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Review Article

Diabetes and its Impact on Root Canal Therapies and Other Oral Conditions

Lisa Slade, Gail Cherry-Peppers*, Jezelle Sonnier, Gillian Robinson-Warner, Xinbin Gu, Mayra Suero-Wade, Maliika Tracey, Jelani Thompson, Alphonzo Davidson and Alphonzo Davidson III

Restorative Department, Howard University College of Dentistry, USA

***Corresponding Author:** Gail Cherry-Peppers, Restorative Department, Howard University College of Dentistry, USA.

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Abstract

Advances in medical science and in preventive dentistry have changed the context of oral health. The American population is living longer with numerous complex chronic diseases. This paper is to raise awareness about the impact of diabetes and the associations with altered success in root canal therapy. Comorbidities can worsen the course of dental treatment. Better communication is needed to improve medical consultation and referral management. It is imperative that dentists receive a very-detailed medical consultation from the patients' medical team. This information will help dentists understand why there may be increased infection rates and slow healing after root canal therapy in diabetic patients. Requests for medical consult are important to provide full patient information and to determine diabetic chronicity.

Keywords: Diabetes and Root Canal Therapy; Apical Periodontitis; Chronic Diseases and Delayed Healing

Introduction

Chronic diseases are the leading causes of death in the US. Oral health risk factors, increased infections, and manifestations of poor wound healing may be warning signs of progression as diabetic conditions get worse. Some of the risk factors for diabetes when considering root canal therapy, include increased inflammation, poor healing and reduction of tissue repair. Emerging findings have shown a connection between the presence of inflammatory conditions in patients with diabetes and the reduction in healing time, and sometimes failure of root canal therapy [1].

Current research shows a bidirectional relationship between oral health and chronic diseases [2]. Dentists should request lab values and full narrative on the chronic diseases in patients needing extensive dental procedures, particularly in those patients with severe chronic diseases and diabetes. Medical professionals should provide a detailed summary by organ system affected. As the population is living longer, patients have numerous diagnoses that impact the severity of oral disease and is greater in many patients with poor systemic health [3]. Detailed medical consultations will afford the dentists an opportunity to adjust treatment planning execution and avoid serious complications [3].

Diabetes

Diabetes mellitus [DM] is a chronic and complex metabolic disorder characterized by hyperglycemia secondary to anomalies in insulin secretion, insulin action or both [4]. According to the CDC, more than 30 million people in the United States live with diabetes and up to 25% of these people have not been diagnosed. Type 2 diabetes is significantly more prevalent than Type 1, with "90% to 95% of all diagnosed cases" having type 2 versus the 5% with type. Diabetes is the "8th leading cause of death [5].

Hyperglycemia may have protean clinical manifestations resulting from associated dysfunction in carbohydrate, fat, and protein metabolism. The two most common types of DM are insulin dependent diabetes more commonly known as Type 1 diabetes (T1DM) and non-insulin-dependent diabetes also known as Type 2 diabetes (T2DM) [6]. T2DM is characterized by insulin resistance, which can be described as a lack of sensitivity to insulin. This review, however, focuses solely on the relationship between T2DM and oral health, most specifically endodontic treatment [6].

Periodontal Disease and Diabetes

Periodontal disease has been listed as the 6th leading complication of diabetes [7]. Along with caries, periodontal disease is one of the most common causes of tooth loss. There is approximately a three-fold increase in the risk for periodontitis in individuals with diabetes compared to those without diabetes [8]. Diabetes affects many functions of the immune system resulting in an increase in risk that's associated with the level of glycemic control, as denoted by the HbA1C level [9].

On the one hand, poor glycemic control in patients with diabetes is related to increased severity of periodontal disease. Conversely, high levels of periodontal disease increases the risk for poor glyce-

mic control. Periodontitis is also associated with an increased risk for diabetic complications. Studies have shown a that there is a bi-directional relationship between diabetes and periodontal disease and between the severity of periodontitis and complications of type 2 diabetes [9] (Figure 1).

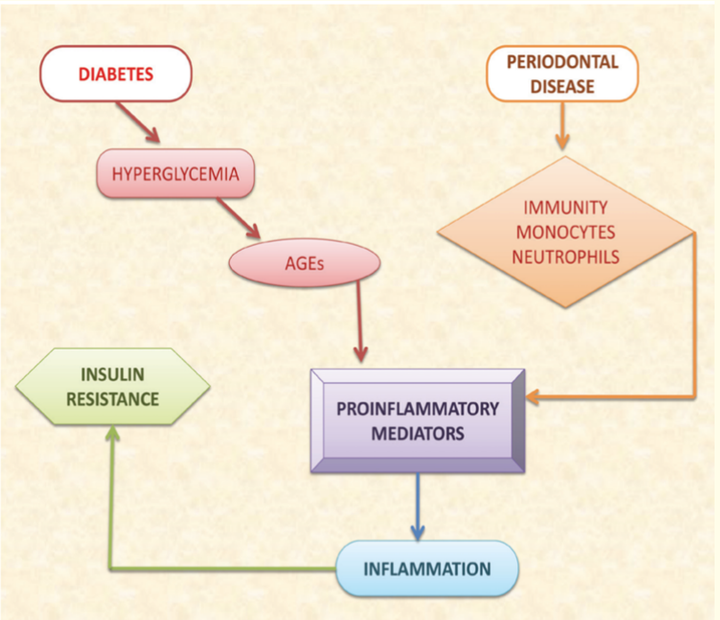

FIGURE 1. A schematic presentation of the two-way relationship between diabetes and periodontitis.

Figure 1: Pathways in Endodontic Therapy (Indurkar, 2016; Clin Diabetes. Jan;34 (1):54-7).

Salivary dysfunction and diabetes

Uncontrolled Diabetes can result in a reduced salivary flow rate and xerostomia [10]. This is because patients with type 2 diabetes T2DM have a lower rate of stimulated parotid gland flow [11]. Saliva has a fundamental role in protecting the dental hard tissues from caries. Xerostomia is a widespread complication of diabetes which may result in difficulty swallowing, an increased risk of developing caries, altered taste and oral burning [3,11].

Caries/tooth loss and diabetes

As mentioned before, diabetics often experience salivary dysfunction as well as periodontal disease. These oral manifestations are usually associated with the onset of other oral conditions such as dental caries or tooth loss [12]. Saliva has a cleansing and buffering capacity that is weakened in diabetic patients. This leads to a higher risk factor of developing caries due to the weakened defense system. Patients with diabetes also experience a higher number of tooth loss, most likely due to periodontal disease [3,11].

Periodontitis may present itself as gums that have pulled away from the teeth thus, resulting in a higher risk of tooth loss. A higher incidence of caries may also be observed over time [10,12].

Wound healing thrush and diabetes

Several aspects of the immune system are compromised and wound healing is delayed, altering effective endodontic therapy. The immune system sometimes causes and decline in salivary flow, and hence, patients develop fungal lesions such as candidiasis (thrush). Candidiasis been found in diabetic patients who do not have their glycemic levels under control [10]. Candidiasis appears as white or red patches located either on the cheek or tongue and can be avoided with both good oral hygiene as well as good glycemic control [3]. Diabetics tend to have delayed vascularization, reduced blood flow, a decline in innate immunity, and psychological stress [13]. All of these factors contribute significantly to wound healing, resulting in longer regeneration times for soft tissue as well as osseous healing [12]. Additionally, adverse wound healing can impede successful endodontic treatment.

Other common oral manifestations include: [3,12]

- Dry mouth
- Burning mouth
- Bacterial infections
- Periapical abscesses
- Taste dysfunction
- Non-candida oral lesions
- Oral mucosal disease
- Plaque
- Neuro-sensory oral disorder
- Failed Root Canal Therapy

Chronic disease and inflammation

Chronic diseases such as diabetes are associated with a low grade of inflammation. Some systemic infections cause an increase of the host to infection, increasing microorganisms in apical periodontitis (AP) [1]. Addidionally, the imnume response is impaired contributing to the inflammatory process and periapcal bone resorption [13]. Delayed wound healing thus may occur, causing failure of root canal therapy. Endodontic and periapical status are important parameters that can predict tooth survival and dental treatment [14].

Diabetic chronic infections can be defined as the presence of an inflammatory response and tissue damage that can drive the clinical spectrum from superficial cellulitis (mild infection) to chronic osteomyelitis (severe infection), with host–microorganism interaction being crucial in determining progression [13,15]. Infection occurs when invading organisms overwhelm the host's defenses. In contrast, colonization is defined as the presence of proliferating bacteria without an overt host immunological reaction. Nevertheless, preexisting diabetic neuropathy, peripheral vascular disease, impaired leukocyte function and a deteriorated innate immune system make DFI clinical diagnosis difficult while simultaneously worsening its prognosis. Under these circumstances, onset of classic signs of infection may not occur, even when there is a high bacterial load. Thus, the invading pathogen may progress and infect with no clinical translation [13].

Staphylococcus aureus is a major pathogen of human skin. This is also the most common pathogen identified in patients with diabetes. This pathogen, in its interaction with the host's diabetic wound environment, is able to amplify certain glucose-regulated genes that ultimately increase its virulence, indicating that hyperglycemic conditions facilitate pathogen adaptation and survival, ultimately worsening patient prognosis [13].

Diabetes reduces the immune systems ability to orchestrate an appropriate microbial response and offers ideal conditions for microbiota establishment and biofilm formation. Biofilm microbial entrenchment hinders antimicrobial therapy effectiveness, arrests the wound's proliferative phase, and prolongs pathogenic inflammation, while perpetuating wound chronicity [13].

Complex diabetic conditions and endodontic therapy

On the other hand, endodontic medicine has also analyzed the possible influence of systemic health status on treatment outcomes in endodontics, mainly the outcome of root canal treatment (RCT) [1]. Some systemic conditions increased the susceptibility of the host to infection, increasing microorganisms in apical periodontitis and/or impairing the immune response, maintaining the inflammatory process and periapical bone resorption after RCT [1,16]. This can not only cause a delay in the healing of the periapical wound (due to inflammation) [17], but also persistent apical periodontitis causing the failure of the RCT and even the need for extraction of the affected tooth [1].

The ultimate objective of vital pulp therapy procedures, such as direct pulp capping and pulpotomy, is to treat teeth with compromised dental pulp without the full removal or excavation of all healthy pulp tissue aiming to preserve the health status of the remaining dental pulp [18]. Similarly, RCT aimed the complete healing of the periapical disease, with the tooth restoration of function [1]. The healing of pulp and periapical lesions after the endodontic treatment is not the result of the curative action of the treatment. The process of healing, both in dental pulp and periapical tissues, begins with inflammation [19] and is resolved by the clearance of the immunogen that induces the immune response [17,20]. In the case of RCT, its objective is to achieve wound healing by removing the source of bacterial antigens and toxins, allowing chronic inflammatory tissue to become reparative tissue [1,21]. RCT reduces the intra-canal bacterial load, seals the root canal system and prevents the passage of pulpal antigens to the periapical tissues, which allows the proliferative and the maturation phases of the healing process to take place, promoting periapical tissue repair [20]. Then, the healing of the periapical lesion is carried out by the periapical tissue itself, by repair or by a combination of repair and regeneration [22].

When any of these mechanisms interrupt pulp or periapical repair, inflammation persists and the lesion remains uncured, becoming chronic [1,21]. In the case of the root filled tooth, persistent apical periodontitis (PAP) occurs, which results in loss by extraction. Systemic conditions associated with poor prognosis of endodontic treatments. Animal and epidemiological studies have provided data suggesting that several systemic conditions, including diabetes, CVDs, smoking habits, menopause/osteoporosis, HIV infection, inflammatory bowel disease and others, can influence the prognosis of endodontic treatments [1,17].

Diabetes mellitus is a group of disorders affecting the metabolism of carbohydrates, lipids and proteins, in which hyperglycemia is a main feature [22]. These disorders are due to a deficiency in insulin secretion caused by pancreatic β- cell dysfunction and/or insulin resistance in liver and muscle. Diabetes is associated with devastating complications, such as retinopathy, nephropathy, neuropathy, vascular disease and impaired wound healing. In diabetics, metabolic glycemic control is performed by determining the glycated hemoglobin [23]. HbA1c levels less than or equal to 6.5% are the goal for optimal glycemic control in diabetic patients. The first studies regarding the possible association of diabetes with the outcome of endodontic treatments date back to the mid-20th century. Bender and Seltzer reported that if proper insulin therapy was not introduced prior to root canal treatment (RCT), periapical healing will not take place and, in fact, the initial lesion may increase in size despite RCT [24]. However, studying a series of 33 well-controlled diabetic patients, they found that endodontic procedures were just as successfully in diabetic patients as in normal control patients. Since then, many experimental animal and human

epidemiological studies have investigated the relationship between diabetes and endodontic treatment and pathology. Experimental studies in rats and mice. Fouad., *et al*. have concluded that diabetic animals have more pronounced pulp and periapical inflammation [25], with larger periapical lesions [1,17,25], accelerated development and progression of apical periodontitis (AP), [16] and inhibition of dentine bridge formation after direct pulp capping [26]. All these findings suggest that diabetes alters tissue repair mechanisms at the pulp and periapical levels, interfering with healing after endodontic treatment. However, an study did not find significant difference between the induction of dentine bridge formation in diabetic and healthy control rats after direct pulp capping with silicate- based cements [27]. Clinical and epidemiological studies conducted in humans analyzing the association between diabetes and the prevalence of apical periodontitis (AP) and RCT also provide data that suggest the influence of diabetes to create a worse outcome of endodontic treatments, especially RCT [1,28]. The literature reveals delayed periapical healing in diabetic subjects, lower rates of repair associated with root filled teeth (RFT) [24], slower reduction in the size of periapical lesions in poorly controlled diabetic patients [28] and a greater percentage of persistent periapical periodontitis (PAP) in diabetics, compared to control subjects [4,25]. Future studies are needed to better define the endodontic treatment process in diabetic patients.

Conclusion

Systemic conditions can decrease the success rate of RCT and provoke incomplete wound healing wound healing and cause root canal failures. The objective of wound healing is to remove the source of bacterial antigens and toxins, allowing chronic inflammatory tissue to become reparative tissue. The repair of the periapical lesion will depend on the host's reparative response working properly.

Appropriate options for treatment can be made after the dental team is clear about the patients' health status, health history and prognosis, and thus, more information concerning the impact diabetes and oral diseases is taken into consideration. Serious infections, slow healing, prolonged bleeding, and hospitalizations can escalate in patients with uncontrolled diabetes. A multidisciplinary team-based approach to patient management can minimize RCT complications and unexpected challenges, thus improving endodontic success.

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