PRINCIPLES OF IMPLANT DESIGN

INTRODUCTION

The integration and long-term success of dental implants exploit the unique biology of the oral cavity, which allows for osseous incorporation of a biomaterial and its long-term health within a bacteria-laden oral milieu.[1] The delicate balance of defense and repair mechanisms underlying this unique environment may be challenged by various factors that can act both locally and/or systemically, thereby increasing the risk of implant loss and jeopardizing the long-term success of inserted implants.

Local risk factors that are present in the oral cavity and systemic risk factors that have the potential to affect oral health on a systemic level can compromise implant treatment at all stages of treatment delivery by:

(a) complicating surgical procedures and other invasive measures required during treatment;

(b) compromising the process of tissue healing following implant insertion/increasing the risk of wound infection;

(c) contributing to the deterioration of long-term peri-implant health and tissue stability.

TABLE 1. Effects of Systemic Diseases

Systemic conditions	Biologic effects	Potential to affect		
		Surgical/invasive procedures	Tissue healing/risk of wound infection	Long-term peri-implant tissue health
Cardiovascular	Fatigue	x		
Bleeding disorder	Innate/iatrogenic hypocoagulation	x	x	x
Osteoporosis	Reduced bone healing Reduced implant stability		x	x
Antiresorptive medication	Reduced bone remodeling Reduced angiogenesis Reduced bone regeneration		x	x

Systemic conditions	Biologic effects	Potential to affect		
		Surgical/invasive procedures	Tissue healing/risk of wound infection	Long-term peri-implant tissue health
Diabetes mellitus	Acquired immunosuppression Hypovascularity		x	x
Rheumatoid disease	Iatrogenic immunosuppression		x	x
Organ transplantation			x	x
Crohn's disease			x	x
Chemotherapy	Iatrogenic immunosuppression Reduced tissue regeneration		x	x
HIV infection	Acquired immunosuppression		x	x
Tobacco abuse	Hypovascularity hypoxia Leukocyte dysfunction		x	x
Local conditions				
Radiation therapy	Hypovascularity, hypocellularity, reduced tissue regeneration		x	x
Mucosal autoimmune diseases	Iatrogenic local immunosuppression		x	x

Conditions that interfere with invasive procedures, which include poor general health status as a result of severe systemic disease, may impact upon implant surgery, healing, and maintenance. These are mostly cardiovascular conditions that can place the patient at high risk during surgery, irrespective of the nature of the intervention. Bleeding disorders, which may be innate or

acquired, as well as attributable to the use of anticoagulants, may also complicate invasive measures. While the former are considered to be relatively rare, the latter may have a significant impact on daily implant treatment in an aging population.

Systemic and local factors that may compromise bone and soft tissue healing after implant insertion make up the majority of medical conditions that require consideration and/or management when contemplating implant therapy. The important systemic factors are:

- osteoporosis.
- anti-bone resorptive medications.
- diabetes mellitus.
- immune deficiency.
- behavioral factors such as substance abuse, in particular tobacco and alcohol.

Important local factors include:

- a history of radiation therapy.
- oral mucosal diseases.

All these conditions can also have a negative impact on long-term peri-implant health and maintenance of peri-implant tissues as a result of compromised vascularity, as well as alterations in the immune defense or repair capacity of peri-implant tissues.

The increasing patient demand for implant-based treatments in conjunction with a demographic shift of the patient population has resulted in a growing body of literature dealing with an increasing number of patients presenting with medical conditions.

A recent cross-sectional analysis indicated that almost 90% of patients aged > 65 years were taking medication for underlying systemic diseases, which could jeopardize implant success. The advent of new treatment modalities, such as antiresorptive drugs or monoclonal antibody therapies, adds to the number of potential risk factors, leading to an increasing challenge for the provision of implant-based treatments in the future.

The aim of this narrative review was therefore to analyze the importance of systemic and local conditions as risk factors for implant loss by critically evaluating the available evidence. During evaluation of the available literature, it was obvious that the term “implant loss” was used to a much lesser degree than “implant failure.”

Very few reports clearly defined implant failure as implant loss, but the context in which this term has historically been used indicates that implant failure was synonymous for implant loss. It is only in the last decade or so that definitions of implant failure have been published, and not until the 2017 World Workshop on Periodontal and Peri-Implant Disease Classification was an international definition agreed upon.

One of the major reasons for implant loss is the progressive loss of peri-implant bone support. Therefore, marginal bone loss was also included in the analysis. As progressive crestal bone loss around implants in the absence of clinical signs of soft tissue inflammation is rare, reported radiographic bone loss was considered in conjunction with clinical peri-implant parameters (where provided) in the individual reports in order to assess the prognostic relevance of the findings.