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Review

Diabetes and oral health: A review

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Abstract

Diabetes mellitus is a common systemic disease whose incidence is currently rising in our contemporary world. In recent years, it has been well-known that chronic periodontitis is listed as an important segment of the complications of diabetes mellitus. Along with chronic periodontitis several other oral manifestations such as increased incidence of dental caries, aphthous ulcers, xerostomia, burning mouth syndrome, etc. It has also been seen that those with diabetes mellitus are more prone to such oral conditions when compared to healthy individuals. Awareness regarding the bidirectional relationship between diabetes mellitus and general oral health, which is bidirectional in nature has shown to be unsatisfactory among the general public and those with diabetes whereas there is satisfactory awareness among physicians and dental practitioners.

Keywords: diabetes mellitus, periodontitis, oral health, gingivitis.

Introduction

Diabetes is a very well-known chronic systemic disease mainly represented by increased blood glucose levels caused mainly due to decreased insulin levels or defective action of the same [1]. Diabetes is commonly categorized into two main divisions: type 1 diabetes mellitus which is insulin-dependent (IDDM) and type 2 diabetes mellitus which is non-insulin-dependent (NIDDM) [2]. Type 1 diabetes is commonly seen in the younger age group and adolescents due to complete insulin insufficiency caused by the destruction of β-cells of the pancreas. Type 2 diabetes is seen in 90–95% of diabetics mostly seen in adults caused due to insulin resistance [1]. Several other classifications based on the etiology of diabetes include genetic defects, diseases associated with the pancreas, endocrinopathies, drug-induced, certain infections, or due to genetic syndromes such as Down's syndrome, Kleinfelter's syndrome, etc. [1]. Symptoms of diabetes for both types 1 and 2 are common with hyperglycemia, polyphagia, polydipsia, and polyuria. Complications of diabetes mellitus have been seen in the long-term comprise of neuropathy, nephropathy, retinopathy, genitourinary, cardiovascular, and sexual dysfunction. Cardiovascular manifestations mainly include hypertension, atherosclerosis, peripheral vascular disease, and cerebrovascular disease [2].

Diabetes can affect other systems of the body and investigations have revealed that the oral cavity is one of them, frequently manifesting as dental caries, inhibition of salivary secretion, oral mucosal diseases such as glossodynia, lichen planus, candidiasis, xerostomia, recurrent aphthous stomatitis, burning mouth syndrome and most importantly, gingivitis and periodontitis [2, 3]. Periodontitis, on the other hand, is also

a chronic disease of the gums usually caused by poor oral hygiene resulting in inflammation of the gingiva surrounding the teeth and can ultimately lead to the destruction of the periodontal ligament, other tooth-supporting tissues, and bone loss. Several studies have revealed undeniable evidence supporting the fact that the two are interrelated such that periodontitis is now considered a complication of diabetes due to susceptibility to infection and slow healing seen in chronic uncontrolled diabetes and the same applies vice-versa [4].

The pathogenesis of such oral lesions and diabetes remains uncertain but a variety of factors such as hyperglycemia coupled with altered collagen metabolism, the influence of inflammatory mediators, altered wound healing can lead to the manifestation of such oral lesions more so in uncontrolled diabetes [5].

Type 1 diabetes mellitus and oral health

A study conducted by Rawal et al. among the Indian population revealed a predominance of dental caries and periodontitis among participants with diabetes when compared to those without diabetes [6]. Bharateesh, J. et al. conducted a study in 2010 in the southern Indian population that showed the incidence of dental caries was 32.3% in diabetics while normal individuals showed about 13.6%, additionally, there was a noticeable difference in periodontal disease with diabetics showing 92.6% and non-diabetics at 83% [7].

An increase in values of Plaque Index (PI), Gingival index (GI), and Calculus index (CI) along with discrepancies in the dental development was seen in children identified with type 1 diabetes mellitus than those without thus proving the adverse effect of diabetes mellitus on the development of dentition and subsequent oral health [8]. A study conducted on 2–15-year-old children of the Benghazi population diagnosed with type 1 diabetes mellitus also showed an increase in PI and GI scores than the control group [9]. Gingival bleeding was also seen to be elevated in type 1 diabetic children showing a higher risk for the primary dentition of type 1 diabetic children [10]. A study by Jolanta et al. revealed that despite similar oral hygiene practices, those with type 1 diabetes mellitus showed remarkably increased GI and CI scores indicating future risk to the periodontal tissues although the OHI-S scores seemed insignificant [11]. Initial periodontal disease when coupled with micro-angiopathy, impaired immunity, change in salivary and collagen composition, and metabolism can progress to severe periodontal disease. [12] A study concluded that the salivary buffer capacity and flow were reduced in type 1 diabetic children which can result in a higher risk of caries. On subsequent DMFT examination, the levels of decay were seen to be of higher value in children with diabetes mellitus [13].

Diabetes and periodontitis

Periodontitis usually manifests in diabetic patients due to the increase in levels of inflammatory mediators which result in damage to the tooth-supporting tissues [14]. Diabetes cannot be attributed entirely as a cause of periodontitis but rather a contributing factor due to its systemic effects [15].

Studies in the 1980s and 1990s

A study conducted by Gunilla Gislen et al. revealed that increased gingival index scores were noted in children with poorly controlled diabetes when compared with a control group of non-diabetics and no increase in gingival scores with controlled diabetes [16]. A survey conducted in the Diabetes Clinic of Mekane Hiwet Hospital, Ethiopia in a sample of 105 patients showed an incidence of dental caries, gingival inflammation, and loss of attachment [17]. A study in which beagle dogs were experimentally induced with diabetes showed lower inflammatory responses in the gingival region during plaque maturation when compared with the period before induction of alloxan-diabetes [18].

A comparative study was conducted by McNamara et al. in the gingival crevicular micro-flora before and after induction of diabetes in experimental rats. The isolation

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of *Proteus* spp., *Lactobacillus* spp. had increased within the first week and decrease of *Escherichia coli*, *Bacteroides* spp., and *Streptococcus* spp. which led to subsequent gingival changes ultimately resulting in deep periodontal pockets. Plaque growth was also seen to be increased in diabetic rats [19]. Furthermore, an *in-vivo* experiment evaluating the leukocytic response in the crevicular fluid of streptozotocin-induced diabetic rats showed that leukocyte response decreased as soon as 4 days following the induction of diabetes. In diabetics undergoing insulin therapy, the response was reduced by 34% and in uncontrolled diabetes, the peak neutrophil response to casein was reduced by 83% [20].

A study by Ervasti et al. comparing gingival bleeding in diabetic adults and non-diabetic adults didn't show much difference. Although, gingival bleeding was found to be remarkably elevated in those with uncontrolled diabetes than those with adequate control [21]. In a similar study, the incidence of the occurrence of pockets and alveolar bone loss in diabetic when compared with a control group was not significant. But in the subgroups according to the management of diabetes, well-controlled diabetics were seen to be associated with better periodontal health and alveolar bone condition [22].

Studies in the 2000s and beyond

A study by Moore et al. concluded that 320 patients with an average age of 32.1 years diagnosed with type 1 diabetes mellitus and smoking habit manifested extensive periodontal lesions [23]. Other studies in which pregnant type 1 diabetic patients showed significantly higher GI and PI scores, more apically positioned gingival margins in comparison with non-diabetic pregnant women confirmed increased periodontal inflammation and destruction [24]. A meta-analytic study done by Nilo Guliberto et al. confirmed increased frequency of periodontal disease in diabetic subjects along with greater progression when compared to non-diabetics [25]. Wei Lian-Sun et al. organized a study to evaluate the association between moderately poorly controlled type 2 diabetes mellitus and chronic periodontitis wherein periodontal therapy was executed on inflammatory mediators such as adiponectin, cytokines, insulin resistance, especially metabolic control. It showed that the depth on probing, loss of attachment, bleeding on probing, and scores of plaque index was better on subsequent comparison 3 months later with the diabetes mellitus-T group in contrast with diabetes mellitus-NT group, both of which were of type 2 (all $p<0.01$) [26].

A study was done by Hee-Kyung et al. in which a sample group of 40 individuals and a control group of 35 individuals to whom tooth brushing instructions, education regarding maintenance of oral health, and supra-gingival periodontal treatment were executed in every patient initially as the standard and evaluation carried out 6 months later to estimate its effects on the periodontal health seen in individuals with type 2 diabetes mellitus who were then subjected to various indices such as the community periodontal index (CPI), Russell's periodontal index, tooth mobility, patient hygiene performance index (PHP), bleeding index, calculus, and plaque index, and the decayed, missing and filled teeth index (DMFT). All these indices showed a notable reduction in the sample subjects from the initial scores recorded at the baseline as opposed to the control group [27]. This study showed that proper oral hygiene education among diabetic individuals can help reduce or deter the progression of periodontitis in such individuals.

A review by Terry C. Simpson et al. on whether periodontal treatment in diabetic individuals helped improve glycemic control showed evidence of improved metabolic control [28]. A randomized control trial by A. Moeintaghavi et al. to check whether non-surgical periodontal therapy (supragingival scaling along with root-planning of the entire oral cavity) helped improve glycemic control resulted in a decline in the HbA_{1c} levels in the treated individuals when checked three months later [29]. Changes in the inflammatory markers and bone turnover markers were seen to be insignificant decrease and increase respectively in diabetics [30].

A randomized controlled clinical trial study of 1-year duration was done wherein homeopathic treatment was administered side

by side with periodontal therapy in individuals diagnosed with type 2 diabetes mellitus as well as chronic periodontitis. The study revealed that both the sample group and the control group showed similar improvement but it was only the sample group that presented with a gain in clinical attachment level [31]. A randomized controlled trial has shown the ability of periodontal treatment mainly curettage in combination with root planning in subjects diagnosed with type 2 diabetes mellitus and moderate to severe chronic periodontitis has the potential in maintaining blood glucose [32].

A study revealed that non-surgical periodontal therapy along with systemically administered melatonin showed improvement in severe periodontal cases of type 2 diabetic patients [33]. A lifestyle change plus dental care (LCDC) has positively shown lower HbA_{1c}, fasting plasma glucose along with lowered GI score and bleeding index score in periodontally affected type 2 diabetic patients of the older age group [34]. This indicates the need for a healthy oral regime to be followed even after regular dental checkups in type 2 diabetic patients. It was also shown that non-surgical periodontal treatment with community health workers in patients with DM-2 positively affected the periodontal treatment outcomes [35].

Diabetes and oral health: Awareness on bi-directional relationship

A cross-sectional survey by Shruthi Mavinahally Shanmukappa et al. to assess the awareness and knowledge among diabetic patients on the association between diabetes and periodontal disease was conducted including 600 patients who visited Davangere clinics. This survey revealed that 69% of patients were unaware that having diabetes would make them more prone to gingival infections than non-diabetics. Only 24% knew about the relationship between diabetes and oral health while about 76% were unaware; 48% of participants were open to more information regarding the same by a dentist [36]. Similarly, a questionnaire-based survey regarding the interrelation of oral health and diabetes among diabetic patients showed that about 54% of the participants were unaware [37]. A study regarding patients' comprehension of the relationship between that periodontal disease and diabetes which was a web-based survey by Oguntimein O. et al. revealed that male and low-education patients with diabetes had lesser understanding and knowledge whereas those with regular dental visits had more knowledge [38].

A cross-sectional survey carried out among dental practitioners and their assistants practicing in the Kingdom of Saudi Arabia to assess their understanding regarding the periodontal disease and diabetes relation, which surprisingly revealed about 78% of dental assistants and 68.5% of dental practitioners agreed that patients with diabetes and periodontal complications have reduced blood sugar level control in comparison with diabetic patients with no signs of periodontal complications, but both the groups had satisfactory knowledge on the association [39]. A similar survey conducted in western Saudi Arabia among dentists and general physicians revealed that the overall knowledge despite being low but dentists' knowledge and awareness were significantly higher than the physicians [40]. A similar survey between physicians and dentists in Kuwait by Areej K. Al-Khabbaz, et al. also revealed that dentists had a higher knowledge regarding the association of gingival-related problems such as bone resorption, tooth mobility, and bleeding of gingiva contrasting to physicians [41]. A study in a large Wisconsin-based integrated medical-dental health care organization also showed that patient education needed sufficient improvement [42]. A study by Jonathan B. Owens et al. among internists and endocrinologists to assess their understanding, notions, and attitude regarding the same showed that they didn't have sufficient knowledge [43].

Conclusions

In our modern world, where there is no reduction in the incidence of diabetes mellitus whether type 1 or type 2, it is acknowledged that the obstacles associated with the systemic disease

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are well-addressed and communicated within the medical community and the dental fraternity as well. However, the association of diabetes mellitus and oral health is often forgotten or ignored due to which instead of diagnosis and treatment of certain oral conditions in the initial stages is recognized too late resulting in tooth loss and even severe complications. Awareness of the oral manifestations and early signs of periodontitis among individuals with diabetes mellitus is the need of the hour such that they can be intercepted and treatment can be sought followed by routine visits to dentists and follow-up. Proper oral hygiene practices should be inculcated by dentists to their patients at early stages to steer clear from oral diseases more specifically periodontal diseases.

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Conflict of interest

The authors declare no conflict of interest.

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