Systemic Factors Affecting Prognosis in Restorative and Prosthetic Dentistry: A Review

Fengyuan Zheng, BDS, PhD[a],
Lovely Muthiah Annamma, BDS, MDS, PhD[b],
Sunil Suresh Harikrishnan, MDS[c], Damian J. Lee, DDS, MS[d,*]

KEYWORDS

• Prognosis • Systemic diseases • Diabetes • Removable prosthesis
• Fixed prosthesis • Osteoporosis • Endocrine disorders • Neurologic disorders

KEY POINTS

- Understanding how various systemic factors can affect the prognostic outcome of removable and fixed prosthetic rehabilitation.
- Healing procedures and bone density are affected by many systemic factors such as metabolic, bone, autoimmune, cardiovascular, and endocrine disorders.
- Patients who are suffering from systemic diseases can have negative prognosis outcomes when treated for prosthodontic rehabilitation.

INTRODUCTION

The integrity and health of the oral cavity play a pivotal role in overall health. Fixed, removable, and implant prosthodontics are effective ways to restore partial or complete edentulous arches and rehabilitate oral cavities to restore or improve oral health and esthetics. The restorative and prosthetic dentistry must rely on the retention and support by remaining hard and soft tissue in oral cavities. On the other hand, the remaining hard and soft tissues, as parts of the body, are closely regulated by systemic conditions and medical interventions.[1,2] Therefore, the purpose of this review is to search and summarize published studies on the impact of systemic factors on supporting structures and outcomes of prosthetic treatments.

[a] Advanced Education Program in Prosthodontics, Department of Restorative Sciences, Division of Prosthodontics, University of Minnesota School of Dentistry, 9-176 Moos Tower, 515 Delaware Street Southeast, Minneapolis, MN 55455, USA; [b] College of Dentistry, Ajman University, PO Box 346, University Street Al Jeft 1, Ajman, United Arab Emirates; [c] Private Practice, Flat No. 26, Building No. 16, Street No. 890, Zone 26, Najma, Doha, Qatar; [d] Department of Prosthodontics, Tufts University School of Dental Medicine, 1 Kneeland Street, DHS 220; Boston, MA 02111, USA
* Corresponding author.
E-mail address: damian.lee@tufts.edu

Dent Clin N Am 68 (2024) 751–765
https://doi.org/10.1016/j.cden.2024.05.007 **dental.theclinics.com**

The main factors that may influence hard and soft tissue turnover and healing capabilities were considered in this review, including systemic conditions and behavioral or medical interventions. The systemic conditions include age, gender, diabetes, autoimmune diseases, and osteoporosis, while behavioral or medical interventions include smoking, Parkinson's, Alzheimer's, bisphosphonates, radiotherapy, and chemotherapy.[1,2] Relevant articles regarding systemic factors affecting restoration, removable and fixed prostheses excluding implants were selected for the review (Fig. 1).

General Factors

Age

While considering prosthodontic treatment, the longevity of the restorations is of a major concern to the patients and the clinicians. The prognosis of the treatment depends on multiple factors. Among them, age, gender, and other socio-economic factors play important roles.[3,4] It is a known fact that the integrity and function of the stomatognathic system are affected by the natural aging process. As age advances, teeth develop caries resistant sclerotic dentin but risk of root caries do prevail.[5,6] Increase in caries incidence in the elderly can be attributed to the alterations in the rate of salivary flow induced by hypo-function of the salivary glands or medication.[3] Also in aged dentin, fracture toughness is decreased and crack propagation is more common due to an internal rearrangement of its structure. Finally, reduced motor capacity is also seen with the older individuals, leading to reduced ability to maintain satisfactory oral hygiene and lesser adaptability to prostheses.[7,8] All the aforementioned changes seen in the aging population may affect the prognosis and longevity of tooth supported fixed prosthetic restorations and therefore increased age may pose a risk factor for success.

There are conflicting results in the literature regarding the influence of patients' age on the longevity of fixed restorations. A systematic review article by G. Ioannidis and colleagues showed that middle aged individuals may present with higher failure rates and the reason attributed to early onset of dental disease.[3] De Backer and colleagues in their 18 to 20 year follow-up study (2007) showed that the patients receiving first

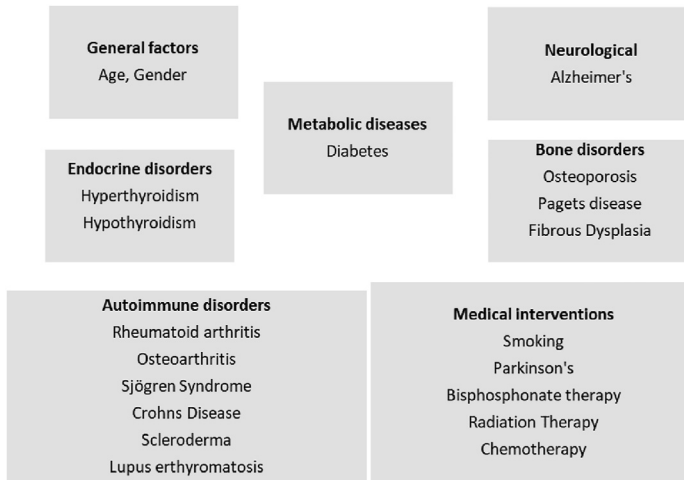

Fig. 1. Common systemic factors affecting prognosis in fixed and removable prosthesis.

restorations at an older age show more failures than individuals receiving their first at a much younger age, regardless complete crowns, 3 unit fixed partial dentures (FPDs), or other fixed prostheses.[9]

In terms of direct restorations, on the other hand, van de Sande and colleagues in a systematic review articles showed that adolescents have more failure rates than younger children in relation to Class I & II composite restorations; individuals around 30 years no significance; people older than 30 years showed lower survival for amalgam restorations; and group between 41 and 45 years had higher failures than older age groups.[10,11]

For complete dentures, the majority of studies showed that age is of no prognostic value in determining the denture success.[7,12,13] Other studies (Diehl [1996], Allen [2003], Zarb [1982]) showed that patients over 60 years of age have difficulty in adapting to dentures, probably due to decreased muscle adaptability and lack of new reflex arcs.[8,14,15]

Gender

Previous studies have shown that no significant correlation between gender and fixed prostheses longevity has been found; nevertheless, higher failure rates on direct restorations among men have been reported.[9,11,16–18] While the stronger occlusal force was considered to be a contributing factor for fatigue of the material, fracture, or debonding, some have reported that that women make regular follow-up visits than men and hence, men show more failures.[19,20]

In terms of complete dentures, there were no studies showing notable correlation between complete denture longevity and gender. However, a far less acceptance rate was found in postmenopausal women due to decreased muscle adaptability and lack of formation of new reflex arcs.[21]

Diabetes

Diabetes mellitus (DM) is a prevalent systemic disease among adults, especially those over the age of 40. Usually the adult-onset type 2 DM has been associated with having a higher prevalence of developing periodontal disease,[22–24] caries,[5,6,25-] diminished masticatory efficiency,[26] and even oral candidiasis associated with removable prostheses,[27] but not research directly related to prosthodontic outcome is scarce. Study by Azogui-Levy and colleagues showed that subjects with DM were more likely to have dental problems, as well as use a form of partial or complete denture.[28] A study by Ambikathanaya and colleagues showed that impact of using a removable partial denture (RPD) may be lessened on developing caries with good oral hygiene, proper RPD instructions, and regular dental visits, regardless of the patient being diabetic.[25] As for fixed prosthodontic patients, diabetic patients were correlated with deeper periodontal pockets, bleeding on probing and increased bone loss with higher values associated with inflammatory markers.[29] A study by Elsalhin and colleagues showed that there was also a higher incidence of deep pockets and gingival recession around FPDs and emphasized on making the design of fixed partial denture more accessible for hygiene for diabetic patients.[30] Because prosthodontic therapy is very dependent on the health of supporting tissues, the bidirectional relationship between DM and oral health and its sequelae must be educated to our patients.[31] Several studies have advocated for patients to understand the nature of DM and being familiar with the clinical manifestation so that patients along with an oral health care provider can work toward preserving oral health, rather than focusing on replacing missing teeth from ongoing exacerbation of DM.[32–34]

Autoimmune Disorders

Autoimmune disorders cause immunosuppression. The most common systemic autoimmune disorders that can affect the outcome of prosthodontic treatment include rheumatoid arthritis, Sjögren Syndrome, and Crohn's disease.[35] Many of the autoimmune disorder patients will be on steroid drugs which in turn can negatively affect bone metabolism causing steroid osteoporosis.[36] Autoimmune disorders can have oral manifestations such as Sjögren Syndrome, epidermolysis bullosa, and oral lichen planus. These patients are prone to hyposalivation and gingival bleeding.[37] Patients suffering from autoimmune diseases wearing removable prostheses are prone to dry mouth and oral ulcers causing unpleasant burning sensations. Hence, the removable prosthesis prognosis is poor for such patients as they are often unable to wear them. The preferred option for these patients is implant retained prosthesis.[38] Other autoimmune disorders such as systemic sclerosis cause stiffening of connective tissues resulting in reduced mouth opening, with subsequent problems such as difficulty in food intake, chewing, swallowing, and dental hygiene.[39] Due to the consequent effects of these disorders, there is a poor outcome of the removable prosthesis and hence, a fixed prosthesis is the preferred treatment option for patients suffering from systemic sclerosis.[40]

Treatment Management

Removable prosthesis requires multiple visits and most of the autoimmune disorders affect the temporomandibular joint movement thereby restricting jaw movement. This causes difficulty in jaw relation procedures.[41] Hyposalivation can also result in *Candida albicans*, seen as erythema of the oral mucosa, and inflamed fissures at the corners of the mouth.[42] A removable prosthesis can cause excessive soreness and ulcerations due to adverse mucosal conditions. In most autoimmune disorders, such as Sjogren's syndrome, implant prosthesis is preferred. An artificial salivary reservoir denture can be used in cases where the implant prosthesis is contraindicated.[43,44]

Osteoporosis

Osteoporosis is a systemic disorder causing a reduction of bone strength due to a reduction in the density of bone.[45] Any decrease in bone loss systemically affects the jawbone causing excessive bone resorption and periodontitis. Periodontitis is a local progressive and persistent inflammatory response of supporting tissues of teeth leading to loss of clinical attachment, alveolar bone loss, and periodontal pocket formation.[46] Osteoporosis commonly occurs in older people, especially women,[47] and periodontal disease in adults with more prevalence in men.[4] Any systemic disorders affecting the bone can, in turn, affect the supporting tooth and edentulous area, because of bone resorption or periodontitis. Patients with bone disorders wearing partial or complete dentures require constant monitoring and adjustments in dentures.[48] The reasons for this are that an existing systemic disease can aggravate the severity of periodontal disease due to the higher level of cytokines and inflammatory mediators present.[49] The prognosis outcomes of rehabilitating patients with bone disorders can lead to deterioration of periodontal status or excessive bone resorption coupled with osteoporosis and other risk factors such as habits, estrogen deficiency, osteopenia, Vitamin D, and calcium deficiency.[50–53]

Most bone disorders affect the prosthodontic treatment outcome due to the loss of supporting structures such as teeth and bone. If the tooth that is affected is an abutment then the retainer component fails causing failure in fixed and partial removable prosthesis. Bone resorption can cause loosening of dentures leading to repeated

relining procedures. The reason for bone resorption is that systemic diseases such as osteoporosis increase the levels of pro-inflammatory cytokines causing osteoclastic activity.[54]

Bisphosphonates

Antiresorptive medications such as bisphosphonates and denosumab, and RANK ligand inhibitors are used to prevent bone resorption in systemic bone disorders.[55] Bisphosphonates cause increased activity of osteoclasts and osteoblasts, while denosumab reduces osteoclast activity.[56,57]

Many bone disorders such as fibrous dysplasia, osteitis deformans, and arthritis are treated by bisphosphonates, which in turn can cause osteoradionecrosis of the jaw.[58] The therapy with bisphosphonates when continued for more than 4 years orally or via intravenous injections the chances of osteoradionecrosis in such patients are high.[59,60] Regarding prosthodontic outcome, the complications in such patients taking bisphosphonates arise when an ill-fitting denture causing ulceration can trigger medication-related necrosis.[61]

Treatment planning for patients with bone disorders

For the success of the RPD, the treatment planning to the design needs a thorough analysis. The treatment planning and designing should be considered to protect the tooth and tissue structures preventing further deterioration in bone resorption and periodontal involvement. Post-operative instructions and dietary guidance with calcium supplements can improve the prognosis. The recommended calcium intake for an average person is 800 mg per day and 1500 mg for a postmenopausal woman.[45]

Neurologic Disease

Direct relationship between neurologic diseases on the treatment outcome for prosthodontic patients may not be very well-documented. Previous studies have suggested that loss of occlusal support may be a risk factor for neurologic disease where it can lead to cognitive dysfunction through the "reduction of chewing-related stimuli, aggravation of nerve damage, and long-term inflammatory stress".[62,63] Alzheimer's disease is a degenerative disease of the brain that may have some detrimental effect on the prosthodontic therapy and its outcome. Previous studies have described the oral health deterioration due to the onset of Alzheimer's disease (Marchini, Campos CH) where mandibular movements, bite force, and masticatory efficiency, as well as quality of life has been affected.[64–67]

Parkinson's disease is a degenerative disease where this happens and that happens. Previous studies have described the impact of Parkinson's disease on the oral health with reduced oral sensorimotor ability such as range of motion in eccentric movements, tongue pressure, dysphagia, and impaired masticatory function.[68–72] Impaired motor function may have negative effect on oral hygiene from increased biofilm formation.[69–72]

Emphasizing good oral health throughout the disease progression and customized plan to address the individual needs are essential in preventing the decline in oral health quality of life.[64]

Cancer and Radiation

Radiation therapy is widely applied to head and neck cancer treatment and the effect of radiation on different types of cells and tissues have been well-studied.[73] Xerostomia, dysgeusia, mucositis, radiation caries, are osteoradionecrosis are the main adverse effects from the radiation therapies.[74–79]

Table 1
Summary of systemic factors and likely prosthodontic complications with reasons

Systemic Factors	Complications Likely to Cause Failures in Prosthodontic Outcome	Reasons for the Poor Diagnostic Outcome
Age *Above 65 ys more complaint*	• Oral stomatitis/burning mouth syndrome • Mucosal lesions • Angular cheilitis, superimposed infection • Hyperplasia, mandibular dysfunction	Older patients with cognitive impairment, frailty multiple chronic diseases have side effects from medications.[87,88]
Gender	Women of menopausal experience more difficulty in adapting to dentures than those in the younger age group	Due to the physical and emotional changes during and after menopause[21]
Smoking and chewing tobacco.	• Median rhomboid glossitis • Chewer's mucositis • Leukoplakia • Oral squamous cell carcinoma • Oral submucous fibrosis	Aggravated by local proliferation of *Candida albicans* on the dorsum of the tongue.[89,90]
Metabolic disorders *Diabetes*	Xerostomia cause difficulty in wearing complete dentures due to soreness and ulceration. Denture retention may be affected by lack of saliva.	Xerostomia in diabetes mellitus is thought to be caused by the polyurea of the disease while drugs like diuretics used in the treatment of hypertension are possible causes of xerostomia.[91,92]
Autoimmune Disorders		
Rheumatoid Arthritis	Jaw movement restrictions	Difficulty in making jaw relations and impressions. Rheumatoid Arthritis decreases masticatory function and maximum bite force.[93,94]
Osteoarthritis	Mandibular movements are painful.	Shorter appointments due to difficulty in opening the mouth for a longer period. Preference for removable prosthesis over the fixed. It is difficult to record and repeat jaw relation records.[95]
Sjögren Syndrome	Hyposalivation, high caries rate, burning sensation, early tooth loss, and repeated failure of restorations	Difficulty in wearing a removable prosthesis which irritates mucosa and causes painful ulcerations. Implant treatment is the preferred choice.38

Crohn's Disease	Oral manifestations, possible hyposalivation, gum bleeding, ulceration in mouth, canker sores, thick mucus, and increased caries	Implant treatment is preferred.[96]
Systemic Sclerosis	Reduced mouth opening, preference for fixed prosthesis	Patients with microstomia can have difficulties in inserting and removing their dentures from the mouth.[39]
Bisphosphonates/Bone Disorders	*Prosthodontic Complications*	
Osteoporosis	Bone resorption Lack of denture retention, gingival attachment loss Interproximal bone loss	Increased osteoclastic activity causing denture loosening Preservation of underlying tissue structure by: i. Mucostatic or open mouth impression technique is recommended ii. Use of non- or semi-anatomic acrylic teeth with narrow buccolingual width is advised iii. Extended tissue rest from dentures is advised for at least 10 hs per day iv. Optimal use of soft liners may be considered and v. Frequent relining of dentures is often required.[97]
Fibrous Dysplasia	Malocclusion, craniofacial defects, growth of the jaw, tooth abnormalities, and high caries index	Frequent recalls are required to redo prostheses and failed restorations.[98]
Osteitis Deformans/Paget's Disease	Affects the jaws	• Prosthesis failures are quite common and need frequent refabrication.[99]
Endocrine Disorders		
Hypothyroidism	Macroglossia, glossitis, enamel hypoplasia, anterior open bite, and micrognathia	Congenital hypothyroidism is reported to have a hypodontia mandible delayed eruption and retained deciduous tooth. These patients will need removable prostheses from a young age with constant relining and rebasing.[100–102]
Hyperthyroidism	Increase caries susceptibility, periodontal disease, burning mouth syndrome, osteoporosis, Sjogren's syndrome, and systemic lupus erythematosus	Can cause failure of abutment tooth in removable cast partial dentures.[103]

(*continued on next page*)

Table 1
(*continued*)

Systemic Factors	Complications Likely to Cause Failures in Prosthodontic Outcome	Reasons for the Poor Diagnostic Outcome
Parkinson's disease (PD)	PD-related rigidity, tremors, and dyskinesia. Also cause cracked teeth, tooth wear, changes in the fit and wear of dentures, and tooth grinding.	Hard to brush one's teeth. Hence oral hygiene maintenance is difficult. Swallowing and speech can also be affected. A well-fitting prosthesis is required but recording of jaw relation to final clinical procedures is difficult depending on the severity of the disease.[104]

The direct effect of radiation therapy on restorative and prosthodontic treatment remains unclear. However, due to the adverse effects on salivary glands, soft tissue, and bone, the risk assessment must be carefully considered when removable or fixed prostheses are planned in conjunction with remaining hard and soft tissue. Xerostomia has been known for high caries risk for remaining dentition and lack of retention for complete denture employment. The increased caries risk associated with RPDs can be aggravated by xerostomia.[80,81] Patients' diligent personal care must be emphasized and closely monitored if such a combination has to be planned and executed. Removable dental prostheses, including complete dentures and partial dentures, that rely on mucosa support may predispose ulcerations and lead to osteonecrosis. Therefore, care must be given meticulous attention to tissue surface adaptation and tissue conditioning to assure well-functioning prostheses.

The self-etch adhesive has shown to be affected by gamma irradiation.[82] Gamma irradiation resulted in reduced fracture resistance of intact teeth and increased cusp strain.[83] The bonding between fiber post and irradiated endodontically-treated teeth dentin resulted in significantly lower bond strength than non-irradiated teeth. Etch-and-rinse showed significantly higher bond strength than self-etch approaches.[84] In terms of adhesive restorative materials, glass ionomer provide clinical caries inhibition but erode easily, while composite resin provides great structural integrity.[85] The radiation therapy, depending on the dosage and location, indirectly adversely affects function and longevity of removable, fixed, and direct restorations. A careful pretreatment planning, maintenance during radiotherapy, dental treatment, and follow-up post-radiotherapy are critical for optimal outcome of dental treatment for patients who have undergone radiotherapies.

Smoking

There are not many studies available relating smoking to prostheses longevity directly; however, mainly describing the effects of smoking on wound healing or periodontal disease. A study by Dutra and colleagues have found that there is no significant association of smoking and prognosis of direct restoration either in retention, marginal discoloration, color matching, integrity, and sensitivity after 6 and 12 months follow-up.[86]

SUMMARY

The summary of systemic factors and likely prosthodontic complications with reasons is outlined in **Table 1**. The oral cavity is considered the gateway to the body. Systemic factors of a patient have a profound impact on the oral health and possibly the outcome of dental treatments. This review explored the relationship between systemic factors and prosthodontic treatment outcomes. Success or failure of prosthodontic treatment is dependent on identifying the risk factors stemming from the systemic conditions and formulating a plan for the patient from the oral health care provider. Customizing a patient-specific recall regimen and home care instruction based on the patient's medical condition is imminent for a successful outcome.

CLINICS CARE POINTS

- It's essential to assess the medical history of all systemic diseases related to metabolic, cardiovascular, autoimmune, and bone disorders.
- These conditions can significantly impact the healing and overall treatment outcomes.

DISCLOSURE

None.

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