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Opinion

Peri-Implantitis: The Biomaterial Biofilm-Associated Polymicrobial Infection could be the Main Cause of Dental Implant Failure

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Abstract

In the past few decades, dental implants have proven aesthetic outcomes to gain recognition as the best treatment options for replacing missing or failing teeth with the optimal partnership of the patient and the Prosthodontist/Implantologist/ Restorative Dentistry Specialist. Polymicrobial biofilm formation on titanium surfaces becomes the main risk factor for inflammatory processes on tissues surrounding implant devices coupled with bone loss, which leads to implant failure. In an era of evidence-based dental medicine, considering the past and present medical histories of the patient to rule out possible elevated risk implant failure becomes a cause for concern. Periodontitis and peri-implantitis are polymicrobial infectious diseases on one hand. On the other hand, both have hyper-immune responsiveness from the host. There is no consistency in the finding of peri-implantitis-associated microbiome due to methodological variations in metagenomic studies conducted to this date. Moreover, there is controversy over the difference in microbiome profiles among peri-implantitis and periodontitis. Putative periodontal pathogens seem to flourish in peri-implants-affected sites, suggesting the increasing virulence of those oral pathogens in dysbiosis and immunosuppressive conditions. Peri-implantitis biomaterial biofilm-associated polymicrobial infection called peri-implantitis could be among the root causes of dental implant failure with remaining unresolved issues and intrigue intricacies. Against this backdrop, this opinion aims to provide novel insights into the potential of dental implantology to unravel the mysteries in microbiology of peri-implantitis with a view to resolving the problem, though the work is still in its infancy. A lot more rigorous research is warranted in this regard, not only to define the implant associated microbiome but also to find a trustworthy solution to biological implant failure at the dawn of antibiotic-coated biomaterial production.

Opinion

Peri-implantitis the biomaterial biofilm associated polymicrobial infections as the main cause of dental implant failure

Introduction

Polymicrobial infections as well as losing teeth due to missed opportunities in restorative or conservative dental treatment are preventable in the era of evidence-based dental medicine [1]. Regular dental checkups and good oral hygiene practices in an adult could ensure preserving the natural or functional teeth at old age thus limiting the involvement of a Prosthodontist [1], except in reconstructive surgeries [2] of oral cancer patients and seriously injured patients with maxillofacial and oro-dental trauma. Dental implants have been one of the most popular treatment decisions of Prosthodontists across the globe, especially in the last few decades [3] for replacing missing, lost or failing teeth in fully or partially edentulous [4], with high survival rates of up to 99% over 10 years [5]. Titanium (Ti) has been the biomaterial of choice for orthopedic and dental implant devices owing to its high biocompatibility imparted by its physical-chemical properties of excellent osseointegration outcomes [6]. Both periodontitis and peri-implantitis are infections with polymicrobial aetiology [7], due to microbial dysbiosis leading to increasing virulence in pathobiont as a consortium but not as a single pathogen [7]. Commensal members in the oral microbiome in eubiosis are equipped with pathogenic potential in dysbiosis to act as opportunistic pathogens not acquired from the external environment. Concomitant to the massive improvements in Next-Generation Sequencing (NGS) technologies, dental implantologist shares an equal opportunity with the metagenomic researcher to understand the cascade of events in peri-implantitis and generalized aggressive periodontitis. Periodontitis may be an oral manifestation of generalized immunosuppression commonly encountered in diabetes mellitus, pregnancies and neoplasms [8] whereas, in peri-implantitis, chronic inflammation of peri-implant tissues is the host's immune response to biofilm associated infection around the implanted biomaterial [9]. Crown loosing or ceramic chipping are easily resolvable complications of dental implants. However, the biological failure of perfectly manufactured dental implants is still challenging. Hence, insult due to biomaterial associated polymicrobial infections is considered as the main foe of dental implant sustainability [10]. Against this backdrop, dental implantology emerges as a promising research arena when combined with metagenomic research and animal experiments. In the light of available evidence, this opinion briefs you on the possibility of indigenous infections of polymicrobial origin as the main cause of dental implant failure, from an oral microbiologist's point of view.

Peri-implantitis the biomaterial biofilm associated polymicrobial infections as the main cause of dental implant failure

Peri-implantitis is a polymicrobial infection occurring in adjacent tissues of dental implants characterized by inflammation in peri-implant mucosa clinically diagnosed by increased probing depths compared to baseline measurements [11-13]. Peri-implantitis seems to start with peri-implant mucositis [14]. The biomaterial of a dental implant may be the physical and chemical stress factor triggering the biofilm formation and subsequent inflammatory process on surrounding tissues [15] may cause the biological failure of an excellent dental implant in a patient with at least one of the past and Present Medical History (PMH) of osteoporosis, anti-bone resorptive medication, diabetes mellitus, cardiovascular diseases, immune deficiency, tobacco and alcohol abuse. Additionally, local factors, a history of radiation therapy and oral mucosal diseases might interfere with the sustainability of peri-implant health and proper maintenance of peri-implant tissues [16].

The oral cavity accommodates the second-highest diverse Meta community, comprising the minimum number of 700 bacterial species [15]. The first biological response immediately after the dental implantation is protein adsorption. Lima and colleagues [16] demonstrated that the pellicle protein composition on Ti surfaces is different compared with hydroxyapatite surfaces (the main mineral of tooth enamel), confirming the effect of material surfaces in the oral environment in modulating protein adsorption [16]. The protein layer adsorbed on implant surfaces seems responsible for subsequent cellular events, such as microbial, host cell adhesion, succession in biofilm formation and the osseointegration process of dental implants [17]. Interaction among co-aggregated oral bacterial species facilitates the succession and accomplishment of the biofilm formation incorporating late colonizers [18]. The early colonization patterns differed in dental implant and tooth surfaces. The red complex: *Porphyromonas gingivalis* (P<0.05), *Tannerella forsythia* (P<0.01), and *Treponema denticola* (P<0.001) among the putative periodontal pathogens detected immediately after surgery to 12 weeks at implant sites. No information provided on the baseline oral hygiene status or periodontal disease condition of the same patient which could be considered as a notable limitation [19]. *Aggregatibacter actinomycetemcomitans* and *Prevotella intermedia* are the other putative periodontal pathogens elevated in higher proportions of peri-implantitis samples [20]. In other studies, *Streptococcus salivarius* [20] *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and viruses were found in peri implantitis samples [21]. Interestingly, periodontitis and peri-implantitis share many commonalities such as biofilm-mediated infections, hyper inflammatory reactions, and progressive absorption of alveolar bone [22]. Still, there is controversy on the composition of biofilm of peri-implantitis [23]. Unfortunately, 16S-rRNA gene sequencing using the Illumina-MiSeq platform could not resolve the problem. More than 40% and greater than 22% of dental implants are affected by mucositis and peri-implantitis respectively [24]. However, meticulous case selection with risk strartification, the well-controlled non-communicable diseases such as diabetes, maintenance of optimal oral hygiene, meticulous infection control in surgery and post-operative care could have effectively prevented and controlled mocositis and especially peri-implantitis. An antibiotic-loaded coating on Ti material appears as a long-term solution in this regard. The ability to reload the surface to maintain an effective local bacteriostatic and bactericidal effect at the implant surface without affecting the host response or causing cytotoxicity to the host tissues surrounding the implants emerges as a future challenges [25]. Powered studies with rigorous methodology are much warranted to resolve the mysteries and clear the ambiguity in compositional similarities of peri-implantitis and periodontitis-associated microbiomes. Obviously, much work is warranted in unravelling and defining peri-implantitis-associated microbiome, even though there is promising evidence on red complex periodontal pathogens in the affected sites of peri-implantitis. Therefore, collaborative partnership of Prosthodontist/ restorative dental specialist/ Implantologist, oral microbiologist and the patient would be the way forward.

Conclusion

Peri-implantitis: the biomaterial biofilm-associated polymicrobial infections are among the root causes of biological dental implant failure. Addressing poor oral hygiene status, periodontitis and considering other comorbidities that may act as risk factors for dental implant failure are of prime importance before embarking onto dental implants as the most suitable treatment option to replace missing teeth in the promising era of dental implantology technology from the oral microbiologist's point of view.

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References

1. Lamloum D, Arghittu A, Ferrara P, Castiglia P, Dettori M, et al. (2023) A systematic review of clinical practice guidelines for caries prevention following the AGREE II checklist. Healthcare (Basel) 11(13): 1895.
2. Chuka R, Abdullah W, Rieger J, Nayar S, Seikaly H, et al. (2017) Implant utilization and time to prosthetic rehabilitation in conventional and advanced fibular free flap reconstruction of the maxilla and mandible. Int J Prosthodont 30(3): 289-294.
3. Himanshu A (2023) Titanium: the ideal dental implant material choice. Surface modification of titanium dental implants. Cham. Springer International Publishing, Switzerland, pp. 1-21
4. Guo T, Gulati K, Arora H, Han P, Fournier B, et al. (2021). Race to invade: Understanding soft tissue integration at the transmucosal region of titanium dental implants. Dental Materials 37(5): 816-831.
5. Kuchler U, Chappuis V, Gruber R, Lang NP, Salvi GE (2016) Immediate implant placement with simultaneous guided bone regeneration in the esthetic zone: 10-year clinical and radiographic outcomes. Clin Oral Implants Res 27(2): 253-257.
6. Spriano S, Yamaguchi S, Baino F, Ferraris S (2018) A critical review of multifunctional titanium surfaces: new frontiers for improving osseointegration and host response, avoiding bacteria contamination. Acta Biomater 79: 1-22.
7. Zhang Y, Li Y, Yang Y, Wang Y, Cao X, et al. (2022) Periodontal and peri-implant microbiome dysbiosis is associated with alterations in the microbial community structure and local stability. Front Microbiol 12: 785191.
8. Perera L, Perera I (2020) Revisiting for resolving: The ecological perspective of periodontal bacteriome for prevention and control of periodontitis in COVID-19 Era. J Dental Sci 5(4): 000275.
9. Jung RE, Zembic A, Pjetursson BE, Zwahlen M, Thoma DS (2012) Systematic review of the survival rate and incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clin. Oral Implants Res 23(Suppl 6): 2-21.
10. Nguyen V, Hao J, Chou J, Oshima M, Aoki K, et al. (2017). Ligature induced peri-implantitis: tissue destruction and inflammatory progression in a murine model. Clin Oral Implants Res 28(2): 129-136.
11. Lang NP, Berglundh T (2011) Periimplant diseases: where are we now?–Consensus of the Seventh European Workshop on Periodontology. J Clin Periodontol 11(38 Suppl): 178-181.
12. Smeets R, Henningsen A, Jung O, Heiland M, Hammacher C, et al. (2014) Definition, etiology, prevention and treatment of peri-implantitis a review. Head Face Med 10: 34.
13. Marsh PD, Devine DA (2011) How is the development of dental biofilms influenced by the host? J Clin Periodontol 38(11): 28-35.
14. Carra MC, Blanc-Sylvestre N, Courtet A, Bouchard P (2023) Primordial and primary prevention of peri-implant diseases: A systematic review and meta-analysis, Journal of Clinical Periodontology 50(S26): 77-112.
15. Perera M, Al-hebshi NN, Speicher DJ, Perera I, Johnson NW (2016) Emerging role of bacteria in oral carcinogenesis: a review with special reference to perio-pathogenic bacteria. J Oral Microbiol 8: 32762.
16. Lima EM, Koo H, Vacca Smith AM, Rosalen PL, Del Bel Cury AA (2008) Adsorption of salivary and serum proteins, and bacterial adherence on titanium and zirconia ceramic surfaces. Clin Oral Implants Res 19(8): 780-785.
17. Kalasin S, Santore MM (2009) Non-specific adhesion on biomaterial surfaces driven by small amounts of protein adsorption. Colloids Surf B Biointerfaces 73(2): 229-236.
18. Kolenbrander PE, Palmer RJ, Rickard AH, Jakubovics NS, Chalmers NI, et al. (2006) Bacterial interactions and successions during plaque development. Periodontol 2000 42: 47-79.
19. Furst MM, Salvi GE, Lang NP, Persson GR (2007) Bacterial colonization immediately after installation on oral titanium implants. Clin Oral Implants Res 18(4): 501-508.
20. Persson GR, Renvert S (2014) Cluster of bacteria associated with peri-implantitis. Clin Implant Dent Relat Res 16(6): 783-793.
21. Schwarz F, Derks J, Monje A, Wang HL (2018) Peri-implantitis. J Periodontol 89(Suppl 1): S267-S290.
22. Liu Y, Liu Q, Li Z, Acharya A, Chen D, et al. (2020) Long non-coding RNA and mRNA expression profiles in peri-implantitis vs periodontitis. J Periodontal Res 55(3): 342-353.
23. Sahrmann P, Gilli F, Wiedemeier DB, Attin T, Schmidlin PR, et al. (2020) The microbiome of peri-implantitis: A systematic review and meta-analysis. Microorganisms 8(5): 661.
24. Apatzidou D, Lappin DF, Hamilton G, Papadopoulos CA, Konstantinidis A, et al. (2017) Microbiome associated with peri-implantitis versus periodontal health in individuals with a history of periodontal disease. J Oral Microbiol 9(sup1): 1325218.
25. Akshaya S, Rowlo PK, Dukle A, Nathanael AJ (2022) Antibacterial coatings for titanium implants: Recent trends and future perspectives. Antibiotics 11(12): 1719.