment system.[16]

The implant survival rate is a pivotal consideration when evaluating attachment systems for implant-retained overdentures. Implant survival is influenced by various factors, including osseointegration, implant design, position, and patient-specific aspects such as bone quality, quantity, and arch shape.[17] Remarkably, several attachment systems have shown high implant survival rates when meticulously planned and executed. Attachment systems that effectively distribute forces evenly across implants, such as bar attachments, have demonstrated the potential to enhance implant survival, contributing to the long-term success of overdenture treatment. Studies have explored the impact of different attachment systems on the survival rates of dental implants used for overdentures.[18-20] While some variation was observed, overall findings suggest that the choice of attachment system may not be the primary determinant of implant success. Additionally, studies have shown that rigid implant splinting, as seen in bar systems, can contribute to favourable outcomes.

Further, marginal bone loss around dental implants can have an impact on the stability of implants and, consequently, the longevity of overdentures.

Attachment systems that minimize micromovement and reduce stress at the implant-bone interface tend to result in less marginal bone loss. For instance, precision attachments like telescopic crowns, with their stable fit and minimal micromovement, have been associated with reduced marginal bone loss in clinical practice. However, some long-term prospective studies have shown that

different anchorage systems used for two-implant-retained overdentures do not significantly impact implant survival, the health of surrounding tissues, or marginal bone loss.[20-22] Initial marginal bone loss of approximately 0.3 mm stabilizes after the first year. It is suggested that the direction of occlusal forces is more influential than the implant connection type, with minimal variations in stress concentration.[23] Concerns regarding bone loss around maxillary implants with O-ring attachments have yielded mixed results and do not predict implant failure.[24] Although mean bone loss may be slightly higher with ball attachments, this discrepancy may be attributed to loading patterns and bone conditions.[25] Improved functionality leads to increased bone mineral content, irrespective of attachment systems. Pantographic imaging reveals some variability in bone loss but no clear link to attachment systems.[26]

Moreover, soft tissue complications, encompassing issues like inflammation and irritation around implant sites, are vital considerations. Numerous studies have investigated how different attachment systems affect soft tissues in implant-retained overdentures. They observed hyperplasia and mucositis around implants, often due to reduced saliva access beneath the denture.[18] Plaque buildup was higher with magnets compared to ball attachments, with no significant differences in other parameters.[24] Over time, Periotest values decreased, indicating greater bone-implant interface stability.[27] However, there was no clear link between bleeding on probing and marginal bone loss. Attachment design (ball or bar) had minimal impact on peri-implant conditions. Ovoid bars with resilient joints caused slight issues, but these were resolved through better oral hygiene and adjustments.[28] Implant-supported overdentures can maintain healthy soft tissues regardless of attachment type, although magnet attachments may accumulate more plaque. Overall, attachment systems with smooth contours, minimal protrusions, and biocompatible materials tend to lead to fewer soft tissue complications. Ensuring proper oral hygiene and regular maintenance is essential to mitigate the risk of these complications and maintain patient comfort and health.

Furthermore, retention, is crucial for comfortable function, because of the attachment system's ability to securely hold the overdenture in place. Various attachment systems offer differing levels of retention, which significantly impact a patient's ability to chew and speak comfortably. The number of implants impacts attachment performance.[17] More implants can lead to alignment complexities, potentially requiring angulated abutments or complex designs. Fewer implants place greater stress on attachments, particularly on soft tissue support. Increasing implant numbers generally improves retention and reduces retention-release issues during use. However, retention often decreases over time, especially with highly retentive designs, although some studies challenge this trend. Bars tend to provide superior retention and distribute forces more favorably, suitable for challenging anatomical situations.[29-31] Most attachment systems offer around 20 N of retentive force, typically sufficient for mandibular overdentures.[32] Magnets, while less retentive, suit specific cases like bruxism or dexterity challenges. Clinical conditions involve complex multidimensional loads, impacting attachment performance.[30] Attachments may experience reduced retention over time, possibly due to occlusal forces. Attachment choice and retention maintenance are pivotal for the long-term success of implant-retained overdentures.

The even distribution of forces on implants and surrounding structures is also paramount to preventing implant failure and complications. Attachment systems that evenly distribute forces, such as bar attachments, help reduce stress on individual implants. Properly designed attachment systems play a vital role in minimizing stress concentration ensuring the longevity of the implants and the health of the supporting tissues. Studying stress distribution in implant-retained overdentures is a complex yet crucial aspect. Photo-elastic research has revealed that stress patterns and intensity are influenced by implant length, shape, and diameter.[33] To make valid comparisons between retention mechanisms, it is essential to maintain consistent implant parameters. When subjected to vertical forces, ball/O-ring attachments seem to transmit minimal stress to implants, while bar/clips create more significant and concentrated stress patterns.[17] Both in vivo and in vitro investigations indicate that ball attachments offer stability with even load distribution on residual ridges.[6,34] Several factors, including alloy choice, bar design, and material properties, impact stress distribution. Rigid designs and cantilever bars tend to increase the transfer of forces to implants. Finding a balance between implant and mucosal load is vital for optimizing overdenture design.

In cases where vertical space within the oral cavity is limited, choosing attachment systems with lower profiles becomes crucial. When constructing overdentures, having adequate space for attachments is crucial. Insufficient room can lead to aesthetic, resin, and technical issues.[35] Horizontal space is vital for structural integrity, especially with complex mechanisms like Hader bar clips, which require about 10-12 mm between implants.[36] For limited alveolar bone, custom milled bars with additional Ceka or ERA attachments may be needed. Vertically, maintaining a minimum 12 mm distance from the implant platform to the incisor edges is crucial. Challenges often arise with bars due to their complexity compared to simpler options like balls or magnets. Recommended bar lengths are 12-16 mm if two small vertical O-ring attachments are placed, and a span length of ≤18 mm with a 2-mm vertical stiffener height in the case of Hader bars.[37] Limit cantilevered segments to 10-12 mm to minimize failure risk. Longer cantilevers can increase stress by 111%. Stick to 10-12 mm cantilever lengths and a 3 mm stiffener height if space allows.[38] Low-profile attachments, like OT Equator attachments, are often preferred for their ability to construct overdentures

without excessive bulk, accommodating restricted interarch space while maintaining functionality.

Maintenance complications can arise from the wear and tear of attachment components over time. Maintenance of implant-retained overdentures is essential for their long-term success, with the initial year typically requiring the most upkeep, often linked to attachment modifications or repairs.[39] There is ongoing debate about whether bar or stud designs entail more maintenance. Common issues include attachment loosening, clip or attachment breakage, corrosion in magnetic systems, and frequent appointments for adjustments.[31] Proper spacing between abutments, implant alignment, and clip activation are important factors affecting maintenance. Some studies suggest that bar designs may have higher maintenance rates, but outcomes vary, and hygiene practices significantly impact peri-implant health.[40,41] Simpler attachment systems like Hader clips may have fewer components to maintain but may necessitate periodic adjustments or replacement of clips to ensure continued functionality.

Patient satisfaction, influenced by comfort, aesthetics, stability, and function, is paramount. Patients prioritize comfort, a natural appearance, and the ability to eat and speak without difficulty. Attachment systems that offer stability, aesthetics, ease of use, and minimal maintenance tend to contribute significantly to higher patient satisfaction, ultimately enhancing the overall quality of life for individuals with implant-retained overdentures. Patient satisfaction with implant-retained overdentures is similar whether using ball or bar/clip attachment systems, as indicated by clinical studies.[42] The initial year following implant placement is the most critical period for complications, but issues related to speech and function tend to decrease over time, enhancing overall patient comfort.[43] Patients who have upper complete dentures and opposing mandibular implant overdentures may encounter challenges in controlling their upper dentures.[44] Spark erosion technique frameworks have shown promising outcomes with minimal complications.[45] In contrast, magnet-retained overdentures often lead to retention issues and prosthetic problems, resulting in patient dissatisfaction. In summary, both bar and ball attachment methods generally yield higher patient satisfaction compared to magnets.[46]

Selecting the most suitable attachment system for implant-retained overdentures necessitates a comprehensive evaluation of patient-specific needs, clinical factors, and treatment objectives. Collaboration between dental professionals and patients is pivotal for making informed decisions that promote long-term success and patient contentment. Furthermore, consistent follow-up appointments and diligent maintenance are critical to preserving the attachment system's effectiveness and the health of the implants and supporting tissues.

CONCLUSION

Attachment systems play a crucial role in the success of implant-retained overdentures. While various attachment options are available, each has its advantages and considerations. Locator attachments, bar attachments, magnets, Hader clips, ball and bar attachments, telescopic crowns, and OT equator attachments offer unique benefits and should be selected based on individual patient needs and clinical circumstances. Implant survival, marginal bone loss, soft tissue health, retention, stress distribution, space requirements, maintenance, and patient satisfaction are all influenced by the choice of attachment system. Proper assessment, planning, and maintenance are essential for achieving optimal outcomes in implant-retained overdenture treatments.

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