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NARRATIVE REVIEW

Systemic Factors in Dental Implant Therapy: Insights from the Literature

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ABSTRACT

Objective: Dental implant therapy has emerged as a reliable and widely accepted solution for rehabilitating partially or fully edentulous patients. This review aims to explore the evolution of dental implant success metrics and the critical patient-related factors influencing implant outcomes.
Background: Dental implants have undergone significant advancements since the clinical success reports in the 1970s and 1980s. The initial focus on long-term implant survival has expanded to include considerations of aesthetics, functionality, and patient satisfaction. These developments have been driven by the advent of improved implant surfaces, innovative surgical techniques, and a more comprehensive understanding of success criteria.
Significance: Modern dentistry requires more than providing functional solutions for missing teeth. Patients now demand long-lasting aesthetic and functional outcomes that align with enhanced quality of life and their overall health. Thus, dental professionals must navigate a range of systemic, anatomical, and physiological factors when planning implant therapy.
Conclusion: Delivering successful dental implant treatment necessitates a thorough understanding of patient-specific variables, including health conditions, longevity, and expectations. By addressing these factors, clinicians can optimize outcomes, ensuring patient satisfaction and treatment longevity.

The experimental studies run by Brånemark and Schroeder demonstrated the concept of direct bone-to-titanium affinity,[1, 2] this biological concept is now widely utilized and referred to as osseointegration. The original implants used showed success rates of 90 and 95%, depending on the follow-up.[3] The evolution of micro-rough surfaces, such as sandblasted and acid etching, showed both faster and improved bone healing as well as higher primary stability.[3-5] This evolution led to improved survival rates, which are reported to be as high as 98.8% over a ten-year follow-up period. This improvement in implant surface technology has widened the scope for potential patients to be considered for treatment.[3,6]

Implant success is often reported as survival rate,[7] which implies that implants are present no matter the condition for a certain time, this criterion was described when different implant designs were in their genesis, and the Brånemark design was not as widely used as it is today. However, the success rate of implants varies significantly across studies. This is due to the different clinical parameters incorporated in the study design, particularly the definition of success criteria, which will materially affect results.[8, 9] During the last decade, the mere survival of implants has satisfied neither dentists' nor patients' expectations. More sophisticated techniques of bone preservation, soft and hard tissue grafting, implant site preparation, instruments, materials, biology, and physiology knowledge have been produced in search of an ideal protocol that allows us to reproduce the idea of healthy dental implant therapy.[10-12]

With the increase in an ageing population requiring implant therapy, systemic health has become more prevalent, and some other factors must be considered at the moment of planning a dental rehabilitation with dental implants. The burden of diseases and injuries for adults 70 years and older has been reported elsewhere.[13, 14] The most common systemic conditions in geriatric patients include cardiovascular disease, cancer, diabetes mellitus, osteoarthritis, respiratory disease, and neurocognitive impairment.

The risks for these conditions can be associated with complications during implant surgery, obstructing osseointegration, peri-implant tissue response and the cumulative impact on implant survival. This review aims to describe the most common systemic conditions affecting dental implant therapy success as reported in recent literature.

MATERIALS AND METHODS

A thorough literature search was conducted across multiple databases, including PubMed, Google Scholar, Scopus, and the University of Sydney's scientific article repository. The search focused on identifying peer-reviewed, English-language studies published up to August 30, 2022. The keywords used in the search included *"Dental implant," "implant survival," "systemic disease," "implant success," "medical condition,"* and *"implant failure."*

The initial screening involved reviewing abstracts to determine relevance, prioritizing studies that provided clinical insights into the impact of systemic and medical conditions on dental implant therapy. A total of 52 articles were selected for their scientific rigor and relevance to the research topic. Additionally, 10 supplementary articles were incorporated to enhance the breadth and depth of the narrative review. These articles were critically analyzed to build a comprehensive understanding of the interplay between systemic factors and dental implant outcomes.

Systemic Conditions

Age

Age has been widely discussed as a prognostic factor in implant success. Older patients often present with potentially longer healing times, a higher prevalence of systemic health conditions, and poorer local bone quality, which may influence implant outcomes.[15] While some studies have suggested that implant failure rates are higher in edentulous elderly patients, the general consensus in the literature indicates that increasing age alone is not a contraindication for implant treatment.[16]

Research suggests that the use of implants in older patients is not necessarily contraindicated and that bone tissue retains a certain capacity for osseointegration despite aging.[17] However, confounding factors associated with age—such as systemic diseases—should be carefully evaluated before proceeding with dental implant treatment. Rather than aging itself, the presence of specific diseases (e.g., osteoporosis or diabetes), as well as the quality and quantity of local bone at the implant site, which often deteriorates with age, are critical factors in determining the success of dental implants.

Cardiovascular Disease, Stroke, and Myocardial Infarction

Variations in medical conditions can significantly impact the outcome of dental implants. Patients with cardiovascular disease (CVD) may present with a range of conditions, including hypertension, vascular stenosis, coronary artery disease, atherosclerosis, and congestive heart failure.

These conditions can compromise blood and oxygen supply to the surgical site, potentially hindering the healing process. Ischemic heart disease (coronary artery disease) can manifest as angina or myocardial infarction (MI), which can lead to severe pain in the jaw, neck, and left arm. Most fatalities associated with MI occur within the first 12 hours. If a patient survives an MI, recovery can take several months, and it is recommended that any planned implant surgeries be delayed for 6 to 12 months to minimize risks to the patient's overall health.

Stroke sequelae may also impair the patient's ability to maintain good oral hygiene, and these complications must be considered during dental treatment planning.[13,18,19] While CVD and stroke are not absolute contraindications for dental implant therapy, careful management of these patients is crucial. Proper post-surgical care and thorough evaluation are essential to ensure safe and successful outcomes in such cases.

Valvular Heart Disease and Valvular Prosthesis Placement

Valvular heart disease occurs when one or more heart valves fail to function properly, which may be either congenital or acquired, and often, the exact cause remains unknown. Although this condition alone does not generally contraindicate dental implant treatment, there are important considerations related to the patient's medication regimen and the heightened risk of infections that could adversely affect their health. [20, 21]
For patients with valvular heart disease or those who have had a prosthetic valve placed, the risk of infective endocarditis (IE) due to bacteremia during dental procedures is a key concern. Prophylactic antibiotics may be prescribed prior to implant surgery to mitigate this risk. It is crucial to work closely with the patient's cardiologist to assess the appropriateness of implant therapy and ensure that all necessary precautions are taken. Proper management of anticoagulants, especially in those with mechanical heart valves, is also critical to reduce the likelihood of bleeding complications during and after surgery.[22, 23]

Osteoporosis

Osteoporosis is a systemic skeletal disease characterized by reduced bone mass and increased marrow spaces, leading to an increased risk of fractures from minimal trauma.[22] In the context of dental implantology, systemic conditions such as osteoporosis and osteopenia have been suggested to contribute to the severity of alveolar bone loss. However, it remains a common misconception that osteoporosis or osteopenia automatically contraindicates dental implant placement. To date, no conclusive studies have demonstrated a direct link between osteoporosis and higher failure rates of dental implants or an increased prevalence of peri-implantitis.[23]

While osteoporosis itself is not considered a contraindication for dental implants, careful consideration of the patient's medication regimen is essential, particularly in relation to medications known to increase the risk of osteonecrosis of the jaw (MRONJ). Bisphosphonates (BPs), frequently prescribed to treat osteoporosis, work by inhibiting bone resorption, thereby increasing bone density. Although early reports suggested a potential link between BP usage and implant failure, recent studies have not confirmed this relationship.[24, 25] Nonetheless, it is crucial to monitor patients on bisphosphonates and collaborate with their healthcare providers to manage any potential risks associated with implant therapy.

Diabetes Mellitus

Diabetes mellitus (DM) is a chronic systemic condition that affects multiple bodily systems and can lead to serious complications if not properly managed. The hallmark of DM is atypical carbohydrate metabolism, which is characterized by hyperglycemia due to impaired insulin secretion and/or resistance to insulin action. It is crucial to understand the type of diabetes the patient has, their current therapy, the degree of glycemic control, and the duration of the disease when considering the implications of diabetes for dental implant therapy.[26, 27]

In general, dental implant placement is considered a safe and predictable procedure for dental rehabilitation in diabetic patients. The short-term survival rate of implants in diabetic individuals is comparable to that of healthy patients, especially within the first six years post-treatment. However, long-term observations spanning up to 20 years have reported a reduced implant survival rate in diabetic patients.[26-28] These findings highlight the importance of careful preoperative evaluation, ongoing glycemic control, and long-term follow-up to ensure the success of implant therapy in this patient population.

Head and Neck Cancer

Head and neck cancer is one of the most common cancer types worldwide. Treatment often involves a combination of ablative surgery, chemotherapy, and radiotherapy.[29] Ablative surgery in the head and neck region frequently results in both soft and hard tissue defects, leading to functional and aesthetic challenges. As such, dental rehabilitation becomes a critical procedure following cancer treatment, particularly for restoring function and appearance.

Radiotherapy, commonly used in the treatment of head and neck cancers, has several destructive effects on both bone and vascularity. The effects on bone include impairment of osteoclast function and reduced proliferation within the bone marrow, while the effects on vascularity result in compromised microcirculation, leading to the destruction of small blood vessels. These combined mechanisms reduce bone viability, impair healing, and negatively affect dental implant osseointegration, contributing to a condition known as osteoradionecrosis.[30]

Historically, dental implants were contraindicated in patients treated for head and neck cancer, particularly when placed in irradiated bone, due to these adverse effects. However, advancements in surgical techniques and implant protocols have improved outcomes, making dental implants a more viable option for prosthetic rehabilitation in this patient population.[31]

Disorders of the Central Nervous System (DCNS)

Central nervous system disorders, particularly common conditions such as anxiety and mood disorders, are frequently encountered by dentists, as many patients with these disorders require dental implant therapy. Although such conditions are generally not contraindications for treatment, many dental professionals may be unfamiliar with the nature of these psychiatric disorders. Dentists must be aware of conditions such as post-traumatic stress disorder (PTSD), body dysmorphic disorder (BDD), and obsessive-compulsive disorder (OCD), as these are among the most concerning mental health conditions that can impact the outcome of implant therapy.

Patients with these conditions may struggle with having realistic expectations, understanding the treatment plan, or comprehending informed consent, all of which are critical factors in the long-term success of dental implant therapy.[32, 33]

For neurodegenerative diseases such as Alzheimer's disease and Parkinson’s disease, a thorough review of the patient's prescribed medications is essential, as is assessing the commitment of the caregiver. Advances in medication have allowed patients with Parkinson’s disease to lead productive lives, but cognitive decline in Alzheimer's disease patients presents significant challenges. In the later stages of Alzheimer's disease, particularly as patients become apathetic and disoriented, caution is warranted when considering implant therapy.[33, 34]

Smoking

There is no doubt that smoking has numerous harmful effects on oral tissues and the host’s immune-inflammatory response. It increases the risk of periodontal disease, oral precancerous and cancerous lesions, root caries, and peri-implantitis. Additionally, smoking contributes to taste alteration, staining of teeth and restorations, as well as delayed wound healing following extractions, periodontal procedures, and orthognathic surgeries.

Nicotine upregulates the expression of pro-inflammatory cytokines, such as interleukin-1, which contributes to tissue damage and alveolar bone resorption. Moreover, nicotine may affect cellular protein synthesis and impair the ability of gingival fibroblasts to adhere, thus interfering with wound healing and exacerbating periodontal disease.[35]

It has been well-documented that smoking increases implant failure rates, the incidence of postoperative infections, and marginal bone loss after dental implant placement.[36-38]

Immunodeficiency

Immunodeficiency can impair a patient's ability to fight infections and affect wound healing. With improvements in healthcare, greater life expectancy, and the expansion of immunosuppressive treatments for conditions such as rheumatoid arthritis, inflammatory bowel disease, and certain dermatologic conditions, dentists are increasingly encountering immunocompromised patients. These patients may exhibit immunosuppression in their medical history, which requires careful management in the context of dental procedures.

While the influence of immunodeficient conditions on the survival of dental implants remains under research, there is currently limited evidence to suggest that immunodeficiency significantly impacts implant outcomes. Nevertheless, clinicians must remain vigilant in managing such patients, considering their medical history and the potential need for tailored postoperative care.[39-41]

Hypothyroidism

Hypothyroidism (HT) is an endocrine disorder characterized by reduced thyroid gland activity, often of autoimmune etiology. This condition is known to influence bone metabolism, typically resulting in decreased bone resorption. Interestingly, studies have suggested that patients with hypothyroidism may experience a decreased rate of bone loss around dental implants, which could potentially reduce their risk of implant failure compared to patients without HT.[42, 43,44]

Although the impact of hypothyroidism on dental implant success is not fully understood, current evidence does not indicate an increased risk for implant failure in these patients. However, due consideration must still be given to their overall health and the management of their condition during implant therapy.

Vitamin D Deficiency

Vitamin D is a steroid hormone that plays a crucial role in calcium and phosphorus metabolism, and it is synthesized in the skin upon exposure to ultraviolet B (UVB) radiation (290–315 nm). It undergoes conversion in the liver and kidneys to its active form, which is essential for bone health and immune function. Deficiency in vitamin D has been linked to several systemic conditions, including periodontal diseases such as periodontitis, early tooth loss, osteoporotic fractures, and impaired fracture healing.[45, 46] Inadequate vitamin D levels are also associated with compromised immune function, which can adversely affect wound healing and overall health.

Studies have shown that vitamin D deficiency can impair osseointegration in animal models, which is a critical process for the success of dental implants. In animal studies, vitamin D deficiency has been found to hinder bone remodeling and osteoblast activity, both of which are essential for effective osseointegration.[47, 48] Despite these findings, clinical evidence regarding the direct effect of vitamin D deficiency on dental implant success in humans is still inconclusive. However, vitamin D's role in modulating the immune system and its potential to enhance bone healing suggest it may have a positive effect on implant outcomes. Vitamin D has been shown to influence the inflammatory response and promote osteoblast differentiation, which could be beneficial during the healing phase following implant placement.[49, 50]

CONCLUSIONS

The provision of implant-supported or retained prostheses in patients with certain systemic conditions is a predictable and reliable treatment option, with high implant survival rates reported across various studies.[51, 52] While specific medical conditions may introduce challenges, such as delayed healing or impaired osseointegration, careful management and proper preoperative assessment can minimize risks and improve treatment outcomes.[53, 54]

The functional and psychosocial benefits of dental implants often outweigh the relative risks associated with common medical conditions, including cardiovascular disease, diabetes mellitus, and osteoporosis.[55, 56] Despite these conditions, patients frequently experience significant improvements in quality of life, aesthetics, and overall function after implant therapy, which is considered a valuable long-term solution for rehabilitation.[57]

However, when planning implant therapy, the dentist must be aware of the patient's capacity for self-care, as poor oral hygiene or failure to follow postoperative instructions can adversely affect the longevity and success of the implant.[58] Therefore, effective communication and patient education are essential to ensure a positive long-term outcome.

Psychological conditions, such as anxiety, body dysmorphia, or cognitive impairments (e.g., in patients with Alzheimer's or Parkinson's disease), have been identified as more challenging predictors of implant success. These conditions can influence a patient's expectations, treatment adherence, and overall satisfaction, sometimes leading to disappointing results despite biologically successful implant placement.[59, 60] Addressing these issues requires an interdisciplinary approach, including psychological evaluation and, when necessary, the involvement of caregivers or mental health professionals.[61]

Furthermore, while some evidence suggests that vitamin D may play a role in improving implant success through its effects on immune modulation and bone health, more conclusive research is needed to establish definitive clinical guidelines.[62] As our understanding of vitamin D's impact on osseointegration evolves, it may become an important factor in treatment planning, particularly for patients with vitamin D deficiency.

In conclusion, dental implants remain a viable and highly effective treatment for patients with medical conditions, but careful evaluation of systemic health, psychological factors, and nutritional status are essential to optimize outcomes. Ongoing research into the influence of factors like vitamin D and the impact of systemic conditions will help refine treatment protocols and enhance success rates in diverse patient populations.

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CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

REFERENCES

1. Schroeder A, van der Zypen E, Stich H, Sutter F. The reactions of bone, connective tissue, and epithelium to endosteal implants with titanium-sprayed surfaces. Journal of Maxillofacial Surgery. 1981;9(1):15-25. Doi: https://doi.org/10.1016/S0301-0503(81)80007-0

2. Branemark PI. Osseointegration and its experimental background. The Journal of Prosthetic Dentistry. 1983;50(3):399-410. Doi: https://doi.org/10.1016/S0022-3913(83)80101-2

3. Buser D, Janner SFM, Wittneben JG, Brägger U, Ramseier CA, Salvi GE. 10-Year Survival and Success Rates of 511 Titanium Implants with a Sandblasted and Acid-Etched Surface: A Retrospective Study in 303 Partially Edentulous Patients. Clinical Implant Dentistry and Related Research. 2012;14(6):839-51. Doi: https://doi.org/10.1111/j.1708-8208.2012.00456.x

4. Sodnom-Ish B, Eo MY, Nguyen TTH, Kim MJ, Kim SM. Clinical feasibility and benefits of a tapered, sandblasted, and acid-etched surfaced tissue-level dental implant. International Journal of Implant Dentistry. 2020;6(1):39. Doi: https://doi.org/10.1186/s40729-020-00234-6

5. Bornstein MM, Hart CN, Halbritter SA, Morton D, Buser D. Early Loading of Nonsubmerged Titanium Implants with a Chemically Modified Sand-Blasted and Acid-Etched Surface: 6-Month Results of a Prospective Case Series Study. Clinical Implant Dentistry and Related Research. 2009;11(4):338-47. Doi: https://doi.org/10.1111/j.1708-8208.2009.00148.x

6. Adell R, Lekholm U, Rockler B, Branemark 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. Doi: https://doi.org/10.1016/S0300-9785(81)80077-4

7. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. The International Journal of Oral and Maxillofacial Implants. 1986;1(1):11-25.

8. Karthik K, Sivakumar, Sivaraj, Thangaswamy V. Evaluation of implant success: A review of past and present concepts. Journal of Pharmacy and Bioallied Sciences. 2013;5(Suppl 1). Doi: https://doi.org/10.4103/0975-7406.113310

9. Papaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: A systematic review. Journal of Dental Research. 2012;91(3):242-8. Doi: https://doi.org/10.1177/0022034511431252

10. Greenberg AM. Advanced dental implant placement techniques. Journal of Istanbul University Faculty of Dentistry. 2017;51(3 Suppl 1). Doi: https://doi.org/10.17096/jiufd.17594

11. Aghaloo TL, Moy PK. Which hard tissue augmentation techniques are the most successful in furnishing bony support for implant placement? International Journal of Oral & Maxillofacial Implants. 2007;22(7).

12. Soydan S, Cubuk S, Oguz Y, Uckan S. Are success and survival rates of early implant placement higher than immediate implant placement? International Journal of Oral and Maxillofacial Surgery. 2013;42(4):511-5. Doi: https://doi.org/10.1016/j.ijom.2012.10.014

13. Global Burden of Disease Collaborative Network. Global, regional, and national burden of diseases and injuries for adults 70 years and older: systematic analysis for the Global Burden of Disease 2019 Study. BMJ. 2022;376

14. Schimmel M, Srinivasan M, McKenna G, Müller F. Effect of advanced age and/or systemic medical conditions on dental implant survival: A systematic review and meta-analysis. Clinical Oral Implants Research. 2018;29(S16):311-30. Doi: https://doi.org/10.1111/clr.13288

15. Wood MR, Vermilyea SG. A review of selected dental literature on evidence-based treatment planning for dental implants. The Journal of Prosthetic Dentistry. 2004;92(5):447-62. Doi: https://doi.org/10.1016/j.prosdent.2004.08.003

16. Ikebe K, Wada M, Kagawa R, Maeda Y. Is old age a risk factor for dental implants? Japanese Dental Science Review. 2009;45(1):59-64. Doi: https://doi.org/10.1016/j.jdsr.2009.02.001

17. Al-Fahd AA. Old age alone may not be a risk factor for dental implant failure. Journal of Evidence-Based Dental Practice. 2016;16(3):176-8. Doi: https://doi.org/10.1016/j.jebdp.2016.07.004

18. Javed F, Romanos GE. Dental Implants in Patients with Cardiovascular Disorders. Springer. 2018; p. 9-12. Doi: https://doi.org/10.1002/9781119212270.ch4

19. Chaudhry S, Jaiswal R, Sachdeva S. Dental considerations in cardiovascular patients: A practical perspective. Indian Heart Journal. 2016;68(4):572-5. Doi: https://doi.org/10.1016/j.ihj.2015.11.034

20. Sugerman PB, Barber MT. Patient selection for endosseous dental implants: Oral and systemic considerations. International Journal of Oral & Maxillofacial Implants. 2002;17(2).

21. Madrid C, Sanz M. What influence do anticoagulants have on oral implant therapy? A systematic review. Clinical Oral Implants Research. 2009;20:96-106. Doi: https://doi.org/10.1111/j.1600-0501.2009.01770.x

22. Giro G, Chambrone L, Goldstein A, Rodrigues JA, Zenóbio E, Feres M, et al. Impact of osteoporosis in dental implants: A systematic review. World Journal of Orthopedics. 2015;6(2):311-5. Doi: https://doi.org/10.5312/wjo.v6.i2.311

23. Venkatakrishnan C, Bhuminathan S, Chandran CR, Poovannan S. Dental implants in patients with osteoporosis: A review. Biomedical and Pharmacology Journal. 2017;10(3):1415-8. Doi: https://doi.org/10.13005/bpj/1247

24. Bell BM, Bell RE. Oral Bisphosphonates and Dental Implants: A Retrospective Study. Journal of Oral and Maxillofacial Surgery. 2008;66(5):1022-4. Doi: https://doi.org/10.1016/j.joms.2007.12.040

25. de-Freitas NR, Lima LB, de-Moura MB, Veloso-Guedes CC, Simamoto-Júnior PC, de-Magalhães D. Bisphosphonate treatment and dental implants: A systematic review. Med Oral Patol Oral Cir Bucal. 2016;21(5). Doi: https://doi.org/10.4317/medoral.20920

26. Naujokat H, Kunzendorf B, Wiltfang J. Dental implants and diabetes mellitus-a systematic review. International Journal of Implant Dentistry. 2016;2(1):5. Doi: https://doi.org/10.1186/s40729-016-0038-2

27. Dubey RK, Gupta DK, Singh AK. Dental implant survival in diabetic patients: Review and recommendations. National Journal of Maxillofacial Surgery. 2013;4(2):142-50. Doi: https://doi.org/10.4103/0975-5950.127642

28. Wagner J, Spille JH, Wiltfang J, Naujokat H. Systematic review on diabetes mellitus and dental implants: An update. International Journal of Implant Dentistry. 2022;8(1):1. Doi: https://doi.org/10.1186/s40729-021-00399-8

29. Nobrega AS, Santiago Jr JF, de Faria Almeida DA, Dos Santos DM, Pellizzer EP, Goiato MC. Irradiated patients and survival rate of dental implants: A systematic review and meta-analysis. The Journal of Prosthetic Dentistry. 2016;116(6):858-66. Doi: https://doi.org/10.1016/j.prosdent.2016.04.025

30. Tanaka TI, Chan HL, Tindle DI, MacEachern M, Oh TJ. Updated clinical considerations for dental implant therapy in irradiated head and neck cancer patients. Journal of Prosthodontics on Dental Implants. 2015:254-62. Doi: https://doi.org/10.1002/9781119115397.ch27

31. Sammartino G, Marenzi G, Cioffi I, Teté S, Mortellaro C. Implant therapy in irradiated patients. Journal of Craniofacial Surgery. 2011;22(2):443-5. Doi: https://doi.org/10.1097/SCS.0b013e318207b59b

32. Addy L, Korszun A, Jagger RG. Dental implant treatment for patients with psychiatric disorders. European Journal of Prosthodontics and Restorative Dentistry. 2006;14(2):90-2.

33. Al-Omiri MK, Abu Hantash RO, Abu Yunis M, Lynch E. Relationship between personality and impacts of implant treatment on daily living. Clinical Implant Dentistry and Related Research. 2012;14. Doi: https://doi.org/10.1111/j.1708-8208.2010.00331.x

34. Javed F, Romanos GE. Dental Implants in Patients with Psychological/Psychiatric Disorders. Springer. 2018; p. 67-9. Doi: https://doi.org/10.1002/9781119212270.ch14

35. Kasat V, Ladda R. Smoking and dental implants. Journal of the International Society of Preventive & Community Dentistry. 2012;2(2):38-41. Doi: https://doi.org/10.4103/2231-0762.109358

36. Chrcanovic BR, Albrektsson T, Wennerberg A. Smoking and dental implants: A systematic review and meta-analysis. Journal of Dentistry. 2015;43(5):487-98. Doi: https://doi.org/10.1016/j.jdent.2015.03.003

37. Naseri R, Yaghini J, Feizi A. Levels of smoking and dental implants failure: A systematic review and meta-analysis. Journal of Clinical Periodontology. 2020;47(4):518-28. Doi: https://doi.org/10.1111/jcpe.13257

38. Mustapha AD, Salame Z, Charara N, et al. Does smoking affect dental implants survival? A systematic review and meta-analysis. International Journal of Implant Dentistry. 2018;4:34.

39. Moy PK, Medina D, Shetty V, Aghaloo TL. Dental implant failure rates and associated risk factors. International Journal of Oral and Maxillofacial Implants. 2005;20(4):569-77.

40. Heitz-Mayfield LJ, Lang NP. Comparative biology of chronic and aggressive periodontitis vs peri-implantitis. Periodontology 2000. 2010;53:167-81. Doi: https://doi.org/10.1111/j.1600-0757.2010.00348.x

41. Pye AD, Lockhart DE, Dawson MP, et al. A review of dental implants and infection. Journal of Hospital Infection. 2009;72(2):104-10. Doi: https://doi.org/10.1016/j.jhin.2009.02.010

42. Esposito M, Grusovin MG, Worthington HV. Interventions for replacing missing teeth: Antibiotics at dental implant placement to prevent complications. Cochrane Database of Systematic Reviews. 2013;7. Doi: https://doi.org/10.1002/14651858.CD003878.pub5

43. Fugazzotto PA, Wheeler SL, Lindsay JA. Success and failure rates of 1,344 6-mm-long implants: A literature review. International Journal of Oral and Maxillofacial Implants. 1993;8(3):315-26.

44. Friberg B, Grondahl K, Lekholm U, et al. Long-term follow-up of osseointegrated implants in patients with congenital and acquired maxillary defects. International Journal of Oral & Maxillofacial Implants. 1994;9(4):522-9.

45. Al-Sabbagh M. Implant success and survival rates. Dental Clinics of North America. 2011;55(1):57-69.

46. Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: The Toronto study. Part II: The prosthetic results. The Journal of Prosthetic Dentistry. 1990;64(1):53-61. Doi: https://doi.org/10.1016/0022-3913(90)90153-4

47. Lekholm U, Zarb GA. Patient selection and preparation. In: Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence; 1985. pp. 199-209.

48. Esposito M, Grusovin MG, Maghaireh H, et al. Interventions for replacing missing teeth: Different times for loading dental implants. Cochrane Database of Systematic Reviews. 2013;3. Doi: https://doi.org/10.1002/14651858.CD003878.pub5

49. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: Anatomic and surgical considerations. International Journal of Oral and Maxillofacial Implants. 2004;19(Suppl):43-61.

50. Araújo MG, Lindhe J. Dimensional ridge alterations following tooth extraction: An experimental study in the dog. Journal of Clinical Periodontology. 2005;32(2):212-8. Doi: https://doi.org/10.1111/j.1600-051X.2005.00642.x

51. Elian N, Tabourian G, Jalbout ZN, et al. A simplified socket classification and repair technique. Practical Procedures and Aesthetic Dentistry. 2007;19(2):99-104.

52. Misch CE, Suzuki JB. Provisional restorations in implant dentistry: A requirement in implant prosthodontics. Dental Clinics of North America. 2011;55(1):83-94.

53. Koutouzis T, Koutouzis G. Removal of failed dental implants: A systematic review of different techniques. Clinical Advances in Periodontics. 2015;5(1):39-46.

54. Salinas TJ, Eckert SE. In patients requiring single-tooth replacement, what factors affect the survival and success of implants? International Journal of Oral and Maxillofacial Implants. 2007;22(Suppl):123-39.

55. Jung RE, Zembic A, Pjetursson BE, et al. Systematic review of the survival rate and the incidence of biologic, technical, and esthetic complications with single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clinical Oral Implants Research. 2012;23(Suppl 6):2-21. Doi: https://doi.org/10.1111/j.1600-0501.2012.02547.x

56. Berglundh T, Armitage G, Araujo MG, et al. Peri-implant diseases and conditions: Consensus report of Workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. Journal of Periodontology. 2018;89(Suppl 1). Doi: https://doi.org/10.1002/JPER.17-0739

57. Mombelli A, Lang NP. The diagnosis and treatment of peri-implantitis. Periodontology 2000. 1998;17:63-76. Doi: https://doi.org/10.1111/j.1600-0757.1998.tb00124.x

58. Renvert S, Polyzois I, Claffey N. How do implant surface characteristics influence peri-implant disease? Journal of Clinical Periodontology. 2011;38(Suppl 11):214-22. Doi: https://doi.org/10.1111/j.1600-051X.2010.01661.x

59. Jepsen S, Mühlemann HR. Peri-implantitis: Prevention and management. International Dental Journal. 2014;64(Suppl 1):9-13.

60. Heitz-Mayfield LJ, Salvi GE. Peri-implant mucositis. Journal of Clinical Periodontology. 2018;45(Suppl 20). Doi: https://doi.org/10.1111/jcpe.12953

61. Lang NP, Berglundh T. Periimplant diseases: Where are we now?-Consensus of the Seventh European Workshop on Periodontology. Journal of Clinical Periodontology. 2011;38(Suppl 11):178-81. Doi: https://doi.org/10.1111/j.1600-051X.2010.01674.x

62. Koo KT, Lee DH, Kim YT, et al. Management of peri-implantitis: A systematic review and meta-analysis. Clinical Oral Implants Research. 2022;33(4):348-63.