

Risks and complications associated with dental implant failure: Critical update

ABSTRACT

Risks and complications have been identified with dental implant failure though there is continuous innovation in implant systems and various interceptive treatment modalities. The success rate of dental implants has increased over a period of years as a treatment option for the rehabilitation of missing teeth. The dental implants are designed that best suits the various types of bone. Endosseous implants fail due to many reasons. Different reasons for the implant failure and their contributing factors have been discussed in this review article. A better understanding of the factors responsible for the implant failure will provide clinical decision-making and may enhance the field of implant dentistry. This article summarizes the factors causing implant failure. This paper presents the results of a survey of dentists practicing implant dentistry and updates regarding their knowledge of risk factors that they consider to be important for predicting dental implant failure.

Keywords: Dental implant, osseointegration, osteoradionecrosis, peri-implantitis, periodontitis

INTRODUCTION

The replacement of missing teeth by titanium dental implants is currently the gold standard in dental rehabilitation.^[1,2] Different statistically analyzed factors associated with implant failure are age and sex,^[3] smoking,^[4] systemic diseases,^[5,6] maxillary implant location, quantity and quality of bone,^[7] and implant surface treatments and characteristics.^[8] Immunological^[9] and genetic factors^[10] have also been reported to be associated with early implant failure. Periodontitis and cigarette smoking are associated with an increased rate of implant failure. It decreases the vascularity of local tissues and interrupts in healing, chemotaxis, and systemic immunity. Overall failure rates have been reported as 11% for smokers as compared to 5% for nonsmokers. Mellado-Valero *et al.*^[11] found more failures in diabetic patients during the 1st year of functional loading. The failure of dental implant is seen in irradiated bone, excessive temperature elevation in bone during placement, leading to necrosis of the supporting bone around the implant^[12] [Table 1 and Figure 1].

Age factor

Age is considered as one of the important prognostic factors in implant success. Older patients are more prone to altered

systemic health conditions, have poor local bone conditions and potentially longer healing times.^[13] Moy *et al.*^[14] studied that advanced age increases the risk of implant failure. Patients older than 60 years have an adverse outcome in two folds. Brocard *et al.*^[15] studied cumulative success rates in a long-term follow-up study and concluded that patients older than 60 years hwwad less implant survival than usual. Implant submersion continues throughout adult life, and its rate varies with age. This process is much more conspicuous

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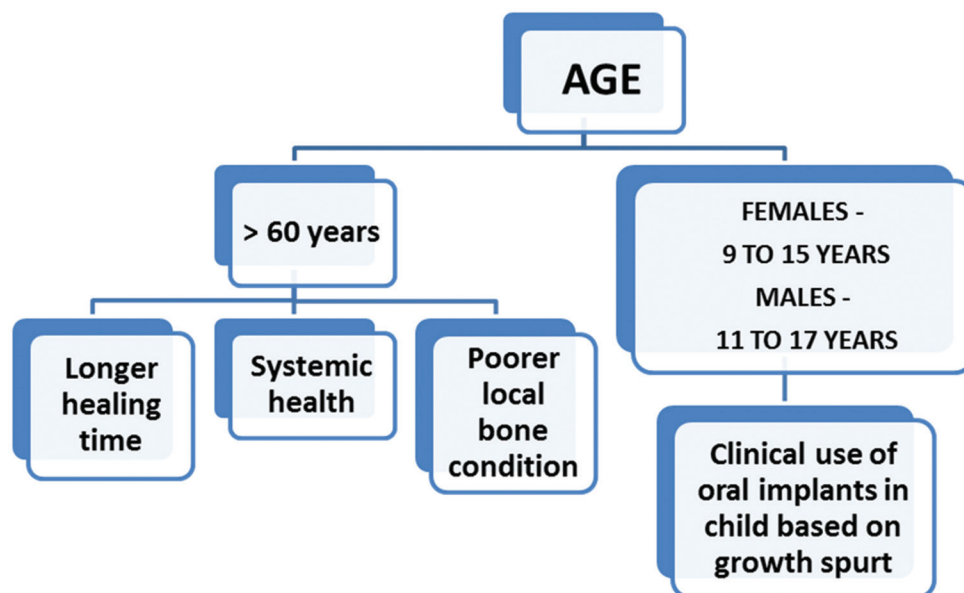


Figure 1: Effect of age on implant health

Table 1: Conditions and factors contributing to implant health

Conditions	Factors
Implant related	Previous history of failure Surface roughness Surface purity and sterility Fitness discrepancies Exposure of implant into oral environment
Mechanical factors	Premature loading Occlusion trauma Dense hypovascular traumatized bone, comminuted bone
Patient (local factors)	Oral hygiene status Gingivitis/periodontitis Quantity and quality of adjacent bone Natural teeth proximity Periodontal status of natural teeth Impaction of foreign bodies Soft-tissue viability
Patient (systemic factors)	Habits such as smoking, alcoholism Prone to infection such as old age, malnourishment Diabetes Steroid therapy Chemotherapy/radiotherapy Hypersensitivity
Surgical technique/environment	Traumatic surgical procedure Overheating of surrounding bone due to handpiece Perioperative bacterial contamination

during the second and third decades of life when compared with the fourth and fifth.^[16] The age at which growth is complete also varies widely from patient to patient.^[17] The common growth spurt occurs at 12 years for girls and at 14 years for boys. However, this age can vary by as much as 6 years. Thus, when planning for the placement of dental implants in a child, this problematic age period extends from 9 to 15 years for girls and 11 to 17 years for boys.^[18]

Mesial drift of teeth in the maxilla and mandible

The spontaneous mesial drift of teeth in the step dentition phase is well understood. There is about 5 mm mesial movement/drift of teeth in the lateral segment of jaw (canine to the first molar) between 10 and 21 years of age. There is 2.5 mm buccal movement of incisors which may result in a loss of space in arch leading to crowd. Dental implant does not take part in this mesial drift of teeth. Thus, an implant can stop the mesial drift, resulting in an asymmetric arch. An implant in the anterior part cannot follow the teeth and will become more lingual with time. Depending on the facial growth pattern and further eruption of the teeth, vertical changes can still occur after puberty, though at a slower pace than during the active growth phase.^[19] [Figure 2]

Oral hygiene and maintenance

The accumulation of bacterial plaque leads to gingivitis, periodontitis, and peri-implantitis. Furthermore, the presence of any symptoms of infection, radiographic evidence of peri-implant bone loss, and/or neuropathies reduced vascularity concomitant with parallel-oriented collagen fibers may be indicative of an ailing or failing implant.^[20] This can be managed by the use of interproximal brushes penetrate 3 mm into the gingival sulcus or pocket. It also requires maintenance visit for the evaluation of prosthetic component for plaque and calculus, stability of the implant-abutment, peri-implant tissue margin, implant body, and radiographs after every 12–18 months.

Some other clinical conditions are association with oral lichen planus, parafunctional habits, and conventional flap versus

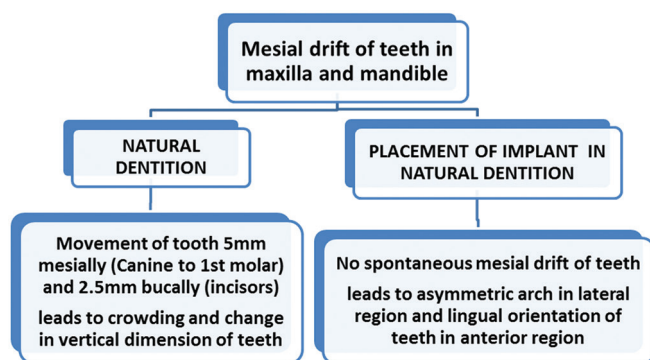


Figure 2: Effect of implant in Mesial drift of teeth in the maxilla and mandible

flapless surgery or piezoelectric surgical technique, status of dentition, and deleterious effects of smoking habit [Table 2].

Bruxism

Glauser *et al.* evaluated 41 patients who received 127 immediately loaded implants. Their results showed that implants in patients with bruxism were lost more frequently than those placed in patients with no parafunction (41% vs. 12%). The higher failure rate among the bruxers is due to uncontrolled functional loading of the implant, which leads to micro-motions above the critical limit, resulting in fibrous encapsulation of the implant instead of osseointegration. It was suggested that early or immediate loading is not detrimental for osseointegration unless excessive micro-motions occur at the bone-implant interface during the healing phase.^[22]

The habit of cigarette smoking

Smoking affects the oral and general health of an individual. Smoking reduces leukocyte activity and causes reduced chemotactic migration rate and low phagocytic activity leading to low infection resistance and delayed wound healing. Smoking also decreases calcium absorption. Dental implants have a lower survival rate in smokers. Smoking affects osseointegration process by lowering blood flow rate due to increased peripheral resistance and platelet aggregation. Smoking residues are carbon monoxide and cyanide, which delay wound healing capacity and along with nicotine, inhibit cell proliferation rate.

Tobacco directly inhibits osteoblast function. Strietzel *et al.* reported that smoking affects implant prognosis with/without augmentations. Studies show significant marginal bone absorption in smokers when compared to nonsmokers.^[26]

Loss of implant/graft material into the maxillary sinus

The immediate implant insertion in the unstable residual bone can lead to the loss of implant or graft material into the maxillary sinus affecting the natural ciliary movement in

the maxillary sinus and mastication (<5 mm of bone). It can be managed surgically by different approaches, including intraoral, endoscopically, transnasal route, and bone reconstruction of maxilla.^[27,28]

Bisphosphonate-related osteoradionecrosis

Bisphosphonates reside at active bone remodeling sites such as jaws causing surgical trauma to the alveolar bone during implant surgery and further increases the postoperative accumulation of the drug to the implanted site. Bisphosphonates interfere with the bone turnover and reduce the peri-implant bone resistance to oral flora, causing increased risk of peri-implantitis.^[29-31]

Injury to adjacent tooth

The placement of implants along an improper axis or an excessively large implant can cause injury to adjacent tooth, resulting in nonvitality of the tooth. Dilacerated roots and excessive tilting in the mesiodistal direction obliterates the implant area and hinders the ideal implant placement. The interpretation of a radiograph with a guide pin of the depth of 5 mm facilitates angulation corrections of osteotomy.^[32] Alternatively, differences between the apical and crestal interdental spaces due to mesial or distal tipping of the roots can be orthodontically corrected.^[33]

Peri-implantitis

Peri-implantitis is a progressive inflammatory condition which affects the tissues surrounding an osseointegrated implant, leading to the loss of the supporting bone and implant failure. It is characterized by bleeding, suppuration, increased pocket probing depth, mobility of implant, and radiographical bone loss. This inflammatory process is more intense and, goes deeper and faster around the dental implant as compared to the inflammation around the adjacent natural tooth.^[34] Cocci and nonmotile rods, the subgingival microflora causing peri-implantitis are the most important pathogens in the failure of dental implants. Soft laser irradiation is effective in the removal of the bacterial pathogens causing peri-implantitis.^[35] Systemic antibiotics for Gram-negative anaerobes alters the microbial composition and clinically improves the condition over a 1-year period.^[36] The local delivery devices such as Actisite which has fibers containing polymeric tetracycline hydrochloric acid can be used, which significantly reduces total anaerobic bacterial counts.^[37]

Hyperglycemia

Hyperglycemia can also affect the osseointegration of dental implants. Hyperglycemia alters the response of the parathyroid hormone which helps in regulating the metabolism of phosphorus and calcium and inhibits osteoblastic differentiation. It affects bone matrix, its

Table 2: Clinical conditions affecting implant survival

Higher success rate is seen in	Study done by
100% survival rate of patient with oral lichen planus	Hernández <i>et al.</i> , 2012 ^[21]
Patients with nonparafunctional habits as compared to patients having parafunctional habits such as bruxism lead to fibrous encapsulation of implant	Glauser <i>et al.</i> , 2001 ^[22]
Conventional flap surgery as compared to flapless surgery	Sennerby <i>et al.</i> , 2008 ^[23]
Implants inserted with piezoelectric surgery split crest	Danza <i>et al.</i> , 2009 ^[24]
Dentulous dentition when compared to edentulous teeth	Kourtit <i>et al.</i> , 2004 ^[25]
Patients with no deleterious habits versus cigarette habit lead to delayed wound healing, inhibit cell proliferation and affects osteoblast function	Strietzel <i>et al.</i> , 2007 ^[26]

components, and adherence, growth, and accumulation of extracellular matrix. The normal glucose level following insulin treatment induces growth in bony matrix and osteoid formation. Hyperglycemia may reduce bone recovery by 40% following circular osteotomies. Treatment with insulin normalizes this recovery index, thus indicating that the bone healing deterioration is strongly related to poor diabetic control. Failures that occur after the second-phase surgery and during the 1st year of functional loading is due to microangiopathy arising as a complication of diabetes. This may compromise the vascularization of the flap, causing infection of soft tissue, and delayed wound healing.^[38,39]

Irradiated bone

Irradiation therapy along with surgical excision is the treatment protocol generally employed for malignant tumors in the craniofacial region. The success rate of placement of dental implants in irradiated bone is 70%. Hyperbaric oxygen therapy in irradiated patients prior to implant therapy increases the success rate of implants.^[40]

Osteoporotic patients

Osseointegration failure in osteoporotic patients is due to the decrease in bone mass and density.^[41] Osteoporosis does not necessarily affect the maxillary and mandibular bones when diagnosed at one particular site of the skeleton.^[42] Intravenous application of bisphosphonates is associated with osteonecrosis of the jaw. There are 63 cases of osteonecrosis of the jaw reported in cancer or osteoporotic patients. Implant treatment on patients having long-term bisphosphonates must be performed with caution.^[43,44]

Corticosteroid therapy

Patients on systemic corticosteroid therapy are more prone to have reduced bone density, increased epithelial fragility, and immune suppression which in turn results in compromised

osseointegration of the dental implant. In these cases, medical intervention and adrenal gland suppression rate should be observed.^[45]

Immune deficiency

Patients with immune deficiency are more prone to infection and compromised tissue repair. According to recent studies, dental implant placement has been performed successfully in patients with stable immune status, HIV-positive cases with a sufficient number of CD4+ cells and using antiviral drugs.^[46,47]

Bleeding disorders

Uncontrolled hemorrhage can be caused by platelet disorders, coagulant factors deficiency, and using anticoagulant drugs such as aspirin and warfarin.^[48] It is due to platelet deficiency $<50,000/\text{mm}^3$.^[49] The most life-threatening adverse effect of dental implant placement in these patients is upper airway obstruction.^[50]

Cardiovascular disorders

Cardiovascular diseases interfere with healing and osseointegration process, resulting in reduced fibroblast activity, impaired macrophage function, and decreased collagen synthesis.^[51] These pathologies include hypertension, atherosclerosis, and congestive heart failure. Cardiovascular disease does not have a significant influence on the long-term success rate of dental implant treatment.^[52]

Organ (heart/liver/renal) transplantation

Patients having transplanted organs undergo long-term immunosuppressant medications to prevent graft rejection. Cyclosporine A is usually given in combination with steroids (anti-inflammatory action). Cyclosporine may have a negative impact on mechanical retention and healing of bone around the dental implant.^[53,54]

CONCLUSION

There is a need to increase the knowledge and awareness regarding the potential risk factors that could impact on implant failures to those who are practicing dental implantology. This can be achieved through continuous dental educational programs and workshops. Regular assessment of the theoretical and practical knowledge of implant dentistry is mandatory to improve their implant experience.

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Conflicts of interest

There are no conflicts of interest.

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