

# Prosthetic Treatment Modalities on Zygomatic Implants: A Review

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## ABSTRACT

Severely atrophic maxilla, often accompanied by sinus pneum, poses significant challenges in dental implant treatment. This condition is characterized by a substantial reduction in bone volume and can complicate implant placement and prosthetic rehabilitation. For resorbed maxilla with sinus pneumatization and in partially or completely resected maxilla, zygomatic implants have come up as a predictable treatment modality, thus reducing the risk of complex surgical procedures/grafting procedures. There are different prosthetic options available for rehabilitation similar to conventional implants. This article aims to review the available prosthetic options and their outcomes of prostheses supported by zygomatic implants.

**Keywords:** Bar, Hybrid denture, Locator, Overdenture, Telescopic attachments, Zygomatic implant.

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## INTRODUCTION

Zygomatic implants have gained prominence in the field of dental implantology as an effective and immediate solution for severe maxillary atrophy. To address this condition and consider the local anatomy of the maxilla and sinus cavity dimensions, various approaches have been recommended.<sup>1</sup> It is an effective treatment modality for both the dentate and edentate patients. These implants offer a valuable treatment option for patients facing challenges such as severe bone resorption and oncological resective surgery. Their versatility is evident as they find application in diverse scenarios, ranging from trauma, cleft palate, mucormycosis, and oral cancer rehabilitation, and serving as an alternative to augmentation in the atrophic maxilla.<sup>2</sup> Different placement techniques, such as quad zygoma, bilateral one implant each on the zygomatic arch, unilateral one or two implants, and in combination with conventional dental implants, allow for customized treatment for individual patients. Aparicio C. introduced the zygoma anatomy-guided approach (ZAGA) as a pioneering protocol for placing zygomatic implants while considering each patient's unique anatomy in a prosthetically driven manner. Zygoma anatomy-guided approach addresses the limitations of the original technique and extra-sinus approaches. The ZAGA classification system (ZAGA 0 to IV) helps dentists comprehend anatomical variations between patients and within the same patient. It defines different implant paths based on the association of zygomatic buttress-alveolar crest regions. Zygoma anatomy-guided approach groups 0–4 are characterized by varying degrees of anterior maxillary wall concavity and implant paths that come in contact with bone at the lateral sinus wall, alveolar crest, and zygomatic bone. Zygoma anatomy-guided approach group 4 implants are specifically designed for patients with extreme vertical and horizontal atrophy in the maxilla and alveolar bone. By tailoring the implant approach to individual patients, ZAGA offers a sophisticated solution for successful zygomatic implant placement.<sup>3</sup>

Zygomatic implant positioning effectively bypasses the need for maxillary sinus lifts and onlay block grafting, which are often required in cases of severely atrophic maxilla reconstruction. Zygomatic implant surgery is associated with fewer symptoms

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and morbidity compared to grafting options. As a result, the use of zygomatic implants offers shorter overall treatment duration thus improving the patient's quality of life. The trabecular and cortical components of the zygomatic bone provide ideal anchorage points for zygomatic implants, further reinforcing their efficacy in addressing severe maxillary atrophy.<sup>4</sup>

Retention and stability are the main concerns with prosthetic rehabilitation. Such can be achieved with the help of different attachment systems such as ball, bar, and locator-retained dentures. The choice of a particular attachment for implant-supported prosthetics is influenced by several factors. These factors include the required level of retention, the anatomical characteristics of the ridge, the patient's preferences, cost considerations, and the manner in which forces are transmitted to the implants.<sup>5</sup> This review article aims to explore and analyze various prosthetic treatment modalities associated with zygomatic implants.

## Hader Bar, Dolder Bar and Milled Bar-retained Denture

Hader and Dolder bars are the different types of extracoronal attachments commonly used for the fabrication of overdentures. The success of rehabilitation with different attachment systems depends on prosthesis movement during function or parafunction. Prosthesis movement may range from PM 0 to 6 according to the different directions of motion. The Dolder bar features an

egg-shaped cross-section, while the Hader bar takes on a round shape. In the case of the Dolder bar, a clip attachment has the ability to rotate directly on the bar. A distinguishing characteristic of the Hader bar is its enhanced flexibility, owing to the fact that round bars exhibit a flexing behavior proportional to the fourth power of the distance, unlike other bar shapes that flex to the third power. To counter potential issues arising from metal flexure and its impact on retention and structural integrity, an apron is commonly integrated onto the tissue side of the Hader bar. This serves a dual purpose—increasing the system's overall strength compared to a round bar design and simultaneously restricting the amplitude of clip and prosthesis rotation around the fulcrum, limiting it to 20 degrees. This controlled rotation fundamentally transforms the assembly into a more rigid configuration. Consequently, when favorable posterior ridge shapes and sufficiently firm soft tissue to curtail prosthesis rotation are present, the Hader bar and clip system is well-suited. It's crucial to emphasize that the hinge attachment must be perfectly perpendicular to the prosthesis rotation axis for efficient system functionality. This alignment results in a two-plane PM arrangement (PM-2). Conversely, if either the Hader or Dolder bar assumes an angle or parallels the desired rotation direction, the prosthesis becomes stiffer, resembling a PM-0 system, this can often lead to overloading of the implant system, leading to complications such as screw loosening, crestal bone loss, and even implant failure. Particularly fitting for an RP-4 prosthesis with PM-0, the Hader bar-clip system serves as an ideal low-profile attachment. These clips are typically distributed across the bar in various planes around the arch to ensure optimal performance.<sup>6</sup>

Further studies by Kim Jeong M et al. reported that a Hader bar with a clip has a higher stress distribution when compared to the Milled bar with a locator in cases of completely edentulous patients with palatal coverage. In severely atrophic maxilla or mucormycosis where there is palatal communication Hader bar with a clip will be superior with quad zygoma placement and complete palate coverage when compared to the Dolder bar or Milled bar with locator.<sup>7</sup>

Studies by ELSyad et al. also recommended the Hader bar attachment is a choice for retaining maxillary implant overdentures due to its superior performance in both axial and nonaxial retention compared to Dolder and Milled bar attachments. This advantage was observed after 6 months of simulated denture use, making the Hader bar attachment a favorable option for enhancing the stability and retention of maxillary implant overdentures.<sup>5</sup> Different studies also reported that there is less stress concentration with the bar attachment system.

### Locator-retained Overdenture

Implant overdentures (IOD) have gained popularity for edentulous patients, offering several clinical advantages. Despite severe jaw bone resorption and multiple systemic medical conditions in elderly patients, two-IOD treatment using Locator attachments proved to be minimally invasive and a viable option for restoration. Locator attachments are the most common attachments for a PM 6 which has a range of prosthesis movement in all directions.<sup>6</sup> In the past, ball anchors were commonly used but they required significant space in the denture, potentially causing complications. On the other hand, Locator attachments offered several benefits, such as a lower profile, resilience, self-alignment, and dual retention.<sup>8</sup>

Finite element studies revealed that that stress levels within the adjacent bone tissues are significantly elevated in the case of four-implant maxillary overdentures utilizing a solitary attachment

system, in comparison to those employing a bar system.<sup>9</sup> Studies, by ELSyad et al. suggest Locator attachments are advisable over Dolder bar attachments for retaining maxillary overdentures from the fact that locator attachments demonstrated superior retention and stability, even following wear simulation, and exhibited minimal retention loss compared to Dolder bar attachments.<sup>10</sup> Further studies demonstrated that marginal bone loss for the bar attachments was within the acceptable range while that for the locator attachments marginal bone loss was significantly higher.<sup>11</sup>

Studies by Onclin P et al. on locator-retained overdentures in the atrophic maxilla revealed a relatively higher risk of implant loss due to osseointegration issues. Potential causes included implant overload and low bone volumes but strategies such as palatal coverage and resilient implant-to-overdenture connections were suggested to counteract possible overload. This study infers that individuals with substantial maxillary bone resorption who are averse to undergoing reconstructive surgery can experience improved masticatory functionality and denture satisfaction through the utilization of two-implant maxillary overdentures retained by solitary attachments. However, this approach is associated with a relatively elevated risk of implant loss.<sup>12</sup>

In the severely atrophic maxilla, mucormycosis, respective surgery or in cases where there are palatal communication locator attachments is not a viable treatment option as compared to other another attachment system because of the high risk of implant failure.

### Telescopic-bar-retained Overdenture

A telescopic denture, sometimes referred to as an overdenture, is a removable dental prosthesis that provides coverage and support by resting on natural teeth, roots, or dental implants. This design involves a primary coping that is affixed to abutments in the mouth and a secondary coping attached to the removable prosthesis itself. This dual-coping structure enhances the prosthesis's stability and retention.

Telescopic denture is a preferred treatment approach over the traditional complete denture. Unlike conventional complete denture, telescopic denture offers solution such as decreasing the rate of residual ridge resorption, compromised stability and retention, diminished periodontal proprioception, and reduced masticatory efficiency. Additionally, they offer the advantage of minimal tissue coverage and more even force distribution, contributing to an improved overall dental experience for patients.<sup>13</sup> Research has shown that telescopic attachments emerge as a favorable choice for maxillary implant overdentures due to their enhancement in masticatory efficiency and maximum bite force compared to Locator attachments and increased stability when compared to Milled bar attachments.<sup>14,15</sup>

### Hybrid Denture and Malo Bridge

Hybrid dentures are acrylic complete dentures that are securely affixed to a bar substructure, which in turn is anchored to dental implants replacing missing teeth and lost soft tissues.<sup>16</sup> Malo bridge, distinguishes itself by employing individual crowns, allowing for the removal and repair of specific components without affecting the entire fixed bridge. This approach not only offers a remarkably natural appearance but also keeps long-term maintenance costs low, making it one of the most favored methods. Its time-saving potential for future corrections is another significant advantage. Utilizing advanced three-dimensional (3D)-printed computer-aided design and computer-aided manufacturing technology not only

ensures a perfect fit but also enhances the overall esthetic appeal of the prosthesis.<sup>17</sup>

Different prosthetic material plays a pivotal role in ensuring the longevity and success of prosthesis. Among the array of options, the cobalt-chromium (Co-Cr) alloy emerges as a prominent choice, because of its remarkable strength and cost-effectiveness when compared to the alternatives, particularly titanium. Titanium, on the other hand, presents a distinct advantage in its lightweight nature because of its low density, alleviating implant load and reducing the potential for complications. Top of form epithelial cells and fibroblasts have exhibited a distinct affinity for titanium over cobalt-chromium (Co-Cr) alloy, as indicated by recent research. This preference has notable implications, particularly in the context of achieving an enhanced epithelial seal surrounding the emergence profile of implants. Such an improved seal serves as a proactive barrier, effectively reducing the potential for microleakage, which can be a concern with Co-Cr alloy. Moreover, this cellular preference for titanium contributes to the prevention of galvanic corrosion, a phenomenon that can undermine the longevity of implants.<sup>18</sup> Some studies suggest PEEK as the viable solution for the effective rehabilitation of patients with atrophic maxilla using the "All on four" concept marked by favorable clinical and radiographic outcomes within a span of 1 year.<sup>19</sup> When compared to titanium and cobalt-chromium PEEK has the advantages of reducing the bone strain around implants and minimizing stress concentration within bar structures but there are certain disadvantages of potential fractures and prosthetic screw loosening.<sup>20</sup> While other studies suggest a Malo bridge with titanium framework is a valuable treatment option for completely edentulous patients.<sup>18</sup>

Studies by Soni R et al. revealed that patients with the "All on four" concept have higher biting force and chewing efficacy when compared to the conventional complete denture and implant-supported overdenture.<sup>21</sup>

## DISCUSSION

In dentate and edentate patients with sufficient bone volume restoring masticatory function with dental implants is typically a reliable and successful approach, yielding acceptable long-term outcomes. However, when it comes to patients with severely resorbed maxilla, the rehabilitation process using traditional endosseous implants becomes notably challenging. This challenge arises from both mechanical limitations and anatomical complexities inherent to the severely resorbed maxillary bone. For severely atrophic maxilla often accompanied by sinus pneumatization and in partial or complete maxillectomy zygomatic implant is a viable treatment modality. Unlike conventional dental implants which are anchored to the jaw bone, zygomatic implants are anchored to the zygomatic bone increasing stability and retention and thus eliminating the need for major surgical and grafting procedures.<sup>22</sup>

The different prosthetic treatment modalities on zygomatic implants are available such as bar-retained overdenture, locator-retained overdenture, telescopic denture, and hybrid denture. Kim M and Hong S conducted a study and revealed that the Hader bar attachment system with complete palatal coverage in maxillary implant-retained overdentures appeared to be advantageous for distributing stresses applied to the supporting bone around the implants when compared to the Milled bar attachment system with complete palate coverage.<sup>7</sup> Further studies by ELSyad et al. obtained similar results that the Hader bar is superior over the Dolder bar in retaining maxillary overdentures.<sup>5</sup>

In the debate over the choice between locator attachments and Dolder bar attachments for retaining maxillary overdentures, recent research points to some compelling reasons to favor the use of locator attachments. One notable advantage is the superior retention and stability demonstrated by Locator attachments, even after subjecting them to wear simulation tests. Moreover, they exhibit minimal retention loss compared to Dolder bar attachments, making them a more reliable choice for long-term denture retention and patient satisfaction.<sup>10</sup>

However, it's essential to consider the broader context. Studies, such as those conducted by Onclin P et al. have raised concerns about the use of locator attachments in atrophic maxillary cases. These studies have highlighted a relatively higher risk of implant loss due to osseointegration issues in these situations. Contributing factors include potential implant overload and low bone volumes in the atrophic maxilla.<sup>12</sup>

In the context of severely atrophic maxilla, situations involving mucormycosis, or cases with palatal communication, the choice of attachment systems for implant-supported prostheses becomes critical. Locator attachments may pose a higher risk of implant failure in these challenging conditions. Conversely, the Hader bar with clips, especially when combined with quad zygoma placement and complete palate coverage, appears to offer superior outcomes compared to alternatives like Dolder or Milled bars with locator attachments. This preference is likely attributed to the enhanced stability, stress distribution, and retention provided by the Hader bar system, making it a more suitable choice for complex maxillary cases or when dealing with the unique challenges presented by mucormycosis and palatal communication.

Additionally, the research indicates that telescopic attachments lead to higher maximum bite forces when compared to locator attachments thus improving the patient's quality of life. This finding underscores the importance of stability and force distribution in the success of implant-supported prostheses.<sup>14</sup> Furthermore, when comparing telescopic attachments to Milled bar attachments, the former exhibit increased stability which is a critical factor in the long-term success of implant overdentures.<sup>15</sup> Furthermore, investigations conducted by Soni R et al. have demonstrated that patients who undergo the "All on four" concept experience notable improvements in biting force and chewing effectiveness compared to those with implant-supported overdentures.<sup>21</sup>

## CONCLUSION

In conclusion, the landscape of implant dentistry is continually evolving, offering a range of innovative solutions to address the unique challenges faced by patients with severe maxillary atrophy and edentulism. Zygomatic implants have emerged as a valuable option, providing stability and eliminating the need for complex grafting procedures. Prosthetic choices, such as the Hader bar attachment system with complete palatal coverage, contribute to enhanced stress distribution and patient satisfaction. The ongoing debate between locator and Dolder bar attachments highlights the importance of careful consideration in selecting the most suitable option for individual cases. Furthermore, the promising outcomes associated with telescopic attachments and the "All on four" concept underscore the potential for improved bite forces and overall quality of life. Ultimately, a patient-centered approach that takes into account various factors, including bone volume and attachment systems, is paramount in achieving successful outcomes in the dynamic field of implant dentistry.

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