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ORAL HEALTH AND DENTAL IMPLANTS IN TYPE 2 DIABETES MELLITUS PATIENTS: A LITERATURE REVIEW

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ABSTRACT

Diabetes mellitus (DM) is a general disease which affects the oral health of the patients. Severe and poorly controlled diabetes is considered a risk factor for implant prosthesis complications. While the number of people with DM is rising, the restoration with dental implants may be a reasonable and predictable prosthetic option, being important to conduct the treatment according to their particularities. **Aim** This study focus on oral health and dental implants success in patients with type 2 DM. **Material and methods** A literature review on aspects related to oral health and implant survival rate in diabetic type 2 patients was conducted. Relevant clinical studies were searched through PubMed, Science Direct, Scopus, Wiley, Cochrane Library database. The following search terms used were: oral health and diabetes; dental implants and diabetes. We included publications with more than 10 patients, written in English, in the last 15 years and with assessment of glycemic status. **Results** Diabetic patients face to numerous oral manifestations: dry mouth by salivary gland hypofunction, periodontal disease, root caries, oral candidiasis, mucosal ulcer, taste impairment, halitosis, burning mouth sensation, delayed wound healing. All of these factors may conduct in the end to higher rate of tooth loss. Diabetes is not an absolute contraindication for dental implant treatment. Patients with chronically uncontrolled diabetes facing other systemic co-morbidities should not receive dental implants. Although the association between diabetes and periodontal disease is well established, health care professionals also need to recognize the risk of tooth loss and its effect on quality of life among people with diabetes. This is the reason why dental implants can be a perfect solution by maintaining the bone height and width which confers stability and more natural appearance of the prosthetic restorations. **Conclusions** Dental implants seem to be predictable procedures for dental rehabilitation in diabetic type 2 patients, with a good osseointegration rate of 85%- 96.4%. Conventional restorations such as bridges or removable prosthesis may be a better option in case of chronic, uncontrolled diabetic patients with elevated HbA1C levels.

Key words: oral health, glycemic control, implant survival, dental prosthesis

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder that affects nowadays over 256 million people. Its prevalence registered a 28% increase in the number of patients with diabetes since 2005. The prevalence of diabetes is higher in men than women, and in people over 65 years of age [1]. Diabetes is the most frequent endocrine disease affecting 5 to 10% of the population [2].

There are two types of DM (Figure 1). Type 1 DM (insulin-dependent DM) is caused by an autoimmune destruction of β-pancreatic cells with a result in partial or totally insulin deficiency. Type 2 DM (previously called non-insulin-dependent) develops in response to genetic and environmental factors and is characterized by variable degrees of insulin resistance in peripheral tissues, impaired insulin secretion and increased glucose production.

Constant high levels of plasma glycaemia are associated with various systemic complications (Figure 2). Oral complications of DM include xerostomia, swelling of the parotid gland and an increased incidence of caries and periodontitis (Figure 3). Today there is little data available concerning the

impact of diabetes on dental implants [3].

Type 1 diabetes
• Immune mediated
• Idiopathic
Type 2 diabetes
• Genetic defects of β cell function or defects of insulin action
• Pancreatic disease
• Drug induced -Corticosteroids, Thiazide diuretics, Phenytoin
• Viral infections -Congenital rubella, Mumps, Coxsackie virus B
• Genetic syndromes- Down's syndrome, Klinefelter's syndrome, Turner's syndrome
• Excess endogenous production of hormonal antagonists to insulin

Figure 1. Classification of DM

Microvascular
• Neuropathic Retinopathy
• Nephropathy
• Peripheral or autonomic neuropathy
• Foot disease
• Erectile dysfunction
• Periodontal disease
Macrovascular
• Myocardial ischemia
• Cerebrovascular disease
• Peripheral arterial disease

Figure 2. Complications of DM

• burning mouth syndrome
• dental caries
• candidiasis
• periodontal disease
• glossodynia
• lichen planus
• salivary dysfunction
• altered taste
• xerostomia
• delayed wound healing

Figure 3. Oral manifestations of DM

Diabetes is associated with systemic complications such as microvascular and macrovascular diseases, increased susceptibility to infection and altered wound healing. This increases the risk of post-surgical complications after dental implant surgery. Diabetes is characterized as a risk factor for periodontal disease and the periodontitis is called the sixth complication of diabetes [4]. It has been demonstrated that in hyperglycemic environments there is a negative impact on bone metabolism with low osteoblast differentiation and proliferation, decreased collagen production and osteoblast apoptosis [5]. As life expectancy continues to rise worldwide, dentists have to treat often patients with DM.

The purpose of this study is to present the state of the art on oral health status and implant survival rate of dental implants in patients with type 2 DM.

METHOD

The following approach was used to review evidence related to oral health and implant survival rate in type 2 DM patients. The following database were used: PubMed, Science Direct, Scopus, Wiley, and Cochrane Library. The following search terms were used: oral health and diabetes; dental implants and diabetes. Publications with more than 10 patients, limited to „humans", written in English, full-text articles, published in the last 15 years and with assessment of glycemic status of the patients were included.

The literature search was conducted between 20 October and 15 December 2017. Out of initial 112 articles, only 17 were included in the present review. The majority of the studies, 11 out of 17 were prospective, 5 were retrospective and one was cross-sectional study, all examining type 2 DM, oral health and dental implant therapy.

RESULTS

Oral status and DM

Oral manifestations of DM may be categorized into two types: those affecting the hard tissue, the bone, and the other affecting the soft tissues of the oral cavity. There are reports in the literature of greater prevalence in diabetic patients of bone loos, gingivitis, periodontitis, irritation fibroma, traumatic

ulcers, fissured tongue, lichen planus, recurrent aphthous lesions, stomatitis and oral fungal infections, such as candidiasis. These manifestations may be due to chronic immunodepression, delayed wound healing and/or salivary hypofunction [6].

According to reviewed articles, the age of the patients can influence the type of the oral manifestations. The relationship between periodontitis and diabetes in young to middle-aged adults (25–55 years of age) has been a much researched subject [7]. The study of Dorocka-Bobkowska [8] stated that there is a higher prevalence of root caries and more profound effect of the xerogenic medications in elderly people, whereas there is neither a change in the prevalence of coronal caries nor salivary flow rate among the younger diabetic patients.

The edentulous, old diabetic patients have a higher prevalence of burning mouth syndrome, angular cheilitis, glosodynia and xerostomia. In one study of Kaur [9], type 2 DM was positively associated with 60–69 year-old subjects and tooth loss was significantly increased in female diabetic subjects compared to non-diabetic female subjects. Salivary function is critical in maintaining the oral health [10]. It is involved in digestion, masticatory function, taste, speech, deglutition and protection of the enamel and oral mucosa.

Xerostomia is a subjective sensation of oral dryness, caused by either thirst (very common in DM), oral sensory dysfunctions, low salivary flow, dehydration, and/or altered saliva composition. It is found that higher HbA1c values or xerostomic medications are directly related to decreased salivary flow [11]. The management of xerostomia may include some actions for the improvement of salivary function and relief of the oral symptoms. Dose adjustment or changing medications, consumption of sugar-free products, avoid dry, spicy or acidic foods, alcoholic and carbonated beverages and smoking can reduce the subjective sensations. It is also recommended to drink a lot of fluids, to use alcohol free mouthwashes and active saliva substitutes, which role in reducing bacterial plaque, gingivitis and oral yeast counts has been demonstrated for several years [12]. Diabetic patients with xerostomic complaints should be referred to dentist for the good maintenance of their oral status.

The burning mouth syndrome which is an orofacial neurosensory disorder of unknown cause is a regular complaint among diabetic patients. It is referred as a bilateral burning sensation of the oral mucosa in the absence of any clinical or laboratory findings [13]. This sensory dysfunction can reduce the ability in maintaining a proper diet and can cause poor glycemic levels. The use of electronic toothbrushes, other alternative hygiene methods are very helpful in maintaining a good oral health.

Diabetes and periodontal disease. Periodontal disease and diabetes are closely linked together. Diabetes is thought to be a risk factor for periodontitis, which appear two times more often in diabetic patients in comparison to non-diabetic people. Periodontal disease in particular has a strong relation with the development of type 2 DM [14-15]. It also has been demonstrated that in poorly controlled diabetic patients there is a higher periodontal attachment lost, more probing depth sites, more dental plaque and gingival bleeding [16-22].

In epidemiological studies, periodontal impairment is significantly more frequent and severe in patients with type 2 diabetes [23]. Also, the patients with poorly-controlled type 2 DM have a significantly higher prevalence of severe periodontitis than those without diabetes after controlling for age, education, smoking and amounts of calculus [24].

The mechanism explaining how diabetes is

influencing the periodontal status is very discussed in the literature. It is by reducing the local immune defense system (leukocyte adherence, chemotaxis, and phagocytosis, bactericidal activity, response to antigen challenge and T-lymphocyte function) and decreasing the renewal of periodontal tissues.

With long-standing hyperglycemia proteins transform into glycated ones-advanced glycosylation endproducts (AGEs) [25]. It has been demonstrated that Advanced Glycation Endproducts (AGE) formed by hyperglycemia can transform macrophages into cells with a destructive phenotype producing high levels of interleukin (IL)-1, IL-6 and TNF-a. The number of pro-inflammatory cytokines (IL-6, Fibrinogen, C-reactive protein) is higher in diabetic patients and this determine the destruction of periodontal ligament and alveolar bone resorption [26]. Furthermore, AGE make the endothelium hyperpermeable which cause an increased susceptibility to infections and an impaired wound healing capacity.

Patients with diabetes have increased pro-inflammatory cytokines within the gingival crevicular fluid and gingival tissues compared to periodontitis subjects without diabetes [27].

Additionally, dyslipidemia may play an important role in linking diabetes and periodontitis. Dyslipidemia among diabetic patients is characterized by modified LDL profile, high concentration of triglycerides (TG), low concentrations of HDL and may be further exacerbated by insulin resistance in uncontrolled glycemic levels subjects [28]. These lipid abnormalities is related to low immune response causing alterations in lipid composition of the cellular membrane.

Knowing the mechanism, it is obviously that initiation, in the early stages, of the periodontal therapy can lead to a decreased level of circulating pro-inflammatory mediators, thereby contributing to a better control of glycemic level.

Masticatory function and diabetes. Oral manifestations of DM can increase the risk of becoming partially or totally edentulous patients. There is a tendency for diabetics to have fewer natural teeth and FTUs than non-diabetics because of the higher prevalence of periodontal disease. One study has reported that the number of teeth decreases with increasing HbA1c values [29]. The number of occluding posterior tooth pairs (FTUs) are an important score for dietary intake and masticatory performance, which in turn are important factors for the quality of life of diabetic patients. A smaller number of FTUs is associated with chewing difficulties, speech problems, negative oral health and modified facial appearance [30].

There is one recent study showing that one of every five cases of edentulism in the United States is linked to diabetes. This prevalence increases with age and the mean number of missing teeth per person was 7.2, among the overall sample of dentate people, over 50 years. Older, with lower income and less educated patients had greater tooth loss [31].

Many studies show a strong relation between altered chewing function and the reduction of healthy food consumption which cause dietary deficiencies in vitamins, fiber, proteins and minerals. Edentate persons then compensate calorically with a diet rich in fats [32-34]. Therefore, functional tooth replacement must be considered in the overall dietary and nutritional management of patients with diabetes [35]. The use of 2 or more dental implants in retaining overdentures can significantly improve satisfaction and offer a better oral health-related quality of life in complete denture wearers [36].

Dental implants and DM

When analyzing survival rate of dental

implants in DM patients, one key issue highlighted in the researches selected was the one of the osseointegration. Of these, two studies investigated the influence of type 2 DM on osseointegration were prospective [5, 37]. In both studies, the inclusion criteria were HbA1c level and they were ranked as following: well-controlled (HbA1c 6.1–8 %), moderately (HbA1c 8.1– 10 %) and poorly controlled patients (HbA1c ≥10 %) while the normal value for HbA1c was ≤6 %. Patients with poorly controlled diabetes had in the first 2 to 6 weeks a lower stability rate and after one year, there was no significant difference between the groups.

Regarding the peri-implantitis in DM patients, the results of the studies analyzed were quite heterogeneous. One study observed that the number of patients suffering from peri-implant inflammation increases with elevated HbA1c values [38]. Other studies observed an elevated risk for peri-implantitis of 1.9 or 4.1% caused by diabetes [39-40]. On the other hand, the retrospective study of Turkyilmaz [41] yield no lower success 1 year after implantation, regarding negative bleeding on probing, no pathological probing depth, and a marginal bone loss of 0.3±0.1 mm in a population of type II diabetics. The results in the prospective study of Gomez-Moreno [42] concluded that elevated HbA1c causes higher bone resorption after 3 years. The bleeding on probing is more frequent in poorly controlled patients while the probing depth remains the same as in healthy patients.

Diabetes and implant failure and survival rate. Diabetes and implant survival is a measured endpoint for dental implant therapy. Our literature search identified 13 publications with implant survival rate. The result for implant survival in diabetics is ranked between 85%-96.4%. The most frequent implant failures were observed in the first year after prosthetic loading. Implant failure in diabetic type 2 was significantly greater than that in non-diabetics when multiple adjoining implants were placed [44-45]. We found no association in the literature regarding the age and survival rate of the implants in diabetic persons.

Influence of quality of glycemic control. In the reviewed studies, the percentage of glycosylated hemoglobin is an indicator for glycemic levels from previous 6–8 weeks. Some studies concluded better implant survival and less peri-implant complications in the well-controlled group [46-47], while others observed no important difference in implant success rate even in the poorly controlled patients [36, 37]. One study focused on patients with poor glycemic control (HbA1c 7.5–11.4 %) and had a 98 % implant survival after 4 months [48].

Influence of duration of diabetes disease. It is believed that systemic side effects increases with duration in diabetic patients. However, the influence of duration of DM on implant surgery outcome is poorly examined. Most of the studies provided no data about duration since diagnosis of diabetes. Two studies analyzed the influence of duration of DM on the implant survival rate. While Olsen concludes that the duration of diabetes may be associated with implant failure [48], Tawil concluded that implant survival is independent from diabetes duration [49].

Management of diabetic patients in order to receive dental implants

A full health history about duration, current treatment and level of HbA1c should be obtained from every patient that will receive a dental implant. If the metabolic control appears to be clinically inadequate, implant therapy should be delayed until better control is achieved. A value of 7% for HbA1c is considered a good level of glycemic control while the normal value for healthy individuals is 3.5 to 5.5% depending on the laboratory.

High levels of glucose in plasma have a negative influence on wound healing and bone formation. In order to ensure osseointegration, it is mandatory to maintain good glycemic control before and after implant surgery [50].

To reduce the risk of infection a ten-day regime of broad-spectrum antibiotics should be started on the day of surgery. The antibiotic usually used is Amoxicillin (2 gr per os 1 hour previously), as the pathogens most frequently causing postoperative complications after implants procedure are Streptococci, Gram-positive anaerobes, and Gram-negative anaerobes. Clindamycin (600 mg per os 1 hour previously), Azithromycin or Clarithromycin (500 mg per os 1 hour previously), first- Cephalosporins (Cephalexin- 2 gr per os 1 hour previously) may be an alternative to Amoxicillin in allergic reaction to penicillin [51].

Beside antibiotic prophylaxis, the use of 0.12% chlorhexidine mouthwash have an important benefit by reducing the failure rates from 13.5% to 4.4% in type 2 diabetics, during a follow-up period of 36 months [52]. Smoking may substantially increase the risks of implant failure in diabetic patients. Systemic and local rehabilitative factors are used in determining the severity of diabetes and its complications, as well as the consideration for the rehabilitating program (Figure 4). The correlation of these factors dictates the type, number of implants placed and also which type of dental implant-supported prosthesis should be performed.

Systemic factors

- Duration of diabetes: longer duration is correlated to more systemic complications
- Sanative protocol: diabetic patients treated by diet alone have less complications than patients using hypoglycemic medication (insulin)
- History of hypoglycemia and hyperglycemia: low level of glucose balance requires hospitalization
- Hemoglobin A1C levels: less than 7% for HbA1c is considered a good level of glycemic control in order to insert dental implants

Local factors

- Restoration type: fixed prosthetics require exact implant localization. Removable prosthesis is preferred in diabetic patient in posterior jaw region because low bone quantity and quality in diabetic patients
- Implant length: failures are more often in short and multiple adjoining implants
- Surgical guide lines: antibiotics and chlorhexidine mouth washes improves the success rates for dental implants. The use of antiseptic mouth rinses and oral-hygiene maintenance helps in achieving a successful dental implant osseointegration in subjects with diabetes. Vitamin D supplements (400-800 IU/day) and calcium (1500 mg/day) during post-operative period should be prescribed.
- Duration of recommended healing period (6 months in maxilla and 4 months in mandible for normal patients) should be increased by another 2 months for good osseointegration. Occlusal adjustment and examination for signs of occlusal overload is mandatory.
- Bone type and quality: bone remodeling around implants in diabetic patients is slower and less effective, so immediate loading should be avoided
- Mandible versus maxilla implant location: symphysis area of the mandible is the ideal location yielding the highest success rate. Success rates are higher in mandible and in more anterior regions
- Bone augmentation: is not advised in uncontrolled diabetic patients although it may be possible in controlled ones

Figure 4. Systemic and local factors analyzed for implant therapy in DM type 2 patients

DISCUSSION

Oral manifestations of diabetes are various and include: dry mouth, root caries, oral candidiasis, oral mucosal ulcer, taste impairment, halitosis, xerostomia, salivary

gland hypofunction, burning mouth syndrome, delayed healing. All of these factors in diabetic persons concur to higher rate of tooth loss. The risk of partial or complete edentulism in the diabetic patients is an important aspect because it may affect the ability to maintain a healthy diet due to a decreased masticatory efficiency [53]. These compromises in diet may have a damaging impact on glycemic control.

Microvascular changes cause impaired immune response and poor wound healing potential. In the long-term observation peri-implant inflammation seems to be increased in diabetic patients. We found in the literature that the biologic complications of diabetes in patients with dental implants are ranked to 29.4% and the most frequent is peri-implant mucositis. Therefore, dental recall programs may be helpful to detect early signs of gingivitis and prevent future complications.

Failure of the implants may appear as a result of: host factors that impair wound healing, poor bone quantity and quality, surgical procedure, peri-implantitis, inappropriate prosthesis design and overload of dental restorations. The implant surgical procedure may require some preparations such as improvement in metabolic control (an HbA1c close to 7% or less is suitable for implant placement) proper oral hygiene, cessation of smoking. Prevention of infection by 8 days systemic antibiotic therapy and usage of CHX 12% for two weeks following surgery are strongly recommended.

On the other hand, in well selected diabetic patients, the osseointegration has a real success (85-95%) although overall, the failure rate is higher in diabetic patients than in healthy subjects.

Oral health influences the nutritional well-being and is part of systemic health of people. Metabolic diseases such as DM have oral manifestations with direct impact in the masticatory function. Good glycemic control may be dependent in part upon good masticatory function. It is demonstrated that diabetes contribute to oral pathologies and tooth loss and therefore tooth replacement with implant therapy may be an important part of patient's overall well-being.

CONCLUSIONS

Oral manifestations of DM are various and concur to higher rate of tooth loss. Success of dental implant treatments are negatively affected by aspects frequently encountered in these patients as, inadequate bone offer, altered mucosa and hyposalivation. Hyperglycemia by type 2 DM may negatively affect the success of the implant procedure causing postsurgical complications (infections, delayed bone healing). Dental implants seem to be predictable procedures for dental rehabilitation in type 2 DM patients, with a good osseointegration rate of 85%-96.4% and complications ranked to 29.4%, the most frequent is peri-implantitis and mucositis. Patients with chronically uncontrolled glycaemia with other systemic comorbidities may not be suitable for dental implant placement procedure. Conventional prosthetic restorations may be more indicated in these patients.

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