SYSTEMIC FACTOR AFFECTING OSSEOINTEGRATION

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ABSTRACT

Oral implantology (implant dentistry) is the science and discipline concerned with the diagnosis, design, insertion, restoration, and/or management of alloplastic or autogenous oral structure to restore the loss of contour, comfort, function, esthetic, speech, and/or health of the partially or completely edentulous patient. Osseointegration, a term coined by Branemark and co-workers in early 1960s, represents a direct connection between bone and implant without interposed soft tissue layers. The aim of the present review is to discuss various factors responsible for loss of oral implants. The factors contributing to failure of osseointegration have been identified as medical status of the patient, smoking, bone quality, bone grafting, irradiation, bacterial contamination, lack of preoperative antibiotics, degree of surgical trauma and operator experience. Furthermore, it appears that implant surface properties, roughness and premature loading influence the failure pattern.

KEYWORDS: Implants; Osseointegration; Failure; Alloplast.
INTRODUCTION

Dental implants are inert, alloplastic materials embedded in the maxilla and/or mandible for the management of tooth loss and to aid replacement of lost orofacial structures as a result of trauma, neoplasia and congenital defects.[1] The most common type of dental implant is endosseous comprising a discrete, single implant unit (screw- or cylinder-shaped are the most typical forms) placed within a drilled space within dentoalveolar or basal bone.[2] They implants have become an important therapeutic modality in the last decade, mainly after the works developed by Brånemark (1960s), in which the direct contact between the bone functional tissues and the biomaterial titanium was termed osseointegration.[3]

1) Age

Age plays no role in implants as the biological age is more important than the chronological age. In the case of young patients, it is better to wait till the age of maturation or till the completion of bone growth. The implant does not allow the bone growth pattern. However, the worst one can expect in the young patients is a short crown that has not followed the bone growth. All that is required in such a case will be a new crown. Endosseous dental implants are stationary in the jaws and do not erupt or migrate during dentoalveolar development. Younger patients may show greater crestal bone resorption around dental implants. It is therefore recommended that implant placement be delayed until growth and development have ceased or are minimal. Both dental age (eruption status of the permanent teeth) and skeletal maturation (hand-wrist radiograph) should be used to assess growth and development. The condition of the jawbone is both age-related and site-specific.[4]

However, implant failure does not correlate with age or sex. Increasing age has no effect on osseointegration or the rate of crestal bone resorption around dental implants. Implants have been successfully delivered to patients as old as 90 years. Therefore, increasing age is not a barrier to successful dental implants, although medical conditions associated with increasing age may require modifications to the implant treatment plan.[4]

2) Oral lesions such as Lichen Planus (reticular type) and in Herpetic lesions

Oral lichen planus (OLP) is a chronic inflammatory disease that presents as white striations, papules, plaques, erythema, erosions, or blisters affecting predominantly the buccal mucosa, tongue, and gingivae.
Dental implant implications: Erosive OLP has been associated with dental implant loss, possibly because of altered capacity of the oral epithelium to adhere to the titanium surface. Hence, dental implant surgery may exacerbate OLP lesions. Dental implant hygiene is crucial in OLP patients. Endosseous dental implants may be used in patients with nonerosive forms of OLP, although patients should be warned of possible lesion exacerbation related to surgery and possible implant failure if gingival lesions become erosive.\[5\]

3) Hypohidrotic ectodermal dysplasia
Hypohidrotic ectodermal dysplasia (HED, EDA, Christ-Siemens-Touraine syndrome) is characterized by hypodontia, hypotrichosis, and hypohidrosis.

Dental implant implications: Dental implants have been used successfully in patients with severe hypodontia associated with ectodermal dysplasia. As discussed, implant placement is generally contraindicated in growing patients. In a recent prospective study, implant placement and prosthetic rehabilitation in young children with ectodermal dysplasia did not restrict transverse or sagittal growth. However, vertical alveolar growth resulted in the occasional submergence of endosseous implants, necessitating revision and the placement of longer abutments.\[6\]

Hence, to conclude, implants may be considered to be the ideal form of tooth replacement in these patients. However, they require careful planning, often of a multidisciplinary nature, so that timing of the various treatment modalities is seamless.\[7\]

4) Osteoporosis
Osteoporosis is a progressive systemic disease characterized by low bone mass and deterioration of bone tissue, leading to bone fragility and fracture.

Osteoporosis and related bone pathologies are increasing in epidemic proportions. The exact etiology of the disease is unknown, but hormonal, dietary and genetic factors all contribute to the related loss of bone density. Research indicates that the mandible and maxilla are affected and show oral manifestations. There is no scientific data to contraindicate the use of two-step osseointegrated implants in osteoporitic individuals. A clinical report described successful implants in an 80-year-old female with severe osteoporosis.\[8\]
On balance, osteoporosis appears not to influence implant survival. Moreover, endosseous dental implants may actually stimulate mandibular bone formation in a load-dependent manner.

5) **Hypertension**

Hypertension is usually asymptomatic and is the major risk factor for coronary heart disease. Risk factors include obesity, high sodium intake, poor diet, lack of exercise and smoking. Hypertension is usually treated with antihypertensive medications, many of which have an impact on implant therapy because of their numerous effects. These include orthostatic hypotension, dehydration, sedation, xerostomia and depression. The side effects may alter treatment or require special precautions eg orthostatic hypotension affects a patient brought from supine to an upright position which can result in syncope and falling with possible injuries. These symptoms may be avoided by allowing the patient to sit upright for several minutes after the completion of their dental procedure. Calcium channel blockers used to treat hypertension or congestive heart failure can cause gingival hyperplasia around teeth or implants. In addition, severe hypertension can lead to angina pectoris, congestive heart failure or even cerebrovascular episode, which can be precipitated by rapid increase in blood pressure during an injection or surgery.\(^9\)

**Dental Implant Implications**: An increased blood pressure is not uncommon in the dental office setting, because stress associated with treatment (also termed as *white coat syndrome*) leads to increased blood pressure due to increase in catecholamines levels. Stress reduction protocol and proper monitoring of the patient should be done along with proper management of pain and discomfort. Stress reduction protocol may include premedication on the night before the appointment (flurezepam, diazepam etc), setting an early morning appointment, minimizing waiting room time and ensuring the duration of treatment does not exceed the patient’s limits. Adequate pain control is also important including preemptive analgesia, profound anesthesia during the procedure and sufficient postoperative pain control including long-acting anesthetics. A resting systolic pressure greater than 180 or a diastolic pressure greater than 110 should indicate that all elective procedures be delayed until blood pressure may be reduced to a safer level.\(^10\)

6) **Myocardial Infarction**

Myocardial Infarction (MI) is a prolonged ischemia or lack of oxygen resulting from deficiency in the coronary arterial blood supply that causes injury to the myocardium. MI
may be precipitated when patient undergoes unusual stress, either physical or emotional. The patient usually has severe chest pain in the substernal or left precordial area during the episode. It may radiate to the left arm or to the mandible. The pain is similar to angina pectoris but more severe. The complications of MI include arrhythmias and congestive heart failure (CHF). The larger the ischemic area the greater is the risk of heart failure or life threatening arrhythmias.\textsuperscript{[11]}

**Dental Implant Implications:** The dental evaluation should include the dates of all the episodes of MI especially the latest and any complications. Any surgical treatment should be postponed for another six months, if possible. Patient who has experienced MI in 6-12 months preceding consultation may have examinations, non-surgical procedures performed after medical consultation.\textsuperscript{[12]}

Elective implant procedures should be postponed for atleast 12 months after MI and only performed after physician’s consultation.

**7) Congestive Heart Failure**

Congestive heart failure (CHF) is a pathophysiologic state, in which an abnormality in cardiac function is responsible for failure of heart to pump blood in adequate volume to meet the needs of the metabolizing tissues.\textsuperscript{[13]}

<table>
<thead>
<tr>
<th>Classification Of Congestive Heart Failure (New York Heart Association)</th>
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<tr>
<td>I. No symptoms or limitations in ordinary physical activity</td>
</tr>
<tr>
<td>II. Mild symptoms and slight limitation during ordinary activity. Comfortable at rest</td>
</tr>
<tr>
<td>III. Marked limitation in activity due to symptoms, even during less-than-ordinary activity. Comfortable only at rest.</td>
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<tr>
<td>IV. Severe limitations. Experiences symptoms even while at rest.</td>
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**Dental Implant Implications**

In patients classified as New York Heart Association (NYHA) I and II, no medical consultation is indicated. In NYHA III and IV, medical consultation is highly recommended for implant type 3 and 4 procedures. Pain and anxiety control are very important for such patients. Patient should be placed in the most recumbent position in which they may breathe comfortably and efficiently. Oxygen supplementation during implant procedures is highly recommended so as to minimize the possibility of hypoxia.\textsuperscript{[14-15]}
8) Subacute Bacterial Endocarditis And Valvular Heart Disease

Bacterial endocarditis is an infection of the heart valves or the endothelial surfaces of the heart. It is a result of growth of bacteria on damaged or altered cardiac surfaces. The microorganisms most often associated with endocarditis following dental treatment and alpha hemolytic *Streptococcus viridans* and less frequently staphylococci and anaerobes. Dental procedures causing transient bacteremia are the major cause of bacterial endocarditis. As a result, the implant dentist should identify the patient at risk and implement prophylactic procedures.

**Dental Implant Implications**

The implant dentist must be familiar with the antibiotic regimens for heart conditions requiring prophylaxis. A similar regimen is suggested for any person requiring antibiotic coverage.[16]

<table>
<thead>
<tr>
<th>Antibiotic regimens for heart conditions requiring prophylaxis.</th>
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<tbody>
<tr>
<td><strong>Situation of the Patient</strong></td>
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<tr>
<td>Standard general prophylaxis</td>
</tr>
<tr>
<td>Unable to take oral medication</td>
</tr>
<tr>
<td>Allergic to Penicillin</td>
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<tr>
<td>Allergic to Penicillin and unable to take oral medication</td>
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In patients classified in the high risk category for the development of endocarditis, elective implant therapy may be contraindicated. Implants may be contraindicated for patients with limited oral hygiene potential and for those with the history of multiple endocarditis events.[17]

9) Diabetes Mellitus

Diabetes mellitus is a chronic disease caused by an inherited and/or acquired deficiency in production of insulin by the pancreas or by ineffectiveness of the insulin produced. Healing is affected by impaired vascular function, chemotaxis, impaired neutrophil function. Patients suffering will be more prone to develop infections and vascular complications.[18]

Many studies in diabetic rats have shown reduced bone contact area and bone thickness around hydroxyapatite and titanium implants. Insulin therapy has been associated with increased periimplant bone formation in the diabetic rat model. However, there was
significantly less bone-to-implant contact in the insulin-controlled diabetic rats compared with normal rats.\textsuperscript{[19]}

**Dental implant implications:** The ASA (Table) suggests that patients on oral agents for diabetes are suitable candidates for dental implants, whereas patients on insulin are not. Others suggest that diabetic patients who are well controlled with insulin are suitable for implant surgery under antibiotic cover, and many studies have reported implant success in diabetic patients. It is suggested that the survival rate of dental implants in controlled diabetic patients can be slightly lower than that documented for the general population. The increased failure rate can occur during the first year following prosthetic loading.\textsuperscript{[20]}

However, it is concluded that endosseous dental implants are usually successful in patients with diabetes, although uncontrolled diabetes contraindicates dental implant placement. Consideration should be given to antibiotic prophylaxis for surgical procedures in diabetic patients.

10) **Pregnancy**\textsuperscript{[21]}
Implant surgery procedures are contraindicated. Almost 15\% pregnancies are terminated by spontaneous abortion or miscarriage during first trimester. Dental prophylactic appointments are suggested in 2\textsuperscript{nd} and 3\textsuperscript{rd} trimester.

Hygienist and dentist should realize that in middle and late 3\textsuperscript{rd} trimester, hypotension can occur in supine mother as a result of pressure of the fetus on the inferior vena cava.

11) **Smoking**
Many studies have shown that smoking interferes with osseointegration and accelerates bone resorption around dental implants. Smoking cessation during the healing phase following implant surgery improved implant survival. It is now clear that smokers are at greater risk of peri-implantitis, especially in the maxilla. In this context, a conventional denture or fixed partial prosthesis may be preferable to endosseous implants for patients who continue to smoke.\textsuperscript{[22]}
12) Oral cancer risk
Squamous cell carcinoma arising around endosseous dental implants has been reported, and dental implants may interfere with oral radiotherapy. There are high complication rates after placement of implants in oral cancer patients. Irradiation adversely affects soft tissue healing. Osseointegration is frequently disturbed, especially when implants were placed in non vascularised bone grafts. In addition, head and neck irradiation following dental implant placement carries a significant risk of osteoradionecrosis. In this context, alternatives to dental implants may be preferable in patients at increased risk for oral cancer. With advances in oral cancer therapy, more patients survive initial tumors. Hence, the incidence of second primary oral cancers is expected to rise. Therefore, in certain situations it may be appropriate to delay implant reconstruction for 2 years following oral cancer treatment.\textsuperscript{[23]}

13) Cytotoxic chemotherapy
The effect of cytotoxic chemotherapy on dental implants is variable and may depend on individual immune status and the peri-implant microflora. General recommendations for patients receiving chemotherapy include: (1) Thorough and regular implant hygiene, and (2) Delaying dental implant placement following cytotoxic chemotherapy until blood values normalize. Concurrent cytotoxic chemotherapy is associated with a high failure rate and contraindicates the placement of dental implants.\textsuperscript{[24]}
14) Irradiation
Radiation induces cellular changes in bone where osteocytes in direct pathway of irradiation are killed. Regenerative potential of the periosteum is compromised because of reduced cellularity, vascularity and osteoid formation potential. Blood vessels patency is reduced leading to diminished hematopoietic turn over. Irradiation therapy in which more than 50 gray (Gy) has been associated with increased risk of implant failure. Radiotherapy results in xerostomia, mucositis, and oral mucosal atrophy.[25] Hence, an implant-supported prosthesis may be preferable to a soft tissue–supported prosthesis following head and neck radiotherapy. A recent study showed that implants placed in irradiated dog mandibles had less bone-to-implant contact than those placed in nonirradiated controls. According to many studies, the failure rate of endosseous implants in irradiated jaw bone has been found to range up to 30%.[26]

**Dental Implant Implications:** Implant placement following head and neck radiotherapy is associated with a significant risk of osteoradionecrosis, especially with irradiation above 50 Gy. Some authors have recommended a 6 to 12 month recovery period after irradiation prior to dental implant placement. Presurgical hyperbaric oxygen may reduce the dental implant failure rate in irradiated jawbone from 60% to 5%. Whatever the method, if endosseous implants are placed in irradiated jawbone, strict long-term follow-up is required to monitor the condition of the peri-implant tissues.[27] Similarly, head and neck irradiation following dental implant placement carries a significant risk of osteoradionecrosis. If irradiation is to be performed in areas where titanium implants have been placed, it is recommended that all prostheses, frameworks and abutments be removed before irradiation. The use of long fixtures, fixed retention will decrease implant failures. Osseointegrated implants can remain in situ, although they should be covered with skin or mucosa. An understanding of the risk factors is important in preventing osteoradionecrosis after radiation therapy.[28-30]

15) Sjögren syndrome[31]
Sjögren syndrome is characterized in part by dry mouth (xerostomia) and dry eyes (xerophthalmia). Xerostomia frequently results in mucositis, candidiasis, and reduced denture retention and hence is a significant concern for conventional denture wearers.

Difficulties associated with soft tissue–supported prostheses in Sjögren syndrome patients may be overcome with implant-supported prostheses. In a recent study, implant-supported
prostheses were shown to considerably increase prosthetic comfort and function in patients with Sjögren syndrome. Although little is known about endosseous dental implants in patients with Sjögren syndrome, implant supported prostheses may be preferable to soft tissue–supported prostheses in patients with xerostomia.

16) Scleroderma

Scleroderma (systemic sclerosis) is a systemic disease that affects many organ systems. It is most obvious in the skin, which appears tight and shiny with characteristic loss of hair, decreased sweating, and loss of the ability to make a skin fold. The gastrointestinal and respiratory tracts and the renal, cardiovascular, and genitourinary systems are frequently involved. The symptoms result from progressive tissue fibrosis and occlusion of the microvasculature by excessive production and deposition of type I and type III collagens. Oral involvement of scleroderma results in reduced denture-bearing area and changing peripheral seal. Implant-retained prostheses may help overcome these difficulties, and successful treatment of scleroderma patients with dental implants has been reported. Scleroderma patients have limited oral access, which makes preventive dental care difficult. In summary, little is known about dental implants in patients with scleroderma. Endosseous dental implants may improve prosthesis function and comfort in scleroderma patients, although access for implant surgery and for oral hygiene may be compromised.\(^{[32]}\)

17) Multiple myeloma

Multiple myeloma is a clonal proliferation of malignant plasma cells in the bone marrow, which causes multiple osteolytic lesions and elevated serum immunoglobulins. Although implant success has been reported in a patient with multiple myeloma, unmanaged malignant disease in general must be considered a contraindication for the placement of endosseous dental implants.\(^{[33]}\)

18) Parkinson’s disease

Parkinson’s disease is a progressive neurodegenerative disorder associated with a loss of dopaminergic nigrostriatal neurons. Parkinson’s disease is one of the most common neurologic disorders, affecting approximately 1% of individuals older than 60 years. Cardinal features include resting tremor, rigidity, bradykinesia, and postural instability. Endosseous dental implants have been used successfully to overcome difficulties with complete dentures in patients with Parkinson’s disease. Implant supported prostheses should be considered in patients with Parkinson’s disease and other diseases affecting orofacial motor function.\(^{[34]}\)
19) Human Immunodeficiency Virus (HIV)

Although patients with AIDS may be at greater risk of peri-implantitis, endosseous dental implants have been placed successfully in HIV-positive patients. Diligent hygiene and long-term follow-up are required for implants placed in HIV-positive patients.\[35\]

CONCLUSION

The long-term efficacy and prognosis of dental implants is usually measured by the survival rates. Implant failures are multifactorial in nature. Reported predictors for implant success and failure are generally divided into patient-related factors e.g. general health status, smoking habits, uncontrolled diabetes, quality and quantity of bone, oral hygiene maintenance etc. Daily self-care and adherence to maintenance recall is mandatory for the long term success of implant and should be conveyed to patients during consultation period only. Since interest of patient and commitment to post treatment care is very important factor.

REFERENCES