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Implant-Supported Prostheses: A Comprehensive Solution for Edentulous Patients – Advantages, Disadvantages, and Clinical Considerations

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ABSTRACT

Edentulous patients have decreased in the masticatory function, loss in vertical dimension, speech impairment and poor esthetics due to loss in facial musculature support. The traditional way for treating edentulous patients is a complete removable denture. However, the progressive tissue changes occur due to wearing the denture should be compensated by adjusting it.Patients with severely resorbed alveolar ridge always having problems with their conventional dentures because of a reduced load bearing capacity, poor in there masticatory action, impairment of the motor control of the tongue, bite force decrease and weakened oral sensory function.In completely edentulous patients the implant supported overdentures is a common treatment plane which could improve oral function and comfort for edentulous patients.Implant supported overdenture improve stability, retention and offers considerable functional and psychosocial advantage compared with conventional one.Maxillary implant-supported overdenture treatment therapy has an advantage of placing implants in the anterior region, because of less morbidity and treatment time, whenever presence of a sufficient bone in the anterior area and sufficient space to cover an attachment system, the overdenture is available. Clinical investigations and implant load analyses encourage the treatment of full-arch fixed prostheses (FFP) by using only four implants rather than five or six implants.(101) However, higher stress concentrations were noted in prosthesis with cantilever extensions on the distal implants adjacent to cantilevers also the masticatory forces distribution appears to be non-uniform.Immediate rehabilitation of both mandible and maxilla by the immediately loaded FFP can be considered a successful treatment option.

Keywords

ed*entulous, masticatory, resorbed alveolar ridge, retention*

1. Introduction

Edentulous patients suffer from limited masticatory function, loss of vertical dimension, speech impairment, and poor aesthetics due to loss of facial muscle support. 1 The traditional treatment for edentulous patients is removable complete dentures. However, the progressive tissue changes that occur when wearing the prosthesis must be compensated by adjustments. 2

Such prostheses, especially mandibular prostheses, often suffer from reduced stability and retention, which are affected by the shape of the alveolar ridge. 3 Over time, alveolar bone loss leads to poor fit of stable prostheses. More than 50% of mandibular complete dentures have stability and retention problems. 4

Patients with severe alveolar ridge resorption always have problems wearing traditional dentures due to reduced load-bearing capacity, poor chewing function, impaired tongue movement control, reduced bite force, and reduced oral sensation. 5

These factors can lead to many problems, such as pain when eating, related to the movement of the prosthesis when eating, laughing or talking, and concerns about the negative image of the prosthesis in social situations. Denture movement can also make chewing difficult, especially in social situations, leading people to avoid chewing altogether. 6 For fully edentulous patients, implant-supported overdentures are a common treatment method that can improve oral function and comfort in edentulous patients. 7

However, implant survival depends on multiple factors, such as bone quantity and quality, number, length and diameter of implants, primary stability, distribution of implants in the dental arch, implant surface and geometry, loading regimen, oral hygiene compliance, prosthesis design and occlusal concept.8

The 2002 McGill Clinic Consensus Statement 9 states that mandibular restorations with two implants are the minimum treatment for edentulous patients, but technical and biological complications may occur. 10

Advantages of implant-supported prostheses

Implant-supported prostheses provide improved stability and support compared to conventional prostheses and offer significant functional and psychosocial benefits. 3

Implants influence oral motor function and improve occlusal stability and support, which is reflected in bite force and chewing efficiency. Masticatory efficiency is improved by 20% with implant-supported dentures compared to conventional complete dentures. 11

Disadvantages of implant-supported prostheses

The main disadvantage of prostheses is patient preference. Some patients seek fixed prostheses mainly to meet their psychological needs and feel that the prosthesis is part of their body. In addition, the lack of space makes the production of prosthetic systems difficult. 12 Recently, some researchers have reported implant-supported mandibular prostheses that produce anterior occlusal loads on the premaxilla, which may cause premaxillary bone resorption. 12

Bar attachments

The bar is an excellent attachment system that provides more retention. Due to its splinting effect, it can better distribute the forces and correct severe non-parallelism. In addition, the fixing components or clips are replaceable and can be reactivated. 13

When patient satisfaction scores were compared for ball, locator, and bar attachment systems with varying numbers of implants supporting overdentures, implant overdentures supported by four implants and bar attachments were found to have a better “quality of life.” 14 The need for larger inter-arch space is considered the main disadvantage of bar attachments, and there is a risk of gingivitis as there is not enough space under the bar to maintain oral hygiene. 13

Bar Attachments

Bar attachments are categorized into three types: extra-bar, intra-bar, and circum-bar 15. Extra-bar attachments require more inter-arch space compared to intra-bar attachments. A key advantage of extra-bar attachments is their placement on the superior part of the bar, which increases the bulk of metal near the attachment, enhancing the overall strength of the cast bar 16.

In contrast, intra-bar attachments require less inter-arch space and direct masticatory forces closer to the ridge crest, reducing the lever arm effect on the supporting implants. However, their position within the bar may compromise bar strength due to reduced metal bulk around the attachment 16.

Circum-bar attachments, such as Hader clips and Dolder clips, wrap around the bar, allowing rotational movement 16. In a crossover study evaluating patient satisfaction, 18 subjects tested magnetic, bar-clip, and ball attachments

over three months each. The results showed that 10 subjects preferred bar-clip attachments, 7 preferred ball attachments, and only 1 favored magnetic attachments 17.

Milled-Bar Overdentures

Implant-supported milled-bar overdentures offer minimal movement compared to tissue-supported overdentures, limit bone resorption by avoiding mucosal contact, and extend the lifespan of attachments due to reduced usage, thereby decreasing the need for maintenance and prosthetic complications 18. These overdentures are particularly beneficial for patients with large tissue defects, such as those resulting from maxillary tumor removal, as they replace missing tissues and improve oral hygiene 19. Studies by Krenmair et al. 20 report a 99% cumulative survival rate for mandibular milled-bar overdentures and a 97.8% rate for maxillary overdentures after five years, with fewer prosthetic complications and maintenance requirements compared to implant-retained prostheses.

Single attachment systems, such as ball and magnet attachments, may offer better peri-implant hygiene than bar systems 21. However, studies evaluating peri-implant parameters like plaque and bleeding indices have found only moderate benefits with single attachments compared to bar systems 22. A recent study by Eitner et al. 21 suggested that single attachments may promote healthier gingival structures compared to bar systems.

Milled-Bar Design

The stability of milled-bar overdentures is enhanced by cantilever extensions posterior to the implants, which are typically placed in the anterior arch. The cantilever length should not exceed 1.5 times the anteroposterior distance between the anterior and posterior implants 20. Milled-bar overdentures also provide better aesthetic outcomes in cases where hard and soft tissues have been lost 23.

Fabrication Techniques

Milled-bar overdentures can be fabricated using electro-formation machinery, CAD/CAM technology, or traditional removable prosthesis techniques 24. The type, number, and location of attachments vary based on the prosthesis design and should provide good retention, be cost-effective, have low maintenance requirements, and allow easy insertion and removal 25. The aesthetic appearance of the overdenture is not significantly affected by the lateral emergence of screws, and bruxism-related issues can be mitigated by removing the prosthesis at night 26.

Rigidly splinted bars attached to four implants effectively prevent non-axial rotation, micromovements, and excessive loading. Cantilever extensions are a practical solution to avoid implant placement in resorbed areas and protect vital structures 27. Adequate posterior occlusal support is achieved by placing cantilevers distal to the bars 28. To minimize functional load, distal extensions should not extend beyond the first molar sites. Bar-retained prostheses can influence alveolar bone loss, but a systematic review by Cehreli et al. 29 found no significant differences in bone loss around implants supporting or retaining overdentures, regardless of implant or attachment design. Other studies have reported that rigidly supported overdentures require less prosthetic maintenance 18.

Fixed Full-Arch Implant Prosthesis

Advantages of Screw-Retained Restorations

The decision between cemented and screw-retained restorations depends on a thorough understanding of the advantages and disadvantages of each. Several factors influence the choice of prosthesis fixation to implants, including retrievability, space requirements, retention, framework passivity, occlusion, aesthetics, ease of fabrication, cost, and potential complications 30.

Retrievability

Retrievability refers to the need for restoration replacement due to reasons such as frequent component replacement, failure of fastening screws, abutment fracture, or the need for prosthesis modification after surgical intervention due to implant loss 30. Screw-retained prostheses offer superior retrievability compared to cement-retained restorations, as they do not damage the restoration during removal 31.

Passivity of Framework

A superior fit of the framework is indicated by minimal strain after fixation 32. Distortion of the restoration can occur due to various factors, including the impression procedure, master cast fabrication, wax patterns, investing and casting processes, porcelain firing, or during prosthesis insertion 33. Non-passive fitting frameworks can lead to biological complications such as bone loss and microflora entrapment between the implant and abutment, as well as prosthetic complications like screw loosening or fracture 30.

Cement-retained restorations often exhibit larger marginal openings, increasing the risk of microflora colonization. Additionally, temporary cement dissolution poses an additional risk for cement-retained restorations 34.

Retention

In cases of implant misalignment, further preparation and tapering of abutments may be necessary to establish an ideal insertion path, potentially leading to overtapered abutments and reduced retention. Screw-retained restorations are preferred in such scenarios, as well as in cases with limited inter-arch space 31. Retention in screw-retained restorations is enhanced by the friction resistance between the internal threads of the implant and the fastening screw 35.

Occlusion

The screw access hole occupies 50% of the occlusal table in molars and more than 50% in premolars, making ideal occlusal contacts challenging in screw-retained prostheses 31. Composite materials are used to cover screw holes, but they tend to wear over time, especially when opposing porcelain teeth 36.

Ease of Fabrication and Cost

Cement-retained prostheses are easier to fabricate due to fewer components and are generally less expensive than screw-retained restorations 30.

Aesthetics

For screw-retained restorations, implants in the anterior region must be placed palatally to allow screw emergence through the cingulum area, resulting in a porcelain ridge lap that compromises hygiene and may cause offset loading of the implant 31. In the posterior region, the screw hole exits through the central fossa, leading to cosmetic and occlusal issues. However, opaque composite materials can mask the gray color of the screw hole 30.

Complications

A systematic review comparing cement-retained and screw-retained reconstructions found that cement-retained restorations had fewer technical but more biological complications, such as alveolar bone loss or implant failure. In contrast, screw-retained reconstructions showed higher rates of reconstruction loss but fewer serious biological complications and lower implant failure rates 37.

Porcelain fracture is more common in screw-retained restorations due to unsupported porcelain at the screw access channel. Using a metal occlusal table, especially in non-aesthetic areas with heavy occlusal loads, can minimize this issue 38.

Disadvantages of Screw-Retained Restorations

Abutment or Prosthetic Screw Loosening/Fracture

A systematic review identified abutment screw loosening as the most common technical complication, with an annual rate of 2.1%, followed by abutment screw fracture at 1.9% 39. Screw loosening or fracture occurs due to forces exceeding the screw joint's fixing force. Titanium-coated screws have reduced loosening but may increase the risk of fracture. Titanium alloy components are less prone to these issues compared to commercially pure titanium and gold alloy components 40.

Screw complications can arise from factors such as overtightening, parafunction, occlusal overload, occlusal interferences, or long cantilevers 41. Stripped screws, though rarely mentioned, can result from repeated removal and replacement of the prosthesis or incomplete seating of the driver into the screw head 42.

Veneering Material Chipping/Fracture

This is the most common prosthesis-related technical complication, with an annual rate of 6.7% 43. Flexure or fracture of the superstructure can lead to loss of acrylic resin or porcelain facing. Porcelain fractures are less common than acrylic resin fractures and may result from poor design, increased occlusal load, or high shear at the metal-ceramic junction 7.

Flexure during function can occur due to thin frameworks, leading to failure at the metal-ceramic junction. Acrylic facing debonding due to framework flexure is uncommon 44. Veneer fractures may result from material fatigue, prosthetic design issues, parafunctional activity, or laboratory errors 45.

Favorable occlusion can reduce non-axial forces, decreasing the likelihood of restorative material failure 46. In fully edentulous patients, impaired mandibular control due to lack of periodontal receptors can lead to excessive bite forces, contributing to veneer fracture 47.

Wear and/or Total Replacement of Acrylic Resin Teeth

Tooth fracture can result from trauma, decreased vertical dimension of occlusion, or premature anterior contact due to posterior wear. Regular occlusion checks and retentive diatorics can help reduce tooth fracture rates 48.

Framework Fracture

Frameworks made from gold, cobalt-chromium, or titanium alloys are generally rigid, with fractures accounting for about 3% of failures 45. Fractures may occur due to faulty design, extreme functional loads, poor occlusal schemes, framework misfit, or excessive cantilevering 49.

A study found no difference in technical complications over five years between fixed prostheses with or without cantilevers 50. Fractures often occur at the start of cantilever arms, which can be prevented by increasing framework thickness and minimizing cantilever length 51. Defective casting technology can also cause framework fractures. Titanium frameworks, being computer-milled, offer better precision and strength than cast alloys 52.

Types of Screw-Retained Reconstructions

Screw-retained restorations are classified by complexity into single-piece or multiple-piece restorations.

Single-Piece Restoration

This type involves a single milled or cast piece screwed directly into the implants or abutments. Accurate labio-lingual inclination is crucial to avoid screw hole visibility or functional loading issues 53.

Multiple-Piece Restorations

Used for severely misaligned implants, these consist of a primary framework screwed to the abutment, with secondary screws retaining the secondary structure 54.

Fabrication Techniques

Pick-Up Restoration

A temporary restoration for immediate implant loading, where a removable denture is perforated at implant sites and attached to temporary abutments using an intra-oral pick-up technique. The denture is then converted into a screw-retained restoration 55.

Cast Restorations

This technique involves casting a pattern into base metal, gold, or titanium alloys. Multiple steps can lead to distortion, requiring additional corrections and increasing time and cost 56.

Milled Restorations

Milled restorations eliminate dimensional changes and technical errors associated with cast restorations 57. A resin pattern is scanned using stylus or optical scanners, and the framework is milled using copy milling or CAD/CAM techniques 58. In CAD/CAM designs, the master cast is optically scanned, and a 3D framework is milled after virtual design approval 59.

All-on-Four® Concept

Advantages

The All-on-Four® concept addresses challenges in rehabilitating the edentulous maxilla, such as bone resorption in the posterior region and limited ridge dimensions. It avoids the need for bone grafting or sinus augmentation, which can involve complications like sinusitis, graft loss, or osteomyelitis 60.

This concept uses four implants (two straight and two tilted) to support a full-arch fixed prosthesis, allowing immediate loading. Tilting the distal implants reduces cantilever length, improves anchorage in cortical bone, and preserves vital structures 61.

Studies support the use of four implants for favorable load distribution in full-arch prostheses 62. Tilting implants to engage the pterygoid plate is a predictable method for maxillary prosthetic support 63.

Limitations

Limitations include deficient bone volume, remaining teeth hindering implant placement, inadequate mouth opening, high smile lines requiring bone reduction, and thin or asymmetrical bone crests 64.

Laboratory tests and finite element analyses suggest that tilted implants may increase bone stress 65. However, splinting implants in a rigid prosthetic structure reduces bending and distributes forces effectively 66. Strain gauge measurements showed no significant differences in loading between axial and tilted implants 67.

Indications

The All-on-Four® concept is indicated for atrophic jaws or edentulous maxillae, with or without remnant teeth. It is suitable for patients reluctant to undergo regenerative procedures like sinus lifts or bone grafts 68.

Studies classify patients based on residual ridge dimensions, with low, moderate, or high surgical difficulty 69. Immediate rehabilitation requires implants inserted with a final torque of 30-50 Ncm and adequate bone height and width 70.

A systematic review noted that most studies included healthy patients with ASA I or II scores, though some did not report surgical risk as an indication 71.

Conclusion

Implant-supported prostheses have emerged as a transformative treatment option for edentulous patients, addressing the limitations of conventional removable dentures. By improving stability, retention, masticatory efficiency, and overall oral function, implant-supported overdentures significantly enhance patients' quality of life and psychosocial well-being. While challenges such as patient preferences, inter-arch space requirements, and potential biological complications exist, advancements in attachment systems, such as bar and milled-bar designs, have further optimized outcomes. The All-on-Four® concept, in particular, offers a promising solution for atrophic jaws, enabling immediate loading and reducing the need for complex bone grafting procedures. Despite the technical and biological considerations, implant-supported prostheses remain a reliable and effective treatment modality, providing edentulous patients with improved comfort, functionality, and aesthetics. Continued research and innovation in implant dentistry will further refine these solutions, ensuring better long-term outcomes for patients worldwide.

Disclosure

The author reports no conflicts of interest in this work.

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