iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** I **Month of publication:** January 2026

DOI: https://doi.org/10.22214/ijraset.2026.76901

Mini Implants and Intraoral Magnets for Denture Stabilization

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Abstract: Edentulism remains a significant global challenge, and mandibular denture instability continues to affect mastication, comfort, and quality of life in elderly populations. Traditional implant systems, while effective, are limited by surgical invasiveness, cost, and bone requirements. Mini dental implants (MDIs) and intraoral magnets have emerged as minimally invasive, cost-efficient alternatives that enhance denture retention, particularly in patients with narrow or resorbed ridges. MDIs provide immediate stability through simplified placement and high primary fixation, whereas magnetic attachments offer passive, self-seating retention with reduced lateral stress. Their combined application yields synergistic benefits, improving functional efficiency, ease of use, and patient satisfaction. This narrative review synthesizes current evidence on the design, biomechanics, clinical protocols, and comparative advantages of MDIs and intraoral magnets, highlighting their value in prosthetic rehabilitation while noting the need for standardized long-term studies to refine patient selection and treatment outcomes.

Keywords: Mini Dental Implants, Intraoral Magnets, Denture Stabilization, Overdenture Retention, Edentulism.

I. INTRODUCTION

Edentulism remains a major global public health concern, particularly among older adults, with prevalence strongly influenced by age, socio-economic status, and access to oral healthcare. Studies show substantial variability across regions for example, in India, more than half of edentulous older adults use dentures, with higher adoption in urban populations due to better income, education, and care availability.[1] Despite dentures improving oral function and quality of life, mandibular dentures frequently present significant retention and stability challenges because of the mandible's reduced surface area, resorbed ridges, muscle interference, and salivary limitations, resulting in compromised chewing efficiency, speech, and patient comfort.[2]

Traditional approaches to enhance denture stability such as conventional implants, bar, ball, and locator attachments, and denture adhesives have provided benefits but may be limited by high cost, surgical invasiveness, the need for adequate bone volume, and extended healing periods. In response to these limitations, mini dental implants and intraoral magnets have emerged as promising alternatives, offering a minimally invasive, cost-effective, and immediate-loading-capable solution for improving denture retention.[3]

Mini implants, with their reduced diameter and simplified placement, are particularly advantageous for patients with limited bone volume or medical fragility, delivering rapid functional improvement and enhanced denture stability.[4]

Complementing these, intraoral magnetic attachments provide retention through magnetic attraction, reduce horizontal stresses on implants, and facilitate easy denture insertion and removal advantages especially valuable in cases with narrow ridges or strong muscular activity where conventional attachments may be less effective.[4] When used together, mini implants and magnetic systems provide a synergistic benefit, improving comfort, chewing function, and overall quality of life while reducing procedural morbidity and financial burden, making them a practical and accessible option for elderly or medically compromised individuals requiring denture stabilization.[5]

II. REVIEW OF LITERATURE

A growing body of literature has highlighted the value of mini dental implants (MDIs) and intraoral magnetic systems in enhancing denture stability, particularly for edentulous patients with compromised alveolar ridges. Early evidence by Bulard et al(2005) demonstrated that the minimally invasive placement of MDIs offers immediate denture stabilization, improving functional outcomes soon after surgery.[6] Subsequent clinical observations by Bohle et al. (2008) further supported the immediate functional benefits of MDIs, emphasizing their role in improving patient comfort during early adaptation phases.[7] The versatility and accessibility of mini-implants were later highlighted by Patel et al (2015), who noted that MDIs are especially advantageous for patients with anatomical limitations or financial constraints, offering a practical alternative to conventional implants with reduced surgical morbidity.[8]

Adding to the body of research, Tomasi et al. (2013) reported high levels of patient satisfaction with mini-implant–supported overdentures, although they cautioned that implant failure risk may increase in maxillary cases or when shorter implants are used, highlighting the importance of case selection.[9] More recently, the integration of magnetic retention systems with mini-implants has garnered attention, with Ramadhany et al (2020) demonstrating that magnets significantly enhance overdenture stability, particularly in situations of pronounced ridge resorption where mechanical attachments may be less effective.[10]

A. Mini Dental Implants (MDIs)

Mini dental implants (MDIs) are defined by their narrow diameter—generally ≤2.9 mm—and are commonly manufactured in one-piece designs that combine the implant body and abutment, simplifying surgical placement and prosthetic steps. These implants typically incorporate a threaded screw configuration to enhance mechanical engagement and provide primary stability, a critical factor in atrophic ridges or areas of limited bone volume. Thread patterns may range from aggressive designs that increase compression and surface area in softer bone to finer threads better suited for dense cortical bone.[9] Their surfaces are usually treated commonly through aluminum oxide blasting and acid etching to increase micro-roughness and improve osseointegration by enlarging the bone-to-implant contact area, while the collar often features a smooth or micro-grooved finish to support peri-implant soft-tissue health. [10]

From a biomechanical perspective, the reduced diameter of MDIs naturally limits the bone contact surface, making careful control of load transfer essential; hence, achieving high primary stability, often reflected by insertion torque values around 30–45 Ncm, helps minimize micromovement and supports immediate loading protocols. Clinically, MDIs are indicated for patients with narrow or resorbed ridges where standard implants cannot be placed without grafting, in cases requiring minimally invasive or cost-effective treatment options, and for stabilizing removable overdentures when bone augmentation is not feasible.[11] However, they may be contraindicated in sites with inadequate bone height or density for achieving stable fixation, in the presence of infection, in medically compromised conditions that impair healing, or in patients with severe parafunctional habits that could overload the narrow implant structure.[12]

B. Significance of Mini Implants

Mini dental implants have gained considerable clinical relevance owing to their ability to provide functional and esthetic rehabilitation in patients who are otherwise unsuitable candidates for traditional implants. Their reduced diameter permits placement in areas of compromised bone density, thereby eliminating the need for extensive augmentation procedures such as grafting or ridge splitting. This makes them especially beneficial for patients with narrow edentulous ridges and severe mandibular atrophy.[13]

Furthermore, MDIs have demonstrated predictable outcomes in stabilizing removable prostheses. Their capacity to improve denture retention and stability has been consistently acknowledged as a major contributor to enhanced mastication, phonetics, and patient satisfaction. Because the surgical procedure is minimally invasive and typically performed under local anesthesia using a flapless approach, patient morbidity is considerably reduced, and postoperative recovery is expedited. The ability to immediately load the implants in selected cases further enhances treatment efficiency and supports rapid functional improvement. Collectively, these attributes underscore the importance of MDIs as a practical, cost-effective, and patient-centered solution for prosthodontic rehabilitation.[14]

C. Composition and Structural Characteristics

MDIs are generally fabricated from commercially pure titanium or titanium alloy (commonly Grade 5, Ti-6Al-4V ELI), materials known for their excellent biocompatibility, mechanical strength, and favorable osseointegration properties. Most MDIs are designed as one-piece implants, integrating the implant body and the abutment into a single unit, which simplifies both surgical placement and prosthetic connection. This design reduces the number of components susceptible to mechanical complications such as screw loosening.[12]

Structurally, MDIs consist of a slender, threaded endosseous post with an apical design optimized for bone engagement and primary stability. The prosthetic head may be ball-shaped commonly used for overdenture retention or square/hexagonal to support fixed restorations. The implant surface typically undergoes conditioning treatments such as sandblasting or acid etching to enhance surface roughness and promote bone-implant contact. These surface modifications play a critical role in accelerating osseointegration, particularly important given the immediate or early loading protocols frequently employed with MDIs.[12]

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue I Jan 2026- Available at www.ijraset.com

III. CLASSIFICATION

Mini implants are primarily classified based on their diameter. While conventional implants range from 3.25 mm to 5 mm, MDIs typically have a diameter of less than 3.3 mm. Common diameters include 1.8 mm, 2.1 mm, 2.4 mm, and 2.9 mm, with selection determined by the available bone width, occlusal load requirements, and prosthetic plan.

Another meaningful classification relates to the design of the prosthetic head:

1) O-ball or Ball Abutments: These are the most prevalent and are used primarily for stabilizing removable overdentures. The ball abutment interfaces with an O-ring housing embedded in the denture base, providing satisfactory retention and ease of insertion.
2) Square, Tapered, or Hexagonal Heads: These designs allow MDIs to support fixed prostheses such as single crowns or small bridges, although their use in high-load posterior zones remains limited.
3) Temporary Anchorage Devices (TADs): A subset of very narrow implants (1.3–2.0 mm) used mainly in orthodontics to provide skeletal anchorage for controlled tooth movement. Though not typically intended for long-term prosthetic loading, they share similarities with MDIs in design and placement technique.

Advantages:	Disadvantages:
MDIs offer several noteworthy clinical benefits: 1. Minimally Invasive Placement: Many MDIs can be inserted using a flapless technique, reducing surgical trauma, postoperative discomfort, and treatment duration. 2. Reduced Bone Requirements: Their small diameter allows placement in patients with significant ridge resorption without the need for grafting. 3. Immediate Loading Potential: In overdenture applications, MDIs often achieve sufficient primary stability to support same-day prosthesis connection. 4. Cost-Effectiveness: Lower material costs, simplified instrumentation, and reduced surgical time translate into relatively affordable treatment. 5. Ideal for Denture Stabilization: They significantly enhance retention and stability in both complete and partial removable prostheses.	Despite their utility, MDIs have inherent limitations: 1. Reduced Fatigue Strength: Their narrow diameter limits their ability to withstand high occlusal forces, making them less suitable for posterior fixed restorations. 2. Higher Susceptibility to Fracture: Mechanical failures may occur in cases of bruxism, inadequate bone support, or improper loading. 3. Potentially Shorter Longevity: Long-term outcomes may be inferior to conventional implants, particularly in high-load clinical scenarios. 4. Restricted Indications: MDIs are best suited for overdentures and small anterior restorations, rather than complex rehabilitative cases.

Brand (Example)	Diameter (mm)	Intra-osseous Lengths (mm)	Abutment Type	Primary Indication
3M™ ESPE™ MDI	1.8, 2.1, 2.4	10, 13, 15, 18	O-Ball, Square Head	Denture Stabilization, Fixed Bridges
Straumann® Mini Implant	2.4	10, 12, 14	Optiloc® (for overdentures)	Narrow Edentulous Ridges, Overdenture Stabilization

One of the earliest and most widely documented clinical indications for MDIs is the stabilization of a mandibular complete denture in patients with advanced ridge resorption. A typical case involves an older, edentulous individual experiencing chronic dissatisfaction with a mandibular denture due to inadequate retention caused by severe bone loss, reduced vestibular depth, and the influence of surrounding musculature.

In such cases, the placement of four to six mini dental implants in the anterior mandible, where bone density remains relatively preserved, provides a predictable solution. The procedure is generally performed under local anesthesia using a flapless technique, minimizing surgical morbidity. The existing denture is then modified chairside to incorporate O-ring housings that engage the ball abutments of the MDIs, offering immediate improvement in prosthesis stability, chewing function, and patient comfort. This clinical application exemplifies the strengths of MDIs as a rapid, cost-effective, and minimally invasive intervention for one of the most challenging prosthodontic problems encountered in geriatric dentistry.

Figure 1- Straumann® Mini Implant System

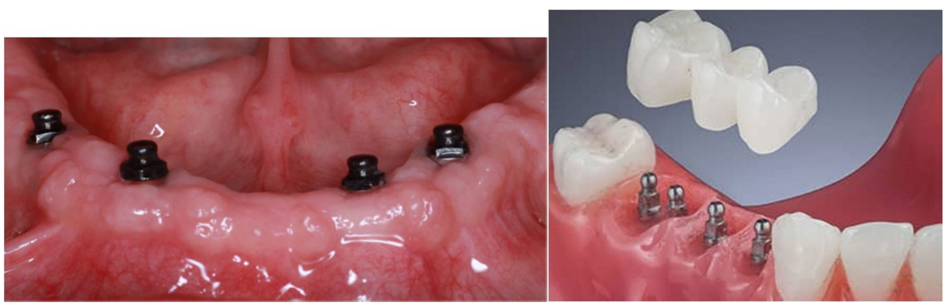

Figure 2: MDIs

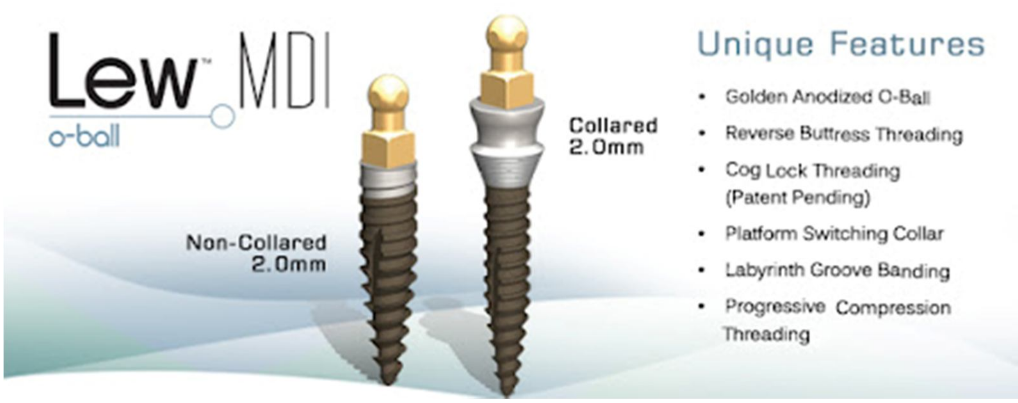

Figure 3: Lew MDI

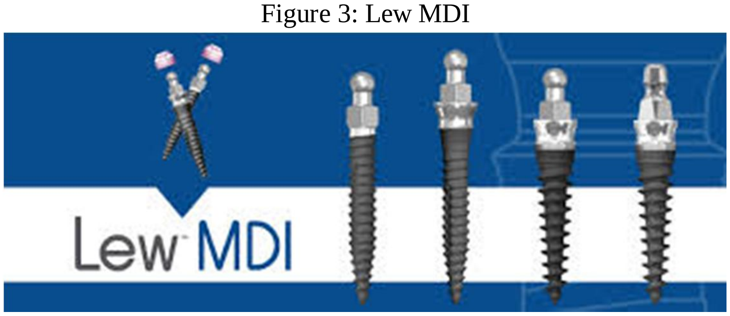

Figure 4: Lew MDI

Figure 5: 3M™ ESPE™ MDI

A. Intraoral Magnets for Denture Retention

Intraoral magnets used for denture stabilization are primarily classified as ferromagnetic or rare-earth types, with neodymium-iron-boron (NdFeB) magnets being the most widely utilized today due to their high magnetic strength in compact dimensions. Because the oral cavity presents a moist and corrosive environment, these magnets are carefully encapsulated within biocompatible coatings such as titanium, stainless steel, or parylene to prevent corrosion, structural degradation, and possible cytotoxic effects should the magnetic core become exposed.[13] Their retention mechanism relies on the attractive force between a magnet housed in the denture base and a metallic keeper attached to teeth or implants, with the overall retention strength influenced by magnetic intensity, pole orientation, and especially the magnet–keeper distance, as magnetic force decreases sharply with increasing separation.[14]

B. Significance

Intraoral magnets, particularly those fabricated from rare-earth magnetic alloys, hold an important role in contemporary prosthodontics and orthodontics due to their ability to generate strong, predictable forces within the confined anatomical spaces of the oral cavity. Their compact size and consistent performance make them especially valuable for prosthetic retention in overdenture therapy and for controlled force delivery in orthodontic tooth movement.[15] In prosthodontics, magnetic attachments facilitate a self-seating mechanism, enabling overdentures whether supported by natural roots, dental implants, or residual alveolar structures to reposition accurately onto their retainers with minimal guidance. This enhances patient comfort, reduces insertion path limitations, and optimizes overall prosthesis stability. In orthodontics, magnets offer the advantage of delivering continuous, reproducible forces that do not rely on patient cooperation, making them useful for applications such as intrusion, extrusion, molar distalization, space opening, and maxillary expansion. Their ability to exert force through soft tissues when appropriately shielded further broadens their clinical utility in selected scenarios.[16]

C. Composition and Structural Considerations

Intraoral magnets used in dentistry are typically permanent rare-earth magnets, necessitating robust protection from the corrosive intraoral environment. These magnets are commonly fabricated from alloys such as Neodymium–Iron–Boron (NdFeB) or Samarium–Cobalt (SmCo), both of which provide exceptionally high magnetic flux density relative to size. NdFeB magnets exhibit the highest magnetic strength but are particularly susceptible to corrosion and heat-induced demagnetization. SmCo magnets, while slightly less powerful, offer superior thermal stability and corrosion resistance, making them better suited for long-term intraoral use.[17]

Because both NdFeB and SmCo are vulnerable to degradation in saliva, the magnetic core must be hermetically sealed within a biocompatible, corrosion-resistant casing. Common encapsulating materials include titanium, stainless steel (e.g., SUS 304 or 316), and gold or gold-tin alloys.[18] This encapsulation prevents ion release, structural breakdown, and loss of magnetic strength over time. In most prosthodontic systems, the attachment consists of two components:

1) The magnetic unit, housed within the denture base; and
2) The keeper (armature), a ferromagnetic plate affixed to the abutment tooth or implant abutment, designed to close the magnetic circuit and maximize force concentration.[19]

This configuration enhances the predictability of retention while minimizing magnetic field leakage into surrounding tissues.

IV. CLASSIFICATION OF INTRAORAL MAGNETS

A. *Classification Based on Magnetic Field Configuration*

1) Open-Field Magnets: These magnets allow field lines to extend freely into the surrounding environment. Although capable of exerting forces over a greater spatial range, they produce significant stray fields, which may interact with adjacent metals or appliances. Their use in modern dentistry is limited and generally confined to earlier orthodontic systems or specialized applications.[19]
2) Closed-Field Magnets: Closed-field systems incorporate a keeper or yoke that redirects and concentrates the magnetic field between the magnet and its corresponding armature. This minimizes field leakage, enhances safety, and increases the effective attractive force. These magnets are the preferred and most widely adopted type in prosthodontics, particularly for overdenture retention and maxillofacial prosthetic anchorage.[20]

B. *Classification Based on Force System*

1) Attractive Magnetic Systems: In these systems, opposite poles (N–S) are oriented toward each other, generating an attraction force. They are primarily used in prosthodontics for retaining overdentures, sectional dentures, and maxillofacial prostheses. The attractive configuration provides vertical seating and retention without mechanical locking.[21]
2) Repulsive Magnetic Systems: Repulsive systems position like poles (N–N or S–S) opposite each other to generate separation forces. They are predominantly utilized in orthodontic biomechanics for tooth movement, including molar distalization, arch expansion, or forced eruption. Their ability to exert force without tethering devices contributes to simplified appliance design and improved patient comfort.[22]
3) Force Dynamics and Pole Orientation: Magnetic force is governed by the fundamental principle that unlike poles attract while like poles repel. Each permanent magnet possesses a north (N) and south (S) pole, with magnetic field lines exiting the north pole and entering the south pole. The clinical implications of pole orientation are significant:
   - When N faces S, a strong attractive force is produced, ideal for prosthesis retention.
   - When N faces N or S faces S, a repulsive force is generated, useful for controlled orthodontic tooth movement.

The magnitude of magnetic force decreases sharply with distance, following an inverse square relationship. Thus, precise alignment between magnet and keeper is essential for optimal retention in prosthodontics.

Advantages	Limitations
• Consistent Force Delivery: Magnetic forces remain stable over time and are not dependent on elastic wear or seating conditions. • Self-Seating Retention: Prostheses are automatically guided into the correct position, simplifying insertion for elderly or dexterity-compromised individuals. • Stress Distribution: Magnetic retention provides a cushioning, non-locking effect, reducing lateral stresses on abutment teeth and implants. • Clinical Simplicity: Laboratory and clinical procedures are generally less complex than those required for precision mechanical attachments. • Soft Tissue Penetration of Force: Magnets can act through mucosa or bone in specialized orthodontic applications.	• Corrosion Risk: Any breach in the protective casing can lead to rapid corrosion, ion release, and magnet failure. • Bulk Considerations: Even with compact designs, magnets may require additional prosthesis thickness, limiting use in patients with reduced interarch space. • Cost: High-performance rare-earth magnets and sealed housings increase material and manufacturing expense. • MRI Interactions: While generally considered safe, magnets may produce imaging artifacts and must be evaluated before MRI procedures. • Rapid Force Decay with Distance: Effective retention requires minimal separation between magnet and keeper.

A 67-year-old female patient with a fully dentate maxilla and completely edentulous mandible presented with significant instability of her mandibular complete denture and reduced masticatory efficiency. She previously wore a bilateral fixed partial denture in the maxilla and a bilateral removable partial denture in the mandible, but progressive periodontal disease led to extraction of the lower anterior teeth, after which the removable partial denture was attached to a complete denture. Preoperative CT imaging was performed with a diagnostic denture containing gutta-percha markers, and a three-dimensional printed mandibular model was fabricated for assessment, revealing a thin anterior residual ridge. Based on this evaluation, two mini implants (Magfit® MIP; Aichi Steel, Japan & Platon Japan) were surgically placed in the anterior mandible following minimal osteoplasty, with the implants inserted parallel to each other under local anesthesia and achieving an initial fixation torque of 25 Ncm. Dome-type keepers were connected at mucosal level, and the existing denture was relined with tissue conditioner to relieve the implant sites. After a three-month healing period, final impressions and interocclusal records were made using the duplicated denture, and a new magnet-retained overdenture with hard acrylic teeth was fabricated. Two magnet assemblies with concave surfaces complementary to the dome-type keepers were incorporated into the denture base using auto-polymerizing resin, allowing simultaneous mucosal and implant support to enhance retention and stability. The patient reported marked improvement in denture stability, comfort, and masticatory performance, expressing high satisfaction with the final prosthesis.[11]

Clinically, this necessitates precise denture alignment and minimal spacing to achieve reliable retention, although real-world forces often fall short of laboratory measurements due to soft-tissue compression, saliva, and functional movement during mastication. Intraoral magnets offer several advantages, including straightforward integration into prostheses, automatic reseating during insertion, absence of complex mechanical components, and reduced lateral stresses transmitted to supporting structures features that make them suitable in situations with limited interocclusal space. Nonetheless, they also present limitations such as relatively weak resistance to lateral displacement compared with mechanical attachments, the potential for corrosion if the protective coating is compromised, risks of interference during MRI, and concerns about cytotoxicity from corroded magnetic materials. Modern closed-field, hermetically sealed magnet systems significantly mitigate these issues, improving safety and durability.[24]

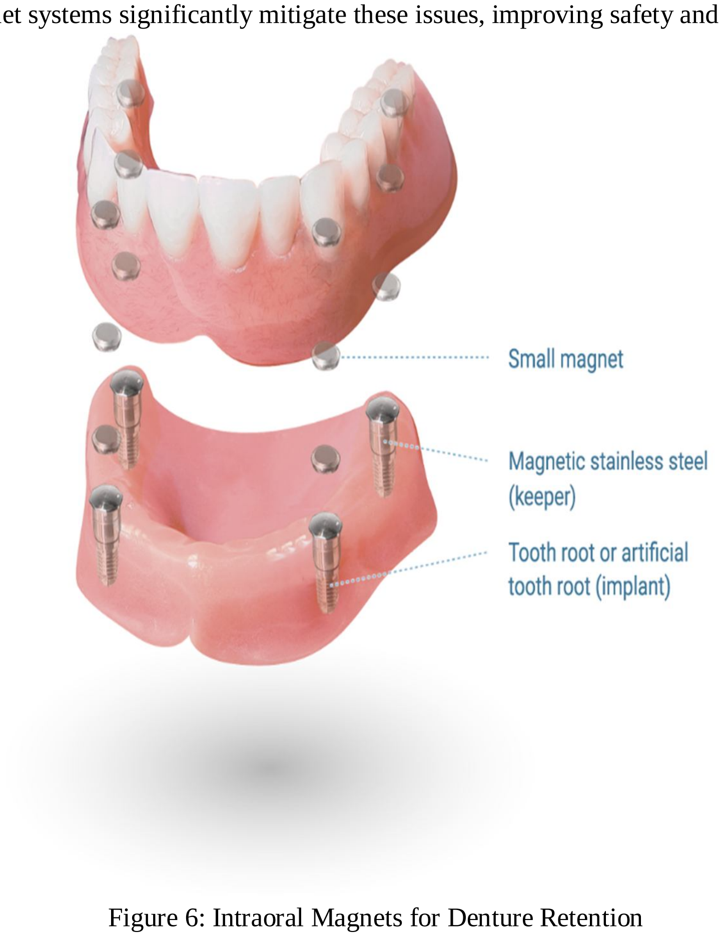

Figure 6: Intraoral Magnets for Denture Retention
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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue I Jan 2026- Available at www.ijraset.com

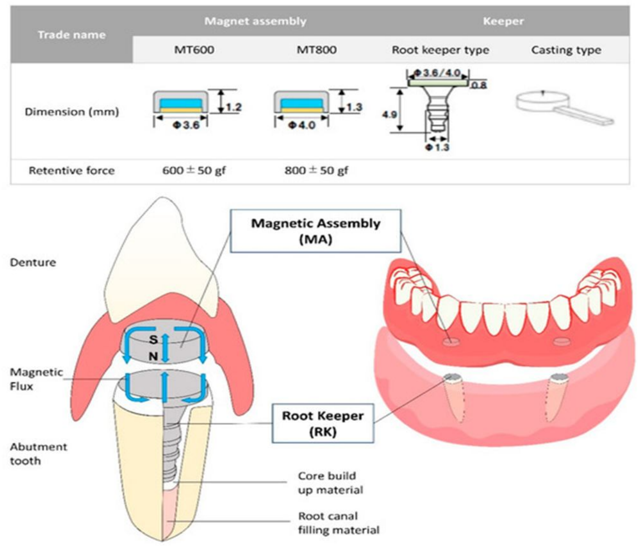

Figure 7: novel magnetic attachment system.

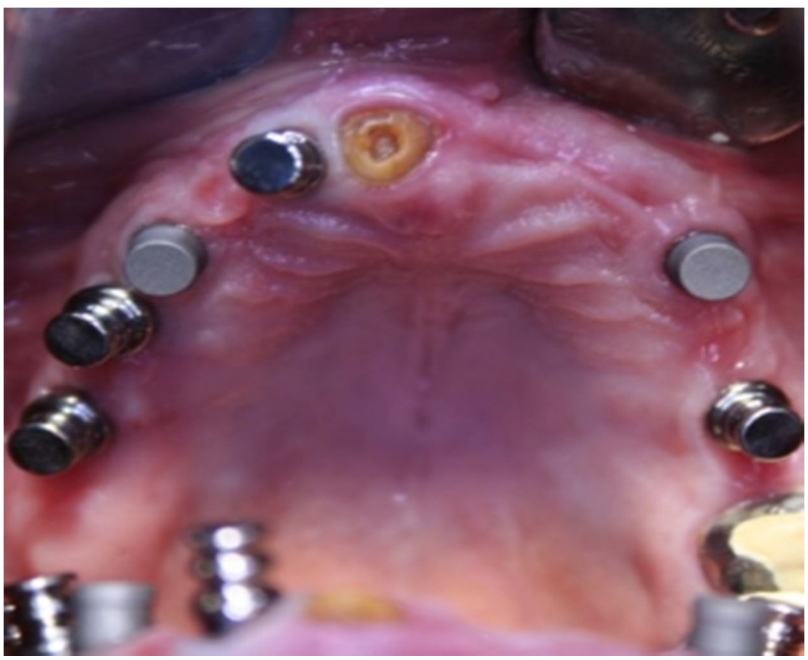

Figure 8: Magnetic Dentures

Figure 9: Titanmagnetics magnetic attachments -poles

Figure 10: Uni Magnet - DELTA

V. CLINICAL APPLICATIONS AND PROSTHETIC PROTOCOLS

Mini dental implants (MDIs) are frequently employed as a standalone solution for stabilizing mandibular overdentures, typically using two to four implants placed in the anterior interforaminal region, with flapless placement favored for its minimally invasive benefits and rapid recovery, although flap elevation may be necessary when bone modification is required.[24] These implants are often immediately loaded, enabling chairside soft-liner relining and early attachment placement, which shortens treatment time, reduces cost, and yields high long-term success rates exceeding 90% over seven years, though ongoing maintenance such as relining, attachment replacement, and denture repairs is essential. In contrast, intraoral magnets are used either when implant therapy is not feasible due to medical limitations, inadequate bone, or patient preference or as retention aids for partial dentures.[25]

They may be positioned within the denture base or in soft-tissue regions, with pick-up procedures ensuring accurate magnet–keeper alignment; while magnets offer straightforward retention and patient comfort, they require periodic replacement due to potential loss of strength or corrosion. The combined use of MDIs and magnets provides enhanced functional outcomes by improving both vertical and lateral retention, minimizing cantilever forces on implants, and creating simplified yet stable prosthetic designs that integrate anterior mini-implants with ball or locator attachments alongside magnetic units. This hybrid approach leverages the mechanical anchorage of implants and the self-seating advantages of magnets, making it particularly beneficial for patients with anatomical limitations or complex rehabilitation needs, while still maintaining predictable clinical performance and manageable long-term maintenance.[26]

Aspect	Mini Dental Implants (MDIs)	Intraoral Magnets	Conventional Implant Attachments
Surgery	Minimally invasive, flapless, no grafting	Non-surgical or minimal	More invasive, may require grafting
Loading	Immediate or early loading	Passive retention only	Usually delayed loading
Retention	Mechanical ball/O-ring, moderate strength	Magnetic attraction, weaker lateral stability	High mechanical retention (ball/bar/locator)
Patient suitability	Narrow ridges, limited bone, medical compromise, cost-sensitive	Medically compromised, partial denture cases	Healthy patients, adequate bone, esthetics needed
Maintenance	Periodic relines, attachment wear	Magnet corrosion, loss of magnetism	Attachment wear, complex maintenance
Longevity & Strength	Durable but less than conventional	Limited by corrosion and magnet decay	Long-term stability and durability
MRI Compatibility	Compatible	Contraindicated or caution advised	Compatible

VI. DISCUSSION

Compared with conventional implant-retained attachment systems such as ball, bar, and locator designs, mini dental implants (MDIs) and intraoral magnets present a different balance of advantages and limitations that influence clinical decision-making.[26] MDIs offer a minimally invasive surgical approach, rapid treatment progression, suitability for narrow ridges without the need for augmentation, and the possibility of immediate loading, all at relatively lower cost—features that make them particularly beneficial for patients with limited bone availability, restricted finances, or medical considerations that preclude more extensive implant procedures.[27] Nonetheless, the smaller diameter of MDIs renders them mechanically less durable, more susceptible to fracture under high occlusal forces, and potentially less long-lasting compared with conventional wider implants, which provide superior biomechanical stability, better force distribution, and broader prosthetic options, albeit with greater surgical demands, longer healing periods, higher expense, and the prerequisite of adequate bone support. In contrast, intraoral magnets provide passive, user-friendly retention with minimal mechanical stress on supporting structures and are especially valuable when implants are contraindicated or as retention aids for partial dentures; however, their limited lateral stability, corrosion risk if protective coatings fail, possible MRI incompatibility, and need for periodic replacement must be considered.[28]

A rational patient-selection approach would prioritize conventional implant attachments for systemically healthy individuals with sufficient bone and willingness to undergo more invasive procedures, reserve MDIs for patients requiring a conservative, cost-effective, or immediate-loading option, employ magnets in medically compromised or non-implant candidates, and use combined MDI–magnet strategies when enhanced multidirectional retention or simplified prosthetic handling is required.[29] Clinically, achieving insertion torque values of 30–45 Ncm for MDIs, preferring flapless placement when feasible, monitoring magnet housings for corrosion, educating patients on MRI limitations, and maintaining regular follow-up to evaluate attachment and magnet integrity are essential practice considerations. It is also important to recognize the limitations of the current evidence base, which is characterized by small sample sizes, short follow-up durations, heterogeneity in implant and magnet systems, and potential publication bias, underscoring the need for larger, standardized, long-term studies to strengthen clinical guidance in this area.[30]

VII. CONCLUSION

Mini implants and intraoral magnets represent valuable advancements in denture stabilization, offering improved retention, patient comfort, and functional efficiency compared to conventional methods. Their minimally invasive nature and high success rates make them especially suitable for patients with compromised bone anatomy. While current evidence supports their clinical benefits, long-term comparative studies are still needed to optimize selection criteria and treatment protocols. Overall, these modalities significantly enhance prosthetic outcomes and patient quality of life.

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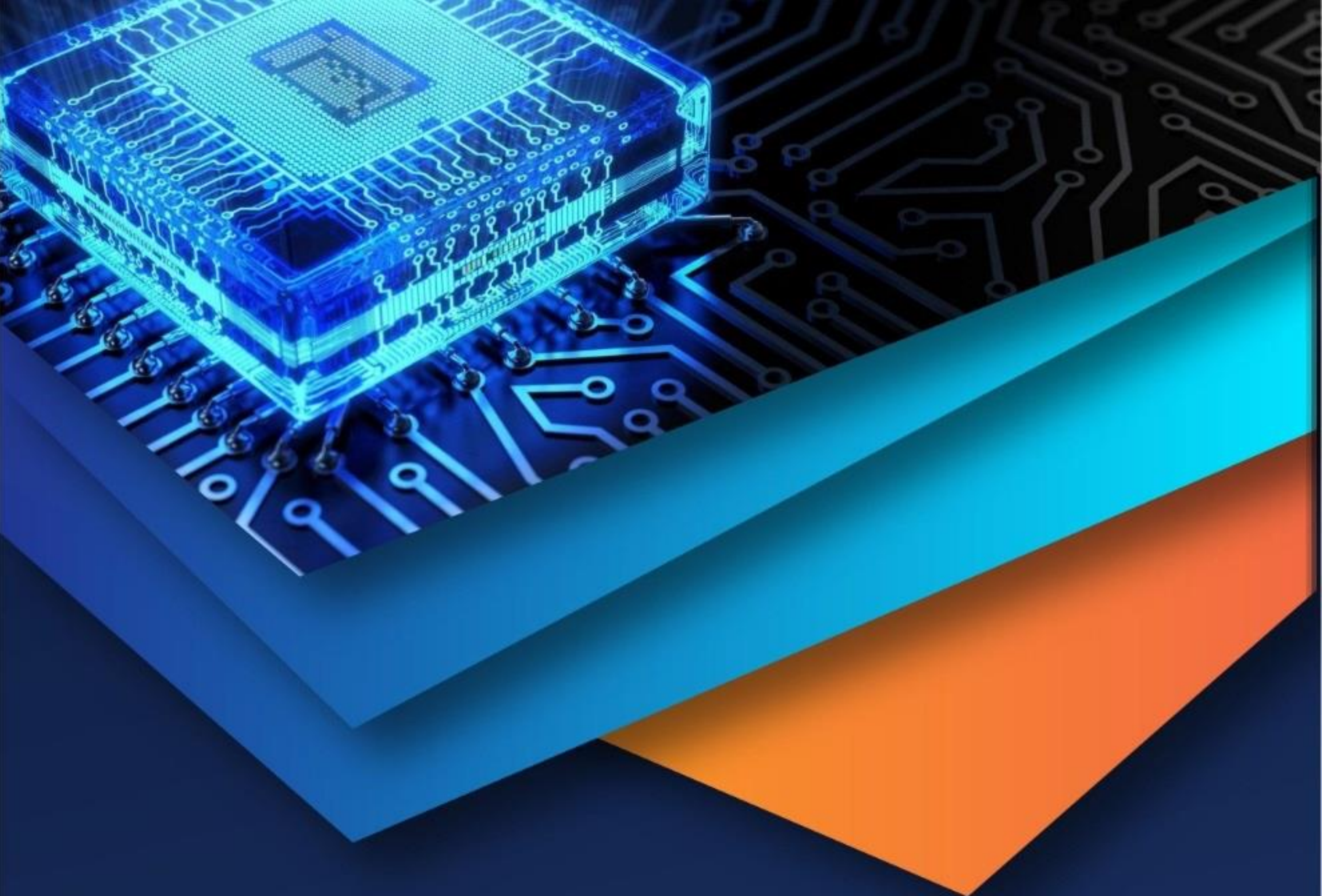

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