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The Use of Mini Implants for Long-Term Support of Removable Prosthesis: A Critical Review

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1. Introduction: Addressing the Edentulous Dilemma

The rehabilitation of the completely edentulous arch remains a core function of the Prosthodontics department. While conventional complete dentures are a foundational treatment, their reliance on residual ridge morphology often results in inadequate retention, stability, and masticatory function, leading to significant patient dissatisfaction [R1]. This is particularly pronounced in the severely atrophic mandibular ridge, where accelerated bone resorption creates a highly compromised foundation. The lack of stability not only impairs function but also negatively impacts the patient's oral health-related quality of life (OHRQoL).

Mini Dental Implants (MDIs), generally defined as implants with a diameter less than 3.0 mm (typically 1.8 mm to 2.4 mm), emerged as a potentially transformative solution [R2]. Initially conceived for transitional stabilization, their application quickly expanded to the definitive, long-term retention of removable prostheses. The MDI protocol offers key advantages over conventional implant therapy: a minimally invasive, often flapless, single-stage surgical approach; reduced treatment cost and time; and the ability to utilize limited bone volume without extensive grafting, thereby avoiding extensive pre-prosthetic procedures [R3, R4].

This review critically examines the current evidence regarding the use of mini implants for the long-term support of removable prostheses, focusing on their biomechanical efficacy, clinical and radiographic outcomes, complication profiles, and patient-reported satisfaction, to establish their definitive role within modern prosthodontic practice.

2. Design Philosophy and Biomechanical Considerations

The distinct characteristics of the MDI govern its functional behavior and long-term prognosis, making a thorough understanding of its material science and biomechanics essential.

Design and Material Science

MDIs are predominantly one-piece fixtures, a monolithic design that eliminates the micro-gap inherent in two-piece systems. This feature is hypothesized to reduce the risk of bacterial ingress and subsequent biological complications, especially peri-implantitis [R2, R5]. The fixtures are fabricated from titanium alloys (e.g., Ti-6Al-4V) to ensure adequate strength despite the narrow diameter. The coronal portion typically features an integrated ball-shaped abutment head, which engages an O-ring or similar resilient housing within the denture base. To compensate for the reduced diameter, modern designs frequently incorporate increased thread depth and advanced surface modifications (e.g., sandblasting and acid etching). These features aim to maximize the bone-to-implant contact (BIC) and enhance primary stability, a prerequisite for the high success rates reported with immediate loading protocols [R2].

Biomechanics in Atrophic Bone

The fundamental biomechanical challenge of the MDI is its narrow diameter, which theoretically makes it more susceptible to bending, fracture, and unfavorable stress distribution [R6]. Finite Element Analysis (FEA) studies provide critical insight into the load transfer mechanism in the severely atrophic mandible.

The MDI-retained overdentures function primarily with muco-implant support, sharing the occlusal load between the implants and the residual alveolar ridge mucosa. This contrasts with the purely implant-supported nature of many standard overdenture designs, where the implant bears the vast majority of the load. FEA studies consistently demonstrate that compressive stresses tend to concentrate in the cervical region of the implant, particularly the dense cortical bone, regardless of the implant connection type [R6, R7]. Excessive lateral or non-axial forces, which frequently occur during mastication, risk escalating these stresses beyond the physiological threshold for bone remodeling, potentially leading to bone loss or implant failure [R7]. For this reason, the use of a minimum of four MDIs in the mandibular anterior segment is strongly supported by biomechanical evidence. The four-implant configuration

is shown to provide a more favorable distribution of forces and moments, significantly enhancing stability compared to the less rigid two-implant protocol [R8].

3. Case Selection and Pre-Surgical Assessment

MDIs are ideally indicated for patients who present with severe alveolar atrophy, where bone width precludes the placement of standard implants without extensive and costly pre-prosthetic bone augmentation. They are also a preferred option for elderly or medically compromised individuals for whom lengthy, invasive conventional surgeries may be contraindicated. Furthermore, their lower cost makes them a vital solution for increasing patient access to effective implant-retained prosthetics.

A critical step is the pre-surgical assessment utilizing Cone Beam Computed Tomography (CBCT). CBCT allows for precise, three-dimensional mapping of the available bone (height, width, and density) and ensures accurate identification of vital structures, such as the mandibular canal and mental foramina, minimizing the risk of iatrogenic injury [R9]. Planning ensures the MDIs are placed in the densest bone available and oriented to receive loads as axially as possible.

Flapless, Single-Stage Surgery and Immediate Loading

The primary clinical advantage is the simplified surgical technique. MDIs are typically placed using a flapless technique in a single stage, which significantly reduces chair time, patient discomfort, and post-operative morbidity compared to traditional implant surgery [R3]. The procedure involves drilling only a pilot hole, followed by controlled insertion of the self-tapping implant.

The prevalent loading protocol for mandibular MDIs is immediate loading. If adequate primary stability (often measured by an insertion torque value typically >35 Ncm) is achieved, the patient's existing denture can be immediately relieved, relined, and adapted to connect with the MDI abutments [R10]. This immediate functional restoration is a major benefit, contributing significantly to patient satisfaction and minimizing the period of functional disability.

4. Long-Term Clinical and Radiographic Outcomes

Long-term studies are essential to validate the role of MDIs in definitive prosthodontic rehabilitation, focusing on implant survival rates and radiographic stability.

Survival and Success Rates

The survival rates for MDIs supporting overdentures are generally high, though systematic reviews suggest they are marginally lower than those reported for standard-diameter implants (SDIs) [R4, R9]. One comprehensive 10-year follow-up study on one-piece MDIs in the mandible reported a remarkable 100% implant survival rate and a prosthetic survival rate of 93% [R4]. Overall, systematic reviews over a 1- to 8.7-year follow-up period have shown MDI survival rates ranging from 66% to 100% [R1].

A key finding is the consistent discrepancy between the arches. Failure rates are notably higher in the maxillary arch (ranging from 11.1% to over 30% failure rate) compared to the mandible (4.2% failure rate) [R10]. This disparity is primarily attributed to the anatomical differences: the presence of poorer quality (Type IV) bone in the maxilla and the larger functional load placed on the maxillary prosthesis.

Marginal Bone Loss (MBL)

Radiographically, long-term MDI studies have demonstrated acceptable levels of marginal bone loss (MBL), which often stabilizes after the first year of loading [R1]. The long-term study reporting 100% survival rate observed a stable MBL with a mean of ~1.12±0.80 mm after 10 years, which is well within the acceptable limits for implant success [R4]. MBL around MDIs appears comparable to MBL around conventional implants over time when managed with appropriate maintenance and case selection [R9]. This stabilization suggests that MDIs, when osseointegrated, can sustain functional loads over the long term without progressive bone deterioration.

5. Complications and Maintenance Requirements

Due to the smaller diameter and the specific retention system, MDIs present a characteristic profile of biological and mechanical complications that must be proactively managed.

Mechanical and Prosthetic Complications

The high frequency of technical complications is a key differentiator and mandates a robust patient maintenance program [R12]. The most common intervention is the periodic replacement of the O-ring/retentive matrix, which is susceptible to wear, loss of elasticity, and functional deformation from continuous insertion/removal and masticatory forces [R11]. Studies indicate that the retention force can be reestablished by replacing the O-rings, a procedure typically required every 6 to 12 months [R11].

Other notable mechanical issues include:

- Denture Base Fracture: Occurs in a significant number of long-term patients (e.g., 25% in one 12-year study) due to stress concentration around the abutment housings, requiring reinforcement [R12].

- Implant Fracture or Bending: While rare (2.5% incidence over 12.1–16 years), this risk is inherently linked to the small diameter, especially under excessive non-axial loads or due to material fatigue [R12].

Biological Complications

Peri-implantitis remains the principal biological threat. The simplified one-piece design, while eliminating the micro-gap, necessitates vigilant patient hygiene, as plaque accumulation at the gingiva-abutment interface is a significant risk factor for bone loss [R2, R4]. Poorly fitting prostheses, which distribute forces unevenly, can also exacerbate peri-implant inflammation and bone loss.

Therefore, regular relining (e.g., every 2–3 years) to compensate for continuing alveolar resorption is necessary to maintain proper prosthesis seating and minimize stress on the implants.

6. Patient-Reported Outcomes and Quality of Life (QoL)

The ultimate success of prosthodontic rehabilitation is measured by the patient's functional and psychological well-being. Evidence overwhelmingly supports the superior outcomes of MDI overdentures compared to conventional dentures [R15, R16].

Studies using standardized Patient-Reported Outcome Measures (PROMs) consistently demonstrate a profound, positive impact on Oral Health-Related Quality of Life (OHRQoL) [R15, R16]. In long-term cross-sectional studies (up to 10 years), patient-reported satisfaction showed significant improvements ($P<0.05$) across all functional domains after MDI stabilization [R12]. The most remarkable improvements were consistently reported in:

- Retention and Stability: This is often cited as the single most improved factor, leading to a dramatic increase in patient confidence and comfort [R12].

- Masticatory Efficiency: Patients report a significantly better ability to chew both soft and hard foods

One 10-year study noted that 87.4% of patients were “strongly satisfied” with the stability of their MDI-retained restorations [R17]. Furthermore, some meta-analyses suggest that patient satisfaction scores for MDI overdentures are comparable to those for standard-diameter implant overdentures, validating their clinical efficacy in enhancing the patient experience [R17].

7. Conclusion and Future Directions

Mini dental implants have secured a definitive and valuable role in the Prosthodontics department, offering an effective, cost-sensitive, and less-invasive solution for the long-term support of removable prostheses, particularly for patients with compromised anatomy or systemic health [R18]. The high reported long-term survival rates and profound improvements in OHRQoL cement their place as a viable alternative to conventional overdenture protocols.

However, MDIs are not without limitations. Clinicians must exercise meticulous case selection, prioritize four-implant stabilization in the mandible, and vigilantly manage the high incidence of mechanical complications through dedicated patient education and a robust maintenance schedule, focusing on frequent O-ring replacement and periodic relining.

Future research should focus on:

- Long-Term Comparative Trials: Conducting large-scale randomized controlled trials comparing the long-term clinical and cost-effectiveness of four-MDI versus two-SDI mandibular overdenture protocols.

- Material Science: Developing new high-strength titanium alloys and advanced surface treatments to improve fracture resistance and enhance osseointegration reliability of narrow-diameter fixtures.

- Advanced Materials: Designing new nano-coating technologies and enhanced surface treatments to further the development of prosthetic mini-implants.

In summary, the MDIs are established as an essential tool in the armamentarium of the modern prosthodontist, demanding careful clinical judgment and a commitment to long-term patient care for predictable and successful outcomes.

8. References

[R1] Al-Nawas, B. et al. (2018). Narrow-diameter implants: A systematic review and meta-analysis. Clinical Oral Implants Research, 29(Suppl 16), 21–40.

[R2] Peron, G. et al. (2023). Dental Mini-Implants. StatPearls [Internet]. NCBI Bookshelf.

[R3] Scepanovic, M. et al. (2024). Patients' Satisfaction with Mandibular Overdentures Retained Using Mini-Implants: An Up-to-16-Year Cross-Sectional Study. Dentistry Journal, 12(2), 19.

[R4] Peloza, S. et al. (2024). One-Piece Mini Dental Implant-Retained Mandibular Overdentures: 10-Year Clinical and Radiological Outcomes of a Non-Comparative Longitudinal Observational Study. Journal of Clinical Medicine, 13(4), 99.

[R5] Duraisamy, R. et al. (2024). Mini-Implants in Dentistry—A Review. Journal of Long-Term Effects of Medical Implants, 32(3), 29–37.

[R6] Lee, S. K. et al. (2017). Biomechanical analysis of four types of short dental implants in a resorbed mandible. The Journal of Prosthetic Dentistry, 118(1), 58–66.

[R7] Costa, L. R. et al. (2024). Analysis of the atrophic mandible rehabilitated with fixed total prosthesis on mono or bicortical implants. Brazilian Dental Journal.

[R8] Zygogiannis, V. et al. (2024). Mini-Implant Survival Rates at the 2-Year Follow-Up (n = 90). ResearchGate.

[R9] SVOA Dentistry. (2023). Survival and Success of Mini Dental Implants Supporting Complete Removable Over-Dentures: A Literature Review. SVOA Dentistry.

[R10] Frazão, V. B. et al. (2024). Clinical and radiographic outcomes of mini-implant-retained maxillary and mandibular overdentures: A systematic review and meta-analysis. Clinical Oral Investigations.

[R11] Zygogiannis, V. et al. (2023). Prosthetic Complications and Maintenance. ResearchGate.

[R12] Scepanovic, M. et al. (2024). Patients' Satisfaction with Mandibular Overdentures Retained Using Mini-Implants: An Up-to-16-Year Cross-Sectional Study. Dentistry Journal, 12(2), 19.

[R13] Ribeiro, R. et al. (2022). Mandibular implant overdenture - treatment modalities and maintenance - an integrative overview. Journal of Dental Implant Research.

[R14] Peloza, S. et al. (2023). Mini-Implant-Retained Overdentures for the Rehabilitation of Completely Edentulous Maxillae: A

[R15] [Author and title partially unclear]. Systematic Review and Meta-Analysis. International Journal of Environmental Research and Public Health.

[R16] [Author and title unclear]. Satisfaction and Quality of Life in Patients with Dental Implants.

[R17] [Author and title partially unclear]. Patient Satisfaction and Quality of Life Outcomes Following Dental Implant Placement.

[R18] Al-Nawas, B. et al. (2018). Narrow-diameter implants: A systematic review and meta-analysis. Clinical Oral Implants Research, 29(Suppl 16), 21–40.