Patient Selection for Endosseous Dental Implants: Oral and Systemic Considerations

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This paper reviews the literature and discusses patient selection for endosseous dental implants and the effect of systemic and local pathology on the success rate of dental implants. Endosseous dental implants may be preferable to conventional dentures in patients with compromised supporting bone or mucosa, xerostomia, allergy to denture materials, severe gag reflex, susceptibility to candidiasis, diseases affecting orofacial motor function or in patients who demand optimal bite force, esthetics, and phonetics. Conventional dentures or fixed partial prostheses may be preferable to endosseous dental implants in growing and epileptic patients and patients at risk of oral carcinoma, anaphylaxis, severe hemorrhage, steroid crisis, endocarditis, osteoradionecrosis, myocardial infarction, or peri-implantitis. A systematic approach to dental implant patient selection is outlined and centralized reporting of dental implant outcomes is recommended. (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:191–201)

Key words: *endosseous dental implants, patient selection*

The bone and soft tissue response following endosseous dental implant placement is controlled by wound-healing factors (cytokines, chemokines, and growth factors); biomechanics (gravitational, functional, and therapeutic loads); and mineral metabolism (hormones, diet, and excretion). Long-term maintenance of a rigid implant interface requires continual bone remodeling.[1] Because of the complexity of the tissue response, osseointegration and maintenance of endosseous dental implants may be influenced by many factors, including age, diet, drugs, systemic disease, and oral disease. Generally, endosseous dental implants may be considered for any patient in reasonable health who desires the replacement of missing teeth and has enough bone in the area or can undergo a bone augmentation procedure. The aims of this article were to define "reasonable health" for dental implant treatment and to provide a systematic approach to the selection of dental implant patients. Material for this article was obtained from journal articles identified in a MEDLINE search and from a review of current dental implant texts.

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TITANIUM TOXICOLOGY

Titanium is a nonessential trace metal. Although titanium ions have been shown to enter the periimplant bone and the regional lymph nodes, kidneys, lungs, and liver in experimental animals, titanium and its alloys have proven to be extremely biocompatible.[2–5] Titanium-aluminum-vanadium alloy (Ti6Al-4V) is used commonly for orthopedic and oral implants with very few reports of titanium sensitivity.[6] In vitro, Ti6Al-4V particles showed little toxicity toward rat peritoneal macrophages.[7] The high corrosion resistance and biocompatibility of titanium and titanium alloys are the result of a thin surface film of titanium dioxide (TiO_2).[8] TiO_2 dust inhalation is not associated with occupational lung disease[9] and rats fed TiO_2 (5% dietary concentration) for 130 weeks showed no toxic or carcinogenic effects.[10] The survival or success of endosseous dental implants may be influenced by a number of local and systemic conditions. Some of these conditions affect the process of osseointegration directly. The following are noted in particular.

Table 1 The American Society for Anesthesiology (ASA) Classification of Physical Status

P1	Normal, healthy patient
P2	Patient with mild systemic disease with no functional limitation, ie, a patient with a significant disease that is under good day-to-day control, eg, controlled hypertension, mild chronic obstructive pulmonary disease (COPD: bronchitis, emphysema), oral agents for diabetes mellitus, stable on digoxin for atrial fibrillation
P3	Patient with severe systemic disease with definite functional limitations, ie, a patient who is quite concerned with their health problems each day, eg, a diabetic on insulin, significant COPD with low exercise tolerance, high blood pressure despite taking 2 or 3 antihypertensive medications
P4	Patient with severe systemic disease that is a constant threat to life
P5	Moribund patient who is not expected to survive 24 hours
P6	Declared brain-dead patient whose organs are being removed for donor purposes

Physical Status

The American Society for Anesthesiology (ASA) has defined a 6-point scale of physical status (Table 1). The ASA restricts intraosseous implants and implant-related surgeries to P1 or P2 patients.[11] As discussed below, endosseous dental implants may be considered for some P3 patients after further patient evaluation.

Age

Endosseous dental implants are stationary in the jaws and do not erupt or migrate during dentoalveolar development.[12] Younger patients may show greater crestal bone resorption around dental implants.[13] It is therefore recommended that implant placement be delayed until growth and development have ceased or are minimal.[12] 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. However, implant failure does not correlate with age or sex.[14] Increasing age has no effect on osseointegration or the rate of crestal bone resorption around dental implants.[13] 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.

Patient Expectations

Compared with patients requesting conventional complete dentures, patients requesting dental implants were less satisfied with the comfort and stability of their existing mandibular complete denture and less able to chew hard foods.[15] In general, expectations of implant-retained prostheses were significantly greater than for conventional dentures.[15] Patients referred for implant treatment because of problems with removable prostheses were more depressed than average.[16] Recent studies showed improved quality of life (comfort, function, speech, esthetics, self-image) following dental implant therapy.[17,18] Although dental implants can enhance esthetics, phonetics, and bite force, it is important to identify unrealistic expectations that patients may have about implants and implant-retained prostheses.

HYPOHIDROTIC ECTODERMAL DYSPLASIA

Hypohidrotic ectodermal dysplasia (HED, EDA, Christ-Siemens-Touraine syndrome) is characterized by hypodontia, hypotrichosis, and hypohidrosis. The X-linked form of the disease (XLHED) has been mapped to the X chromosome (Xq12-q13.1) and a gene from this region, termed EDA1, has recently been cloned. The EDA1 gene encodes a predicted transmembrane protein of 135 amino acids, which is expressed in keratinocytes, hair follicles, and sweat glands.[19] The EDA1 protein has a predicted extracellular collagenous domain, which may play a key role in epithelial-mesenchymal interactions.[20] Mutation in the predicted transmembrane hydrophobic domain of the EDA1 protein has been described.[21] Recent data suggest that the EDA1 protein plays a critical role in tooth, hair, and sweat gland morphogenesis.[22] Autosomal dominant hypohidrotic ectodermal dysplasia (ADHED) has similar clinical features to XLHED. ADHED maps to a gene (EDA3) on the proximal long arm of chromosome 2 (q11-q13).[23]

Dental implants have been used successfully in patients with severe hypodontia associated with ectodermal dysplasia.[24–27] As discussed, implant placement is generally contraindicated in growing patients. However, most of these reports describe successful implants in young children. Of interest, alveolar bone growth may continue after dental implant placement in the edentulous ridges of children with ectodermal dysplasia, suggesting that alveolar growth is not dependent on the presence of teeth per se.[28] 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.[29]

SMOKING

Many studies have shown that smoking interferes with osseointegration[30–33] and accelerates bone resorption around dental implants.[34,35] Smoking cessation during the healing phase following implant surgery improved implant survival.[36] It is now clear that smokers are at greater risk of peri-implantitis, especially in the maxilla.[37] In this context, a conventional denture or fixed partial prosthesis may be preferable to endosseous implants for patients who continue to smoke.

OSTEOPOROSIS

Osteoporosis is a progressive systemic disease characterized by low bone mass and deterioration of bone tissue, leading to bone fragility and fracture. The prevalence of osteoporosis increases with age and after menopause. Osteoporosis can cause oral bone loss.[38] However, implant failure does not correlate with age or sex,[14] and hormone replacement therapy did not influence the survival of dental implants in postmenopausal women.[39] Furthermore, steroid-induced osteoporosis had no effect on mandibular implants in rabbits.[40] One report described a patient who lost 5 implants after commencing diphosphonate therapy for osteoporosis.[41] Another report described successful implants in an 80-year-old female with severe osteoporosis and chronic polyarthritis receiving methotrexate disodium and acemetacin.[42] In a recent study, implant failure did not correlate with peripheral dual-energy x-ray absorptiometry bone measurements at the distal and proximal radius and ulna.[43] On balance, osteoporosis appears not to influence implant survival.[44,45] Moreover, endosseous dental implants may actually stimulate mandibular bone formation in a load-dependent manner.[46]

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. Such a deficiency results in increased concentrations of glucose in blood, which, in turn, leads to damage of many of the body's systems, especially the blood vessels and nerves. In type 1 diabetes (formerly known as insulin-dependent diabetes), the pancreas fails to produce insulin. This form of diabetes develops most frequently in children and adolescents, although the incidence in later life is increasing. Type 2 diabetes (formerly known as non–insulin-dependent diabetes) is more common and accounts for about 90% to 95% of all diabetes cases worldwide. This form of diabetes occurs almost entirely in adults and results from the body's inability to respond properly to the action of insulin produced by the pancreas. Between 120 and 140 million people suffer from diabetes mellitus worldwide, although this number may double by the year 2025. Much of this increase will occur in developing countries and will likely be the result of population aging, unhealthy diets, obesity, and a sedentary lifestyle.[47]

Many studies in diabetic rats have shown reduced bone contact area and bone thickness around hydroxyapatite and titanium implants.[48–51] Insulin therapy has been associated with increased peri-implant 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.[52] The ASA (Table 1) suggests that patients on oral agents for diabetes (P2) are suitable candidates for dental implants, whereas patients on insulin (P3) are not.[11] Others suggest that diabetic patients who are well controlled with insulin are suitable for implant surgery under antibiotic cover,[53] and many studies have reported implant success in diabetic patients.[54–56] In a recent retrospective study, the survival rate of dental implants in controlled diabetic patients was slightly lower than that documented for the general population. The increased failure rate occurred during the first year following prosthetic loading.[57] 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.

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 skinfold. 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.[58] 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.[59,60] 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.

SJÖGREN SYNDROME

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.[61,62] In a recent study, implant-supported prostheses were shown to considerably increase prosthetic comfort and function in patients with Sjögren syndrome.[63] 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.

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,[64] unmanaged malignant disease in general must be considered a contraindication for the placement of endosseous dental implants.

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.[65] Endosseous dental implants have been used successfully to overcome difficulties with complete dentures in patients with Parkinson's disease.[66] Implant-supported prostheses should be considered in patients with Parkinson's disease and other diseases affecting orofacial motor function.

CYTOTOXIC CHEMOTHERAPY

Cytotoxic chemotherapy following endosseous dental implant placement may have little effect on implant osseointegration or survival.[67] Other dental implant patients experience complications following cytotoxic chemotherapy.[68] 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.[69]

BONE MARROW TRANSPLANTATION

Successful dental implant therapy following allogeneic bone marrow transplantation have been reported.[70] Hence, bone marrow transplantation is not a barrier to the osseointegration or survival of dental implants. Implant placement should be delayed until cytotoxic chemotherapy has ended and the marrow graft has taken. Bone marrow transplant patients may develop oral graft-versus-host disease that is clinically similar to oral lichen planus (see next page).

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.[71] Diligent hygiene and long-term follow-up are required for implants placed in HIV-positive patients.

SYSTEMIC DRUGS

As discussed, concurrent cytotoxic chemotherapy contraindicates the placement of endosseous dental implants. Peri-implant soft tissue hyperplasia may occur in patients taking dilantin sodium (phenytoin)[72] or nifedipine.[73] Careful follow-up of dental implant patients taking calcium channel blockers or other drugs associated with gingival hyperplasia is essential. Patients taking anticoagulants (including aspirin) are at risk of severe hemorrhage during implant surgery. Patients on long-term systemic corticosteroids are at risk of steroid crisis during implant surgery. Furthermore, steroid-induced osteoporosis may complicate dental implant treatment.[44] Consultation with the patient's physician prior to dental implant placement is desirable for patients on anticoagulants or long-term systemic corticosteroids.

OTHER EXTRAORAL DISEASES

Little is known about endosseous dental implant outcomes in patients with multiple sclerosis, systemic lupus erythematosus, rheumatoid arthritis, psoriasis, eczema, osteoarthritis, depression, anxiety, cardiovascular disease, gastric ulcer, Crohn's disease, celiac disease, ulcerative colitis, emphysema, bronchitis, or hematologic diseases.

CHRONICALLY INFECTED IMPLANT SITES

In a dog model, immediate implants placed in the extraction sockets of teeth with experimental periapical lesions were reported to be as successful as those placed in control sockets.[74] Implant success in this model may be attributed to the antibacterial activity of dental implant metals.[75] However, recent studies identified possible transmission of periodontopathic organisms from periodontitis sites to implant sites in monkeys[76] and humans.[77] Periodontitis and periapical lesions should be diagnosed and treated prior to dental implant placement.

ORAL LICHEN PLANUS

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.[78] Erosive OLP has been associated with dental implant loss, possibly because of altered capacity of the oral epithelium to adhere to the titanium surface.[79] Reticular OLP (white keratotic striations) does not appear to influence dental implant survival.[79] OLP is associated with the Koebner phenomenon and surgical trauma is known to exacerbate oral lesions.[80] Hence, dental implant surgery may exacerbate OLP lesions. Furthermore, atrophic (erythematous) and ulcerative (erosive) gingival OLP lesions benefit from intensive oral hygiene, suggesting that dental implant hygiene is crucial in OLP patients.[81] 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. As discussed below, OLP is associated with a slightly increased risk of oral squamous cell carcinoma. In this context, alternatives to dental implants may be preferable in patients with OLP.

HEAD AND NECK RADIOTHERAPY

Radiotherapy results in xerostomia, mucositis, and oral mucosal atrophy. 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.[82] Many studies have examined implant experience in head and neck radiotherapy patients: *(1)* 5% of implants failed to osseointegrate in irradiated mandibular bone[83]; *(2)* 7% of dental implants failed in irradiated patients and 6% in nonirradiated patients[84]; *(3)* 10% of implants in irradiated bone failed to osseointegrate and 10% of implants lost osseointegration over time[85]; *(4)* irradiation had no effect on the success rate of mandibular implants in patients treated for oropharyngeal carcinoma[86]; *(5)* 29% of dental implants in irradiated bone and 8% in nonirradiated bone developed soft tissue complications[87]; and *(6)* 27% of dental implants in irradiated mandibular bone and 15% in nonirradiated mandibular bone were lost in the first 36 months after placement.[87] Hence, the failure rate of endosseous dental implants in irradiated jawbone can range up to 30%.

Table 2 Benign Oral Lesions with Malignant Potential

Actinic cheilitis
Chronic hyperplastic candidiasis
Submucous fibrosis
Discoid lupus erythematosus
Oral lichen planus
Proliferative verrucous leukoplakia
Dyskeratosis congenita
Epithelial dysplasia

Implant placement following head and neck radiotherapy is associated with a significant risk of osteoradionecrosis, especially with irradiation above 50 Gy.[85] Some authors have recommended a 6- to 12-month recovery period after irradiation prior to dental implant placement.[88] Others have suggested that immediate dental implant placement can reduce the number of surgical procedures.[89] Presurgical hyperbaric oxygen may reduce the dental implant failure rate in irradiated jawbone from 60% to 5%.[90] 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. Similarly, head and neck irradiation following dental implant placement carries a significant risk of osteoradionecrosis.[91] 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. Osseointegrated implants can remain in situ, although they should be covered with skin or mucosa.[91]

ORAL PREMALIGNANT LESIONS

A proportion of benign oral mucosal lesions undergo malignant transformation (Table 2).[92] The effect of dental implants on oral premalignant lesions is unknown. However, squamous cell carcinoma arising around endosseous dental implants has been reported,[93] and dental implants may interfere with oral radiotherapy.[94] In addition, head and neck irradiation following dental implant placement carries a significant risk of osteoradionecrosis.[91] Hence, alternatives to dental implants may be preferable in patients with oral premalignant lesions.

ORAL CANCER RISK

Squamous cell carcinoma arising around endosseous dental implants has been reported,[93] and dental implants may interfere with oral radiotherapy.[94] In addition, head and neck irradiation following dental implant placement carries a significant risk of osteoradionecrosis.[91] In this context, alternatives to dental implants may be preferable in patients at increased risk for oral cancer. Increased oral cancer risk is associated with exposure to ultraviolet B radiation, tobacco, alcohol, betel quid, and *Candida albicans*.[92] A diet deficient in fresh vegetables (particularly carrots, tomatoes, capsicum, and green leaf) may also increase the risk of oral cancer.[95] Family members of oral cancer patients are at slightly higher risk of oral cancer.[96] Endosseous dental implants are used extensively in reconstruction following oral cancer therapy. However, approximately 2% to 3% of oral cancer patients develop a second primary cancer each year after removal of the primary tumor, and 90% of recurrences become manifest within 2 years of oral cancer treatment.[97] With advances in oral cancer therapy, more patients survive initial tumors. Hence, the incidence of second primary oral cancers is expected to rise.[98] Therefore, in certain situations it may be appropriate to delay implant reconstruction for 2 years following oral cancer treatment.

TARDIVE DYSKINESIAS

Tardive dyskinesias are involuntary movements of the tongue, lips, face, trunk, and extremities that occur in patients treated with long-term dopaminergic antagonist medications. Tardive dyskinesias are seen most commonly in patients with schizophrenia, schizoaffective disorder, or bipolar disorder who are treated with antipsychotic medication, but they occasionally are seen in other patients as well. Orofacial dyskinesias appear as involuntary, repetitive, and stereotyped facial grimacing, lip smacking, lip puckering, chewing, sucking, tongue writhing, tongue protrusion, or jaw opening and closing.[99] Tardive dyskinesia may complicate dental implant therapy.[100] Alternatives to endosseous dental implants should be considered for patients with neurologic disorders including orofacial dyskinesia, trigeminal neuralgia, or orofacial dysesthesia.

OTHER ORAL DISEASES

Little is known about endosseous dental implants and oral mucosal diseases including recurrent aphthous

Table 3 Simplified History for Patients Considering Endosseous Dental Implants

Medical history
Allergies—drugs, local anesthetic solution, metals
Bleeding disorder
Cardiac infarct or bypass
Drugs, depression, or diabetes
Endocarditis, rheumatic fever, mitral valve prolapse, heart valve prosthesis, or heart murmur
Radiotherapy—head and neck
Pregnancy
Medical care or hospitalization
Oral and perioral history
Oral mucosal disease
Jawbone disease
Head and neck cancer
Orofacial trauma
Temporomandibular joint disease
Salivary gland disease
Maxillary sinus disease
Uncontrolled periodontitis
Trigeminal neuralgia
Orofacial dysesthesia
Orofacial dyskinesia

Table 4 Preference for Endosseous Dental Implants over Conventional Dentures

Compromised supporting bone
Severe ridge resorption
Jaw reconstruction (oral cancer, bone tumors, trauma)
Congenital and developmental abnormalities, eg, cleft palate
Compromised supporting mucosa
Oral lichen planus
Recurrent aphthous stomatitis
Pemphigus vulgaris
Cicatrical pemphigoid
Discoid lupus erythematosus
Scleroderma
Allergy to denture base materials
Severe gag reflex
Dry mouth patients
Drugs
Sjögren syndrome
Head and neck radiotherapy
Patients who are highly susceptible to oral candidiasis
Immunosuppressive therapy (eg, steroid inhaler, chemotherapy)
AIDS
Anemia
Endocrinopathy
Neuromuscular disease
Parkinson's disease
Other diseases affecting orofacial motor function
Patient preference
Increased bite force
Improved esthetics
Improved phonetics
Enhanced self-confidence

stomatitis, pemphigus vulgaris, cicatricial pemphigoid, discoid lupus erythematosus, erythema multiforme, hyperkeratosis, dysplasia, herpes zoster, or recurrent oral herpes. Little is known about endosseous dental implants and oral bone diseases including sclerosis and exostosis, Paget disease, fibrous dysplasia, cherubism, osteomalacia, hyperparathyroidism, Langerhans cell histiocytosis, or central giant cell granuloma.

PATIENT SELECTION

The following approach is suggested when assessing patients for endosseous dental implants:

1. Obtain a medical history (Table 3).
2. Obtain an oral and perioral history (Table 3).
3. Discuss smoking, alcohol, and diet.
4. Identify familial diseases—cardiovascular disease, cancer, autoimmunity, other.
5. Perform a thorough clinical and radiographic oral examination to identify candidiasis, hyperplasia, other mucosal disorders, benign tumors, jaw cysts, root remnants, periodontitis, periapical lesions, and other jaw pathology.
6. Obtain a specialist opinion for oral or systemic disease prior to dental implant placement.
7. Seek multiple opinions prior to dental implant placement in patients with oral or systemic disease.
8. Record oral and systemic changes following dental implant placement.
9. Record changes in oral and systemic diseases following dental implant placement.
10. Report oral and systemic changes to a central register.

Table 5 Contraindications for Endosseous Dental Implants

Oral and perioral pathology
Oral soft tissue pathology
Jawbone pathology
Temporomandibular joint disease
Salivary gland pathology
Maxillary sinus pathology
Uncontrolled periodontitis
Trigeminal neuralgia, orofacial dysesthesia, orofacial dyskinesia
Severe systemic disease
Severe bronchitis or emphysema
Severe anemia
Uncontrolled diabetes
Uncontrolled hypertension
Abnormal liver function, cirrhosis
Nephritis, chronic urinary tract infections
Severe psychiatric disease
Malignant disease
Systemic medications
Cytotoxic chemotherapy
Calcium channel blockers (nifedipine, felodipine, verapamil)
Anti-epileptics (phenytoin, sodium valproate)
Cyclosporin
Anticoagulants (including aspirin)
Corticosteroids—steroid crisis during surgery, osteoporosis
Other conditions
Anorexia, bulimia
Dwarfism, gigantism, acromegaly
Pregnancy
Epilepsy
Growing patients
Anaphylaxis risk
Allergy to titanium
Allergy to local anesthetic solution
Severe hemorrhage risk
Anticoagulants
Hemophilia
Thrombocytopenia
Leukemia
Liver disease
Endocarditis risk
History of endocarditis
Rheumatic fever
Prosthetic heart valve
Mitral valve prolapse
Some heart murmurs
Osteoradionecrosis risk
Head and neck radiotherapy
Myocardial infarction risk
Cardiac infarct or bypass within 6 months
Peri-implantitis risk
Smoking
Diabetes
Immunosuppressive therapy
AIDS
Oral cancer risk
Tobacco (smoking, chewing)
Alcohol
Betel quid
Ultraviolet B radiation
Chronic *C albicans* infection
Oral premalignant lesions (Table 2)
Previous oral cancer
Family history of oral cancer

Many of these contraindications are relative and dental implants may be considered after further patient evaluation and risk assessment.

CONCLUSIONS

Endosseous dental implants may be preferable to conventional dentures in patients with compromised supporting bone or mucosa, xerostomia, allergy to denture base materials, severe gag reflex, susceptibility to candidiasis, or diseases affecting orofacial motor function or in patients who demand optimal bite force, esthetics, and phonetics (Table 4). Conventional dentures or fixed partial prostheses may be preferable to endosseous dental implants in growing and epileptic patients and patients at risk of oral carcinoma, anaphylaxis, severe hemorrhage, steroid crisis, endocarditis, osteoradionecrosis, myocardial infarction, or peri-implantitis (Table 5). The effect of many oral and systemic conditions on osseointegration and maintenance of endosseous dental implants is unknown. Centralized reporting of endosseous dental implant successes and failures will facilitate the process of patient selection and will expand the applications of dental implant treatment.

ACKNOWLEDGMENTS

Philip Sugerman is supported by a National Health and Medical Research Council (Australia) Industry Research Fellowship (# 143125).

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