ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2024; 10(4): 321-328

www.oraljournal.com
Received: 12-10-2024
Accepted: 16-11-2024

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Bridging Gap: Abutments as sentinels of periimplant health

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DOI: https://doi.org/10.22271/oral.2024.v10.i4e.2078

Abstract
The abutment, a crucial component in dental implant systems, plays a pivotal role in peri-implant tissue health and overall implant longevity. This review explores the influence of abutment design, material, and surface characteristics on peri-implant tissue integration and management. Various abutment materials, including titanium, zirconia, and hybrid composites, exhibit distinct biological responses at the soft tissue interface. The connection type, micro-gap formation, and bacterial colonization are also critical factors affecting peri-implant tissue stability. Clinical protocols for selecting and maintaining abutments to minimize peri-implantitis risks are discussed. Recent advancements in abutment technologies, including CAD/CAM customization and antibacterial surface coatings, provide promising avenues for improving clinical outcomes. Future research should focus on optimizing abutment designs to enhance soft tissue sealing and reduce inflammatory responses around implants.

Keywords: Abutment surface characteristics, antibacterial coatings, CAD/CAM abutments, implant-abutment connection, micro-gap formation, peri-implant tissue stability, peri-implantitis, soft tissue integration, titanium abutments, zirconia abutments

Introduction
Dental implant therapy has become the standard of care in modern dentistry, yet the rising incidence of peri-implant diseases presents a challenge to long-term implant success [1]. Peri-implant diseases include peri-implant mucositis, which is a reversible inflammation of the soft tissues surrounding implants, and peri-implantitis, an irreversible condition marked by inflammation in the peri-implant mucosa and progressive bone loss [2]. First described by Levignac in 1965 and later defined by Mombelli in 1987, peri-implantitis is often considered similar to chronic periodontitis [3]. According to Frank Schwarz in 2017, peri-implantitis is a pathological condition of peri-implant tissues characterized by mucosal inflammation and bone loss [4]. The main cause is bacterial biofilm, with key species such as *Porphyromonas gingivalis*, *Prevotella intermedia*, and Aggregatibacter actinomycetemcomitans identified, alongside factors like smoking, poor oral hygiene, prior periodontitis, genetic predisposition, and implant surface characteristics [5]. Prosthetic designs that impede proper hygiene can exacerbate the disease [6]. Peri-implantitis is classified into early, moderate, and advanced stages, and is diagnosed through probing, microbial evaluation, analysis of peri-implant crevicular fluid or saliva, pocket depth and radiographic assessment of bone loss [Figure 1] [7]. Treatment options range from non-surgical mechanical debridement to surgical interventions aimed at halting disease progression and restoring implant function [8]. Abutments, which connect the implant fixture to the prosthetic restoration, are critical in preventing peri-implant diseases by fostering soft tissue integration, reducing micro movements, and blocking bacterial infiltration [Figure 2] [9].

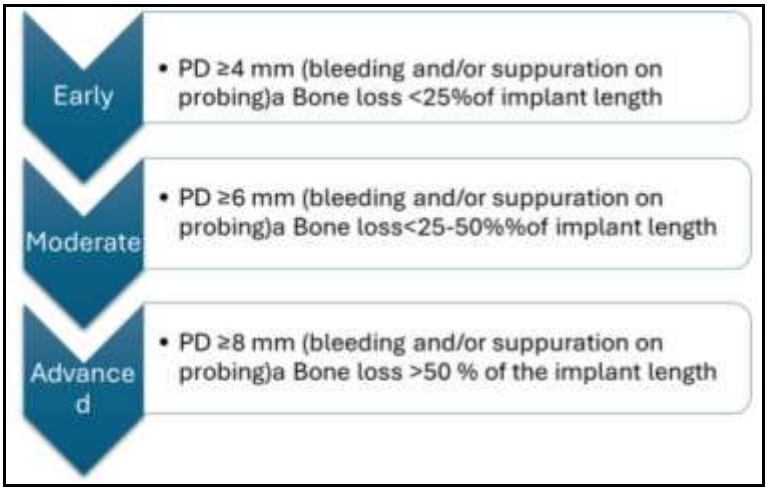
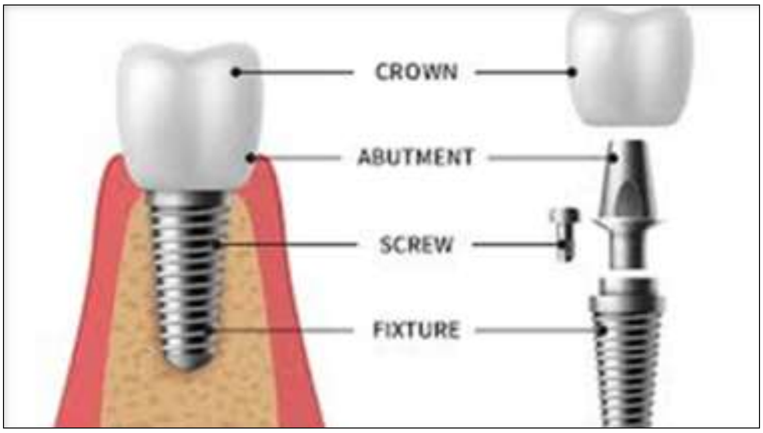


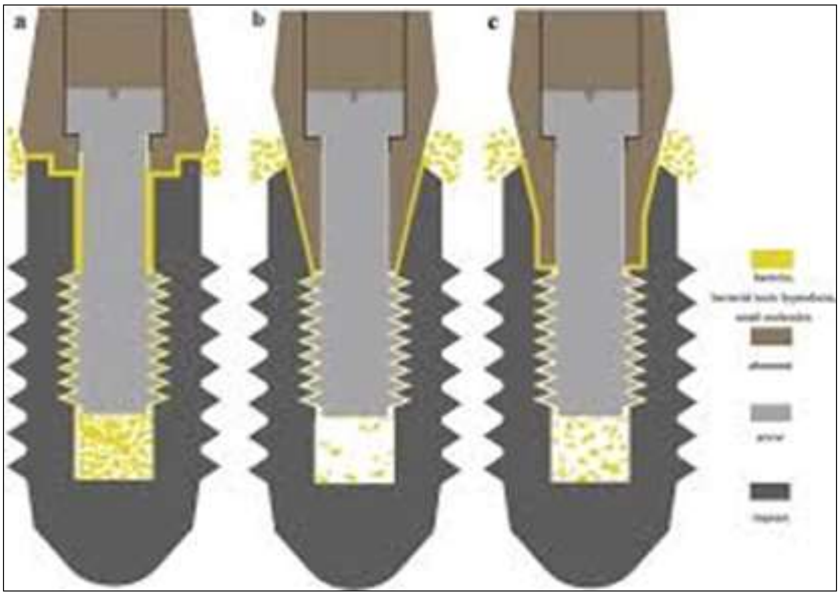
Fig 1: Classification of peri-implantitis (Froum and Rosen 2012)



Courtesy: https://www.fmsdental.com/blog/comprehensive-guide-to-dental-implants-types-and-procedures/

Fig 2: Components of implant system

Innovations such as conical connections and platform switching enhance bacterial sealing and preserve marginal bone, with advanced collar designs, including threads and micro-threads, further stabilizing crestal bone [10]. Studies suggest that micro-threads reduce bone loss compared to machined surfaces, while modern designs without micro-threads also offer excellent bone preservation, particularly in patients with systemic conditions or compromised bone quality. The precision of implant-abutment interfaces is vital, as even micro gaps smaller than 10 microns can contribute to crestal bone loss when combined with micro movements [Figure 3] [11].



Courtesy: Liu Y, Wang J. Influences of microgap and micromotion of implant-abutment interface on marginal bone loss around implant neck. Arch Oral Biol. 2017; 83:153-60.

Fig 3: Microgap and micromotion effects on marginal bone loss at implant-abutment interface

Research, including studies from the University of Gothenburg and Weng *et al*., shows how microgap designs and implant placement influence bone stability, with subcrestal placement of microgaps accelerating bone loss before implant loading [12]. These findings emphasize the importance of careful design, placement, and management to ensure peri-implant health and achieve successful functional and aesthetic outcomes [13]. Marginal bone loss is a crucial factor in determining implant success [14]. Early bone loss, often considered a natural part of the healing process, occurs rapidly during the first year after implant placement [15]. Progressive bone loss is typically seen as an early indicator of peri-implantitis, which may be triggered by initial bone loss [16]. Several factors, including surgical trauma, implant positioning, occlusal overload, implant-abutment connection type, plaque accumulation, and changes to the biological width, can contribute to marginal bone loss around implants, highlighting the need for precise techniques and ongoing management to maintain optimal peri-implant health [Figure 4] [17].

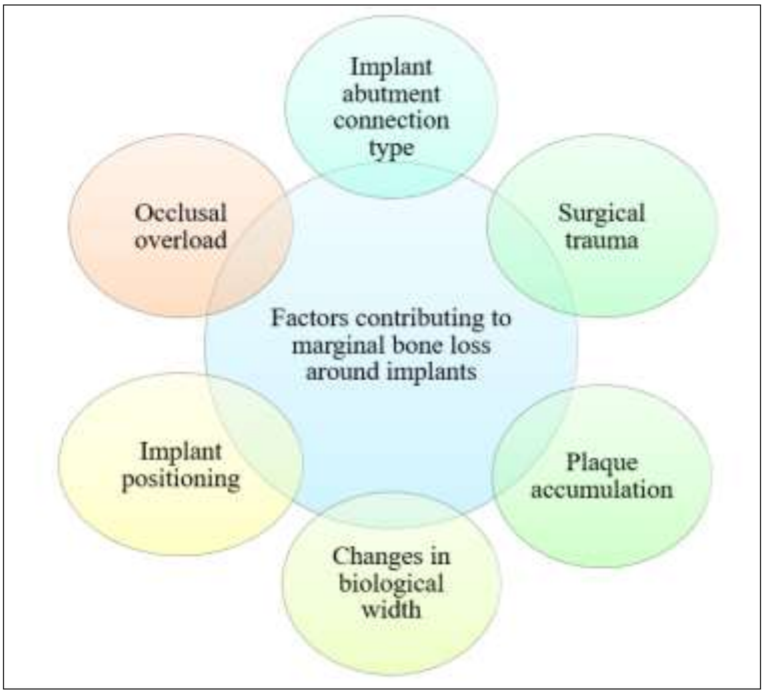


Fig 4: Factors influencing marginal bone loss around implants

Similar to natural teeth, the supracrestal tissue attachment surrounding dental implants serves as a biological barrier against bacterial invasion and food debris at the implant-tissue interface. The height of the abutment has been shown to influence peri-implant marginal bone loss, as it affects the space available for the biological width to re-establish, the distance between the abutment/crown and bone, and the positioning of the subgingival crown margin. This review consolidates key insights on how abutments influence peri-implant health, emphasizing their role in stability, disease prevention, and long-term implant success [18].

Discussion

The evolution of dental implant design highlights the strengths and limitations of both one-piece [Figure 5] and two-piece systems [19].

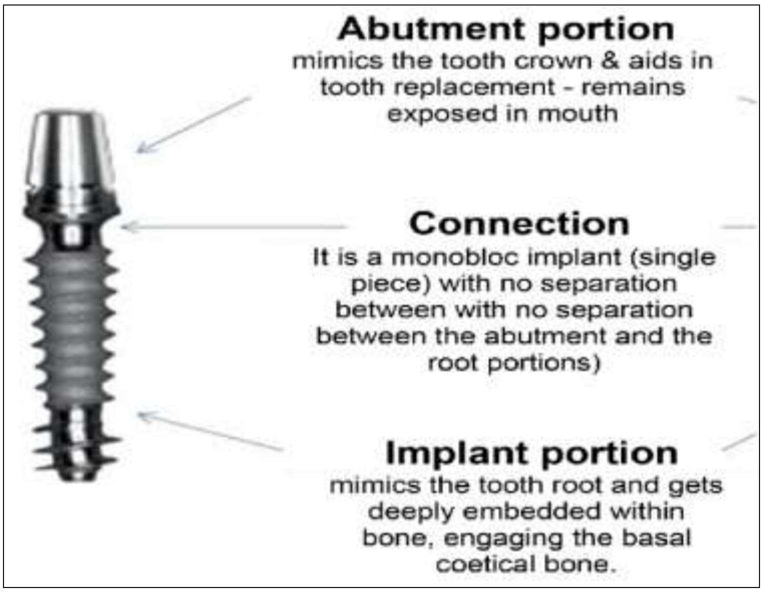


Fig 5: Single piece implant

Studies by Sasada and Cochran suggest that one-piece implants, which lack micro-threads and microgaps, offer favorable long-term outcomes, but challenges such as achieving parallel placement in angulated cases, aesthetic limitations due to crestal bone loss, and visible implant necks in aesthetic zones limit their routine application [20]. To address these issues, two-piece implants were developed, incorporating innovations like reduced-diameter abutment necks, introduced in the 1980s, to preserve crestal bone height and interdental papillae [21]. Notable systems like Bicon and Ankylos enhanced apical load transfer, stability, and outcomes for cement-retained restorations [22]. The development of conical Morse-cone connections has significantly advanced implant systems by creating a tight, virtually one-piece implant-abutment interface that minimizes micro movements, provides bacterial seals, and enhances stability under loading [23]. Systematic reviews confirm that Morse-connections [Figure 6] offer superior performance in terms of abutment fit and long-term stability, with studies showing consistent crestal bone preservation over 13 years, even in subcrestally and epicrestally placed implants [24].

Courtesy: https://www.dentistrytoday.com/the-advantages-of-the-morse-taper-dental-implant-connection/

Fig 6: Morse taper dental implant connection

Advancements in implant abutment design and placement protocols: Advancements in dental implantology have emphasized the critical role of abutment design and placement protocols in ensuring peri-implant tissue stability and mitigating complications. The "platform switching" approach, characterized by a smaller abutment neck diameter relative to the implant platform, was first introduced by Gardner and further validated by Lazzara and Porter through histological studies in humans [25]. This technique has been shown to preserve crestal bone levels, as evidenced by seven systematic reviews and meta-analyses confirming its effectiveness in peri-implant bone maintenance [26]. However, some studies argue that while platform switching contributes to bone stability, other factors, including precise implant positioning, alveolar ridge dimensions, micro motion management, and 3D implant placement, play a more decisive role [27]. Canine studies have highlighted negligible differences in bone remodeling between platform-switched and non-platform-switched implants, attributing crestal bone resorption more to implant design nuances than to platform switching itself [28]. Recent data also suggest that platform switching minimizes tribo-corrosion byproducts, reducing adverse tissue responses through decreased osteoblast viability and cytokine activity [29]. The "one-abutment" protocol, supported by animal and clinical research, has demonstrated advantages in placing definitive abutments at the time of surgery without subsequent disconnection. This method minimizes micro movements, preserves the mucosal seal, and enhances the stability of peri-implant soft and hard tissues [30]. Clinical investigations, such as those by Degidi *et al*., have confirmed the efficacy of this approach in maintaining tissue stability around subcrestally positioned, immediately restored implants, even under challenging conditions like smoking [31]. Additionally, emerging research highlights the impact of abutment geometry on biological width [32]. Abutments with wider, flat emergence profiles are associated with apical displacement of the peri-implant biological width, resulting in crestal bone loss [33].

Conversely, concave abutment neck designs promote the formation of thicker soft tissues around the neck, offering a robust barrier against bacterial invasion. These findings support the adoption of one-piece implants with concave transmucosal components to optimize tissue health and stability [34]. Studies by Cochran *et al*. highlight significantly lower bone loss around implants with non-matching implant-abutment diameters compared to butt-joint connections [35]. While canine studies are fundamental in understanding these dynamics, further clinical evidence is necessary to substantiate these findings for broader application. These advancements emphasize the critical role of abutment design, platform switching, and immediate loading protocols in achieving successful long-term outcomes in dental implant therapy [Figure 7] [36].

Courtesy: https://www.c-tech-implant.com/en/implants/dental-implant/features/platform-switching-implant

Fig 7: Platform switching

The morse-tapered connection

Conical implant-abutment interfaces are widely used today, with their degree of angulation playing a significant role in mechanical and anti-rotational stability [37]. The taper angle of a Morse taper, commonly around 1.49 degrees, creates substantial frictional resistance due to the clamping force [38]. Many systems include additional non-rotational features, such as hexagonal interconnections, to enhance rotational stability and improve the placement accuracy of prosthetic components [39]. Notably, an 11-degree Morse taper has demonstrated superior resistance to microbial leakage compared to butt-joint connections [40]. A poor fit at the implant-abutment interface can result in complications such as abutment overload, screw loosening, improper force distribution, bacterial proliferation, and even implant fracture [41]. Ensuring a precise fit between the abutment and implant is critical for mechanical interlocking, stability, and bacterial sealing [42]. Studies show that Morse tapered connections create a gap smaller than 1 micron, effectively limiting bacterial infiltration, as the smallest bacteria are approximately 1.5 microns in size [43]. Research by Yao *et al.* highlights that optimizing the design of a 5.7-degree Morse-tapered connection reduces the risk of abutment fractures, enhances the longevity of implants, and improves patient satisfaction [44].

A prospective clinical study compared Morse-tapered and butt-joint connections under identical conditions in patients [45]. Implants restored immediately after placement showed that 70% of those with butt-joint connections experienced more than 2 mm of crestal bone loss, compared to only 11% for Morse-tapered connections [46]. This underscores the significance of implant design in maintaining bone levels. Factors such as bone preservation, soft tissue thickness, and keratinized peri-implant mucosa also play a role in crestal bone stability. The use of dental implants has become a standard in oral rehabilitation due to their predictable success. However, implant failures, most commonly due to peri-implantitis, remain a concern. Peri-implantitis, a progressive destructive disease of bacterial or mechanical origin, affects both the hard and soft tissues surrounding the implant [Figure 8] [46].

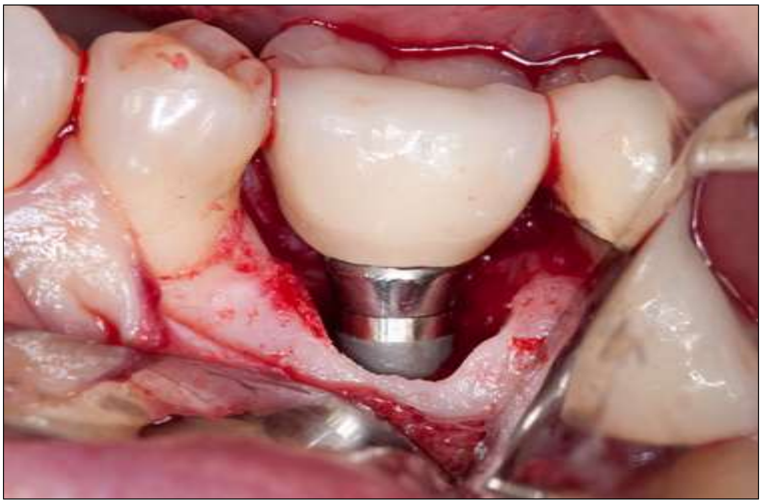


Fig 8: Peri-implantitis

Courtesy: Hsu A, Kim JW. How to manage a patient with peri-implantitis. J Can Dent Assoc. 2014; 79:e24.

Prevalence rates at the implant level range from 6.5% to 47%, and at the patient level from 18.8% to 47% [47]. Dental plaque and associated microorganisms are universally identified as primary etiological factors in peri-implantitis, with mechanical issues being secondary contributors [48]. Additional risk factors include local conditions such as parafunctional habits and anatomical challenges, systemic factors like age, genetics, and diabetes, as well as behavioral factors including oral hygiene and patient compliance [49]. Uncontrolled diabetes significantly raises the risk of peri-implantitis compared to controlled diabetes or healthy sites [50]. Microbiological analysis has identified pathogens such as *Porphyromonas gingivalis*, *Prevotella intermedia*, *Treponema denticola*, *Tannerella forsythia*, *Staphylococcus* species, and viruses like Epstein-Barr and cytomegalovirus. Elevated levels of inflammatory cytokines, particularly IL-1β and TNF-α, are strongly associated with peri-implantitis sites compared to healthy sites, while the roles of IL-6, IL-7, and IL-10 remain less conclusive. These findings highlight the complexity of implant design, patient-specific risk factors, and the need for precise diagnostic and management strategies to ensure the long-term success of dental implant therapy [51]. Peri-implantitis treatment has been explored through both non-surgical and surgical interventions [Figure 9] [52].

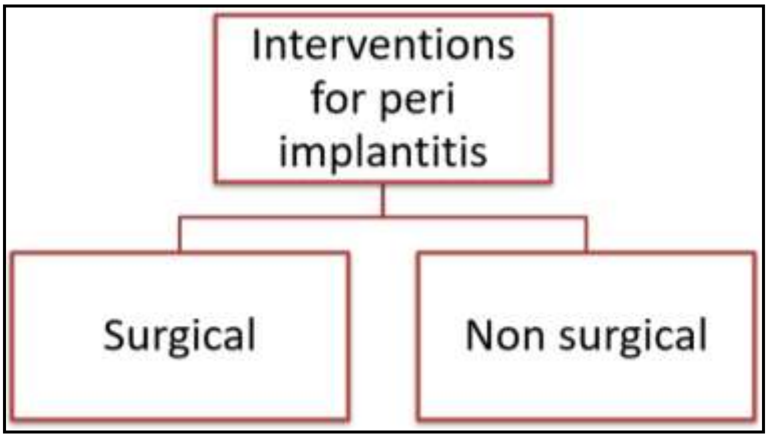


Fig 9: Treatment approaches for peri-implantitis

Non-surgical therapy includes modifications to the implant surface, soft tissue debridement, and the adjunctive use of antimicrobials, lasers, and host-modulatory agents. While non-surgical therapy is effective in eliminating local etiologic factors, it may not be effective in treating osseous defects. Surgical interventions involve flap reflection, debridement, and the use of various bone graft materials and membranes. The combination of bone grafts with guided tissue regeneration membranes has been proven to be the most effective treatment option with long-term predictable results. As the demand for dental implants increases, so does the incidence of peri-implant diseases. Therefore, understanding the etiology, pathogenesis, and treatment strategies for these conditions should be given equal importance [53]. [Table 1] presents an overview of various studies on abutment design, material, and protocols affecting peri-implant health and bone preservation.

Table 1: Overview of studies on abutment design

Study	Authors	Year	Focus	Findings
Platform switching and bone preservation	Lazzara and Porter [25]	2006	Effect of platform switching on marginal bone preservation	Platform switching reduces crestal bone loss by shifting inflammatory response away from the bone-implant interface.
Microgap and peri-implant bone loss	Weng *et al.* [12]	2008	Influence of implant-abutment microgap on peri-implant bone loss	Microgaps contribute to crestal bone loss; subcrestal placement of microgaps accelerates bone resorption.
One-abutment one-time protocol	Abrahamsson *et al.* [55]	2009	Concept of single abutment placement without repeated disconnection	Reduces peri-implant marginal bone loss and maintains biological width.
The Role of abutments in peri-implant health	Degidi *et al.* [31]	2013	Impact of "one-abutment" concept on tissue stability	Non-removal of abutments improves peri-implant soft and hard tissue stability in immediately restored implants.
Abutment material on peri-implant tissues	Canullo *et al.* [56]	2016	Effect of titanium vs. zirconia abutments on peri-implant soft tissue	Zirconia abutments improve soft tissue integration; titanium abutments exhibit higher bacterial colonization.
Abutment connection type and bone loss	Schwarz *et al.* [3]	2017	Comparison of Morse-taper vs. butt-joint connections	Morse-tapered connections minimize micromovements and bacterial infiltration, preserving crestal bone.
CAD/CAM abutments and peri-implant health	Mangano *et al.* (57)	2019	Role of custom CAD/CAM abutments in promoting tissue stability	CAD/CAM abutments provide precise fit and reduce microbial leakage at the implant-abutment interface.
CAD/CAM abutments and peri-implant health	Mangano *et al.* [57]	2019	Role of custom CAD/CAM abutments in promoting tissue stability	CAD/CAM abutments provide precise fit and reduce microbial leakage at the implant-abutment interface.
Antibacterial coatings for abutments	Rupprecht *et al.* [58]	2021	Development and efficacy of antibacterial coatings for abutments	Coatings reduce bacterial colonization, decreasing peri-implant inflammation and infection rates.

Future prospects in peri-implant management and the role of the abutment

The future of peri-implant management through advancements in abutment technology is promising, with several exciting prospects:

1. **Innovative materials:** Development of bioactive and biocompatible materials, such as functionalized zirconia or titanium alloys with enhanced antibacterial properties, may improve soft tissue integration and reduce the risk of peri-implantitis (59).
2. **Surface engineering:** Advances in surface modifications, including nano-texturing, bioactive coatings, and drug-eluting surfaces, hold potential for fostering superior tissue attachment and long-term peri-implant health (60).
3. **Customized abutments:** CAD/CAM technology will continue to evolve, enabling the creation of highly personalized abutments that closely align with the patient's anatomical and functional requirements, improving both aesthetics and outcomes (61).
4. **Improved implant-abutment connections:** Enhanced connection designs, such as conical or Morse taper connections, aim to minimize micro-gaps and bacterial infiltration, ensuring greater peri-implant stability.
5. **Digital integration:** Advances in digital workflows, incorporating intraoral scanning and AI-driven design, will streamline abutment selection and manufacturing, leading to higher precision and consistency (62).
6. **Biological integration:** Future research may focus on biomimetic abutments designed to replicate natural periodontal structures, promoting seamless integration with soft tissues and enhanced long-term outcomes.
7. **Long-term monitoring:** Integration of smart technologies, such as sensor-embedded abutments, could enable real-time monitoring of peri-implant health, early detection of complications, and data-driven maintenance strategies.

These prospects highlight the potential for transformative advancements in peri-implant care, with the ultimate goal of achieving optimal tissue health, longevity, and patient satisfaction (63).

Conclusion

The abutment plays a critical role in the success and longevity of dental implants by influencing peri-implant tissue health, osseointegration, and resistance to bacterial colonization. Factors such as material choice, surface characteristics, and connection design significantly impact soft tissue integration and the prevention of peri-implantitis. Advances in abutment customization, including CAD/CAM technology and antibacterial surface treatments, provide promising solutions for optimizing peri-implant health. A thorough understanding of these factors, combined with rigorous clinical protocols, can enhance treatment outcomes and reduce complications. Future research should focus on improving abutment design to better mimic natural tissues and further mitigate the risk of peri-implant diseases.

Financial support and sponsorship

Nil

Conflicts of interest

There are no conflicts of interest

References

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria for success. International Journal of Oral and Maxillofacial Implants. 1986;1(1):11-25.
2. Binon PP. The effect of implant/abutment hexagonal misfit on screw joint stability. International Journal of Prosthodontics. 1996;9(2):149-160.
3. Schwarz F, Hegewald A, Becker J. Impact of implant-abutment connection on the clinical outcomes of dental implants: A systematic review. Clinical Oral Investigations. 2017;21(4):703-717.
4. Cochran DL, Schenk RK, Lussi A, Higginbottom FL, Buser D. Bone response to loaded and unloaded titanium implants with a sandblasted and acid-etched surface: A histometric study in the canine mandible. Journal of Biomedical Materials Research. 1998;40(1):1-11.
5. Hermann JS, Cochran DL, Nummikoski PV, Buser D. Crestal bone changes around titanium implants: A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible. Journal of Periodontology. 1997;68(11):1117-1130.
6. Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontology 2000. 1994;4:127-138.
7. Cardaropoli G, Lekholm U, Wennström JL. Tissue alterations at implant-supported single-tooth replacements: A 1-year prospective clinical study. Clinical Oral Implants Research. 2006;17(2):165-171.
8. Friberg B, Andersson B, Bergström C, *et al*. A 10-year follow-up study of patients with single-tooth implants placed in the anterior maxilla. Clinical Oral Implants Research. 2007;18(5):660-665.
9. Hämmerle CH, Jung RE. Bone augmentation by means of barrier membranes. Periodontology 2000. 2003;33:36-53.
10. Lindhe J, Meyle J. Peri-implant diseases: Consensus report of the Sixth European Workshop on Periodontology. Journal of Clinical Periodontology. 2008;35(8):282-285.
11. Atieh MA, Ibrahim HM, Atieh AH. Platform switching for marginal bone preservation around dental implants: A systematic review and meta-analysis. Journal of Periodontology. 2010;81(10):1350-1366.
12. Weng D, Nagata MJH, Bell M, Bosco AF, Melo LGN, de Lima AF. Influence of microgap location and configuration on peri-implant bone morphology in nonsubmerged implants: An experimental study in dogs. International Journal of Oral and Maxillofacial Implants. 2008;23(4):710-716.
13. Canullo L, Caneva M, Tallarico M, Radovanovic S, Covani U. Microbial colonization at the implant-abutment interface and its possible influence on peri-implantitis: A systematic review and meta-analysis. Journal of Prosthodontic Research. 2016;60(3):139-145.
14. Misch CE. Contemporary Implant Dentistry. 3rd ed. St. Louis: Mosby; c2007.
15. Gross M, Abramovich I, Weiss EI. Microleakage at the abutment-implant interface of osseointegrated implants: A comparative study. International Journal of Oral and Maxillofacial Implants. 1999;14(1):94-100.
16. Lang NP, Wilson TG, Corbet EF. Biological complications with dental implants: Their prevention, diagnosis, and treatment. Clinical Oral Implants Research. 2000;11(1):146-155.
17. Rasperini G, Canullo L, Dellavia C, Pellegrini G, Simion M. Crestal bone changes at platform-switched implants under different loading protocols: A pilot study. International Journal of Periodontics and Restorative Dentistry. 2010;30(2):131-139.
18. Koo KT, Kim JJ, Kim CS, Lee HJ, Jung UW, Choi SH. The effects of bone grafting material and a collagen membrane in the treatment of peri-implant dehiscence: An experimental study in dogs. Clinical Oral Implants Research. 2012;23(2):100-106.
19. Dua P, Grover M, Gupta A, Rawat S, Kaushik N, Chopra R. Single-piece implant rehabilitation within 72 hours. International Journal of Dental Sciences and Innovative Research. 2024;7(3):1-6.
20. Sasada Y, Cochran DL. Implant-abutment connections: A review of biologic consequences and peri-implant outcomes. International Journal of Oral and Maxillofacial Implants. 2017;32(6):1296-1307.
21. Shibli JA, Piatelli A, Iezzi G, Mangano C, Mangano F, Onuma T, *et al*. Bone-to-implant contact around immediately loaded titanium implants with a bioactive surface (*Biomimetic Monitored Osseointegration*): Histological and histomorphometrical analysis in humans. Clinical Oral Implants Research. 2013;24(8):850-856.
22. Schwarz F, Becker K, Sager M. Efficacy of professionally administered plaque removal in managing peri-implant mucositis: A systematic review and meta-analysis. Journal of Clinical Periodontology. 2015;42(16):202-213.
23. Gardner DM. Platform switching as a means to achieving implant esthetics. New York State Dental Journal. 2005;71(3):34-37.
24. Schmitt CM, Nogueira-Filho G, Tenenbaum HC, Lai JY, Brito C, Döring H, *et al*. Performance of conical abutment (Morse-taper) connection implants: A systematic review. Journal of Biomedicine and Materials Research A. 2014;102(2):552-574.
25. Lazzara RJ, Porter SS. Platform switching: A new concept in implant dentistry for controlling post-restorative crestal bone levels. International Journal of Periodontics and Restorative Dentistry. 2006;26(1):9-17.
26. Sanz M, Chapple IL. Clinical research on peri-implant diseases: Consensus report of Working Group 4. Journal of Clinical Periodontology. 2012;39(12):202-206.
27. Buser D, Chen ST, Weber HP, Belser UC. Early implant placement following single-tooth extraction in the esthetic zone: Biologic rationale and surgical procedures. International Journal of Periodontics and Restorative Dentistry. 2008;28(5):441-451.
28. Romanos GE, Biltucci MT, Barros RR, Shibli JA. Peri-implant bone loss around immediately restored rough- and machined-surface implants in the posterior maxilla of nonhuman primates. International Journal of Oral and Maxillofacial Implants. 2010;25(1):123-129.
29. Chrcanovic BR, Albrektsson T, Wennerberg A. Platform switch and dental implants: A meta-analysis. Journal of Dentistry. 2015;43(6):629-646.
30. Kotsovilis S, Fourmousis I, Karoussis IK, Bamia C. A comprehensive and critical review of dental implant placement in diabetic animals and patients. Clinical Oral Implants Research. 2006;17(5):587-599.

31. Degidi M, Nardi D, Piattelli A. The one abutment-one time concept: A retrospective study on 1, 562 implants. Clinical Implant Dentistry and Related Research. 2013;15(3):332-340.
32. Rodrigo D, Aracil L, Martin C, Sanz M. Diagnosis of implant stability and its impact on implant survival: A prospective case series study. Clinical Oral Implants Research. 2010;21(3):255-261.
33. Kourtis S, Sotiriadou S, Voliotis S, Doukoudakis A. Private practice results of dental implants. Part I: Survival and evaluation of risk factors. Part II: Surgical and prosthetic complications. Implant Dentistry. 2004;13(4):373-385.
34. Brunski JB. Biomechanical factors affecting the bone-dental implant interface. Clinical Materials. 1992;10(3):153-201.
35. Cochran DL, Buser D, ten Bruggenkate CM, Weingart D, Taylor TM, Bernard JP, *et al*. The use of reduced healing times on ITI implants with a sandblasted and acid-etched (SLA) surface: Early results from clinical trials on SLA implants. Clinical Oral Implants Research. 2002;13(2):144-153.
36. Oh TJ, Yoon J, Misch CE, Wang HL. The causes of early implant bone loss: Myth or science? Journal of Periodontology. 2002;73(3):322-333.
37. Norton MR. Assessment of cold welding properties of the internal conical interface of two commercially available implant systems. Journal of Prosthetic Dentistry. 1999;81(2):159-166.
38. Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. International Journal of Oral Surgery. 1981;10(6):387-416.
39. Quirynen M, Van Assche N, Botticelli D, Berglundh T. How does the timing of implant placement to extraction affect outcome? International Journal of Oral and Maxillofacial Implants. 2007;22:203-23.
40. Naert I, Duyck J, Hosny M, Van Steenberghe D. Freestanding and tooth-implant connected prostheses in the treatment of partially edentulous patients. Part I: An up to 15-year clinical evaluation. Clinical Oral Implants Research. 2001;12(3):237-244.
41. Cho HW, Kim JM, Kim YK, Lee JB. Clinical evaluation of the effect of implant-abutment connection design on marginal bone level: A 5-year retrospective study. Journal of Periodontology. 2018;89(2):197-205.
42. Patel VV, Russell JS, Carlson ER. Implant-based therapy in patients with osteoporosis: A review of evidence. Journal of Oral and Maxillofacial Surgery. 2007;65(11):2496-2502.
43. Buser D, von Arx T, Zembic A, Martin W. Early implant placement with a resorbable membrane for bone augmentation: A retrospective analysis. Clinical Implant Dentistry and Related Research. 2010;12(2):131-140.
44. Gaddo M, Carlsson GE, Jönsson M. Implant rehabilitation of edentulous patients with advanced bone loss: A systematic review. Journal of Prosthetic Dentistry. 2012;108(5):302-311.
45. Paolantonio M, Punzi L, Ferrara L, D'Ercole S, Boccellino M, Pagnotti P. Impact of smoking on the risk of peri-implantitis: A systematic review and meta-analysis. Clinical Oral Implants Research. 2019;30(5):469-478.

How to Cite This Article
Wadhawan R, Verma B, Pachauri R, Sharma P, Chatterjee R, Jhingan J. Bridging Gap: Abutments as sentinels of periimplant health. International Journal of Applied Dental Sciences. 2024; 10(4): 321-328.