

Orthodontic Treatment Consideration in Diabetic Patients

Ahmed Almadih^{a, c}, Maryam Al-Zayer^a, Sukainh Dabel^a, Ahmed Alkhalaf^a,
Ali Al Mayyad^a, Wajdi Bardisi^b, Shouq Alshammari^c,
Zainab Alsihati^d

Abstract

Although orthodontic treatment is commonly indicated for young healthy individuals, recent trends showed an increase in number of older individuals undergoing orthodontic interventions. The increased age resulted in a proportionate increase in the prevalence of systemic diseases facing dentists during orthodontic procedures, especially diabetes mellitus. This necessitates that dentists should be aware of the diagnosis of diabetes mellitus and its early signs particularly in teeth and oral cavity. It is also essential for them to understand the implications of diabetes on orthodontic treatment and the measures to be considered during managing those patients. In this review, we focused on the impact of diabetes mellitus on orthodontic treatment. We also summarized the data from previous studies that had explained the measures required to be taken into consideration during managing those patients. We included both human and animal studies to review in depth the pathophysiological mechanisms by which diabetes affects orthodontic treatment outcome. In conclusion, this review emphasizes the need to carefully identify early signs and symptoms of diabetes mellitus in patients demanding orthodontic treatment and to understand the considerations to be adopted before and during treating these patients.

Keywords: Orthodontic; Orthodontic treatment; Diabetes mellitus; Consideration

Introduction

Over one million individuals in the United States undergo orthodontic treatment every year. Over two-thirds of them are females. Although the most common age of orthodontic treatment ranges between 12 and 15 years, recent figures demonstrate an increased number of older individuals demanding orthodontic intervention. This eventually made dentists see

various patients with systemic co-morbidities, particularly diabetes [1-3].

Being a systemic disease, diabetes mellitus has a major negative impact on different organs and systems, including teeth. During the last few decades, researchers explored the effect of diabetes mellitus on dental health and dental procedures outcome. In many situations, dentists are faced with diabetic patients demanding orthodontic treatment, or undiagnosed diabetics presenting for the first time to dentists with dental and oral signs and symptoms of diabetes. This necessitates a detailed knowledge about the diagnosis and management of diabetes and the measures to be considered before proceeding to orthodontic interventions.

Prevalence of Diabetes

Diabetes mellitus is a common and a serious public health problem. It is estimated that over 30 million adults and 1.25 million children had diabetes in the United States. Furthermore, 1.5 million new cases are diagnosed every year. Among individuals below the age of 20, approximately 0.24% had diabetes [4]. Diabetes mellitus is the most common endocrinological disorder that is characterized by dysfunction of glucose metabolism due to pancreatic beta cell destruction, insulin resistance, inadequate insulin secretion, inappropriate glucagon secretion, or combination of one or more of those mechanisms [5].

Types of Diabetes Mellitus

Type 1 diabetes mellitus is commonly known as juvenile onset diabetes or insulin-dependent diabetes mellitus (IDDM) [6]. As the name indicates, it is prevalent among young individuals commonly below the age of 20 years, but can occur as late as the fourth decade of life. Type 1 diabetes mellitus results from autoimmune destruction of pancreatic beta cells resulting in inability of the body to secrete insulin [7, 8].

Type 2 diabetes mellitus, on the other hand, starts insidiously commonly beyond the age of 40 years as a result of a combination of insulin resistance, glucagon excessive secretion and insulin inadequate secretion from pancreatic beta cells of Langerhans. Type 2 diabetes mellitus is also called “maturity onset diabetes” or “non-insulin-dependent diabetes mellitus (NIDDM)” [5, 6].

Beside type 1 and type 2, comes another specific type

Manuscript submitted November 29, 2017, accepted December 15, 2017

^aPrimary Health Care, Ministry of Health, Saudi Arabia

^bFaculty of Dentistry, Umm Al-Qura University, Saudi Arabia

^cDepartment of Dentistry, Hail University, Saudi Arabia

^dPrimary Health Care, Siba Smile Clinic, Saudi Arabia

^eCorresponding Author: Ahmed Ibrahim Almadih, Primary Health Care, Ministry of Health, Saudi Arabia. Email: dr.ahmedalmadih@hotmail.com

doi: <https://doi.org/10.14740/jocmr3285w>

Table 1. Dental Complications of Diabetes Mellitus

1	Mouth dryness and burning (xerostomia)
2	Oral acetone smells in poorly controlled patients
3	Brittle teeth
4	Dental caries
5	Recurrent oral infections, e.g. oral candida
6	Mouth ulcerations
7	Altered taste sensation
8	Delayed healing of mucous membranes
9	Teeth disposition and misalignment
10	Periodontitis
11	Gingivitis

of diabetes that occurs exclusively during pregnancy and so called “gestational diabetes”. Females who are genetically predisposed to diabetes can develop diabetes mellitus during pregnancy because the physiological as well as the hormonal changes occurring during pregnancy make this stage of reproductive life diabetogenic [6].

Diagnosis of Diabetes

Common clinical manifestations of diabetes include polyuria, polydipsia, polyphagia, generalized fatigue, and weight loss. Younger patients with type 1 diabetes are commonly admitted with diabetic ketoacidosis as their first presentation. Diabetic patients are generally prone to recurrent infection especially of the cutaneous and mucous membranes [5, 7, 8].

Clinical suspicion of diabetes mellitus warrants carrying out particular lab investigations to establish or exclude the diagnosis of diabetes. The American Diabetes Association (ADA) established diagnostic criteria for diabetes mellitus that include elevated fasting plasma glucose level of 126 mg/dL (7 mmol/L) or more, elevated 2-h plasma glucose level above 200 mg/dL (11 mmol/L) during conducting an oral glucose tolerance test (OGTT) with 75 g glucose, or an elevated random plasma glucose above 200 mg/dL (11 mmol/L) in clinically suspected patients [7]. Gestational diabetes mellitus, on the other hand, is defined by the WHO as the WHO definition of gestational diabetes is fasting blood sugar of \geq 126 mg/dL (7 mmol/L) or a 2-h level of \geq 140 mg/dL (7.8 mmol) [6].

Diabetes Among Patients Seeking Orthodontic Treatment

Diabetes is commonly encountered in patients seeking orthodontic treatment. Whereas orthodontic treatment was more common to be performed among adolescents and young adults, recent advances encouraged elder individuals to seek dental clinics for orthodontic intervention. This leads to the increased prevalence of patients presenting to dental clinics with associ-

ated medical morbidities especially diabetes mellitus. Many researchers have reported that about 5% of patients seeking medical advice at dental clinics are diabetics [9]. Other studies reported that around 4% of diabetic patients were first diagnosed with diabetes at dental clinic through their dental complications of diabetes [10]. The reason behind the relatively high prevalence of diabetes among dental patients is probably the bidirectional relationship between diabetes and dental ill-health [11, 12]. Diabetes is associated with a local, as well as systemic, inflammatory response that negatively affects the teeth, and the unhealthy teeth impair glycemic control [13]. Thus, tight control of diabetes is essential to decrease the dental complications of the disease. Similarly, periodontal treatment is fundamental for reduction of HbA1c levels in diabetic patients [14].

Oral and Dental Manifestations of Diabetes Mellitus

It is estimated that up to 50% of diabetic patients develop oral and dental manifestations of diabetes at least once in their life time [11, 12]. Many patients may be first diagnosed with diabetes at their dentist clinic. Common oral symptoms of diabetes include mouth dryness and burning (xerostomia), oral acetone smell in cases of poorly controlled diabetes, brittle teeth, dental caries, oral candida, mouth ulcerations, altered taste sensation, delayed healing of accidentally injured mucous membranes, and recurrent frequent infections [11, 15]. Diabetes also commonly destroys periodontal tissue leading to teeth disposition and misalignment. The eroded tissue results in the development of periodontitis and gingivitis [16]. Dental complications of diabetes are summarized in Table 1.

Pathophysiology of Dental Complications of Diabetes Mellitus

Diabetes mellitus has major negative health consequences including microvascular, macrovascular, and neuropathic complications. It is a systemic disease that affects almost every single system from cutaneous to renal systems; it also causes severe dental dysfunction [17].

Many theories had been proposed to explain the pathophysiology of dental complications of diabetes. Diabetic-related microangiopathy remains the widely accepted theory. In diabetes mellitus, the small and medium blood vessels are specifically affected. Such microangiopathy results in a considerable decline of blood flow to the supplied organs and tissues. The compromised vascular supply to teeth and dental structures leads to ischemic toothache, tenderness of gums, bone erosions, and even teeth loss [15].

Polymorphic dysfunction is another pathophysiological mechanism involved in dental poor health among diabetes that facilitates recurrent oral infection. Hyperglycemia also impairs protein metabolism, enhances collagen breakdown and eventually delay healing [17]. Table 2 summarizes the pathophysiological mechanisms involved in dental complications among

Table 2. Pathophysiology of Dental Complications of Diabetes

Proposed mechanism	Pathophysiology and impacts
Diabetic microangiopathy	Small and medium sized vessel angiopathy Decline blood flow to dental structure Ischemic tooth ache Tenderness of gum Bone erosions Teeth loss
Polymorphic dysfunction	Recurrent oral ulcers
Protein metabolism impairment	Collagen breakdown and delayed healing

diabetic patients.

Treatment Consideration in Diabetic Patients

Consideration before deciding orthodontic treatment

Because diabetes causes erosion of gum bones, diabetic patients' teeth often get misaligned and move to undesirable positions. Thus, it is not uncommon to find many diabetics demanding orthodontic treatment. Diabetic tooth movement had been extensively studied in human and animal models. Researchers stated that poor bone turnover, encountered in diabetic patients, is a major contributing factor to bone destruction and misalignment of teeth [15]. Braga et al [18] in their study on a mouse model declared that diabetes had a major negative impact on alveolar bone remodeling, and that the reversal of diabetes was associated with a significant improvement in bone health and reduction of teeth inappropriate movement.

Diabetes mellitus is not a contraindication for orthodontic interventions [19]. However, diabetic patients must establish very tight control of their glycemic states and kept under proper monitoring before getting into active orthodontic treatment. Additionally, good oral hygiene and periodontal health are prerequisites to successful orthodontic intervention. Researchers have demonstrated that diabetic patients who undergo orthodontic treatment while their glucose is poorly controlled had very high risk to periodontal breakdown [12].

Diabetes patients were reported to have higher risk to develop periodontal disease, and subsequently higher risk to have poor bone health and to lose their teeth. Furthermore, some dental diseases can have deleterious impact on the control of diabetes. For instance, periodontitis was demonstrated to significantly increase blood glucose levels and their fluctuations. Researchers had also indicated that diabetic patients got their blood glucose controlled when they had their gum disease treated. Periodontitis is common among diabetic patients and it is very essential to exclude it before proceeding to orthodontic treatment, because the presence of inflammation will increase the risk of unpredictable movement of orthodontic teeth [11].

Good oral hygiene has been established as the most potent protective factor against poor dental health among diabetic patients and one of the major considerations before going into active orthodontic treatment [13].

Consideration during the process of orthodontic intervention

Given the diabetes-related low blood flow to teeth and dental tissue, dentists should take into consideration that diabetic patients' teeth are fragile and thus apply as light physiological forces as possible not to overload the already compromised teeth [12].

Because diabetic patients' immune system is often compromised, antibiotic prophylaxis is essential during certain orthodontic interventions. Diabetic patients who will undergo orthodontic band placement, separator placement, or screw insertion are at high risk for developing oral infection, a matter that requires the use of prophylactic antibiotics before these procedures. Simple adjustment or replacement of appliances, however, does not necessitate antibiotics [20, 21].

Diabetic emergencies during orthodontic treatment

Along with the aforementioned monitoring as well as procedural considerations, dentists should be aware of and ready to deal with potential diabetic emergencies that are likely to occur during orthodontic treatment. The most dangerous emergency is hypoglycemia. Hypoglycemia occurs when serum blood glucose level drops below 50 mg/dL [22]. When patients develop hypoglycemia, they go through two stages; the neurogenic (or adrenergic) stage followed by the neuroglycopenic stage. During the adrenergic stage, there is a considerable activation of sympatho-adrenal systems leading to shivering, cold sweating, tremors, and tachycardia. If the diagnosis of this stage was missed, patients develop neuroglycopenic symptoms including dizziness, blurred vision, confusion, generalized weakness, and even coma and death. Dentists as well as orthodontic team should be well-trained to early identify and manage hypoglycemia [22, 23]. For ultimate control, they should always put it into consideration when dealing with a diabetic patient and be always ready for action. Once early hypoglycemia symptoms are recognized, oral glucose is to be administered in a dose of 50 g. If the patient was unconscious, intramuscular glucagon 1 mg or intravenous dextrose should be immediately infused [24]. Another measure to avoid hypoglycemia is to ensure the patient consumes a morning meal on the day of orthodontic procedure [20]. The different orthodontic treatment considerations in diabetic patients are summarized in Table 3.

Table 3. Summary of Orthodontic Consideration in Diabetic Patients

Considerations before deciding orthodontic treatment	Ensure good oral hygiene and dental health (most potent) Tight control of diabetes Exclude periodontitis Monitor blood glucose before going into active orthodontic treatment
Considerations during the process of orthodontic treatment	Apply light physiological forces Antibiotic prophylaxis before: orthodontic bed placement; separator placement; screw insertion Antibiotic prophylaxis is not needed in: simple adjustment of appliances; simple replacement of appliances
Considerations to prevent or manage emergencies during the process (especially hypoglycemia)	Morning meal on day of orthodontic treatment If symptoms of hypoglycemia occurred: IV dextrose; IM glucagon 1 mg

Conclusions

Diabetes mellitus is commonly encountered in patients seeking orthodontic treatment. Because diabetes exerts a considerable negative effect on bone remodeling, diabetic patients' teeth are very likely to be misaligned and to require dental correction. Thus, it is necessary for dentists to have a basic and solid background knowledge about diabetes diagnosis, management, dental consequences, and the considerations to be taken into account during treating those patients. Diabetes is not a contraindication to orthodontic treatment. However, uncontrolled diabetes may have significant negative consequences on the outcomes of the procedures. Dentists should be aware about the importance of tight control of diabetes before conducting any dental procedure, and to exclude periodontitis. During orthodontic treatment, they should be careful not to overload the weakened teeth, to give prophylactic antibiotics when required, and to be aware with early signs of hypoglycemia.

Acknowledgments

The authors would like to thank the Ministry of Health of Saudi Arabia for providing the necessary access and tools to search and complete this article.

Disclosures

The authors declare that no competing or financial interests exist.

References

- Orthodontic Statistics: Did You Know ...? Johnson Elite Orthodontics. [Online]. Available: <http://www.johnsoneliteortho.com/orthodontic-statistics-did-you-know/>. [Accessed: 04-Nov-2017].
- Tak M, Nagarajappa R, Sharda AJ, Asawa K, Tak A, Jali-hal S, Kakatkar G. Prevalence of malocclusion and orthodontic treatment needs among 12-15 years old school children of Udaipur, India. *Eur J Dent.* 2013;7(Suppl 1):S45-53.
- Whitesides J, Pajewski NM, Bradley TG, Iacopino AM, Okunseri C. Socio-demographics of adult orthodontic visits in the United States. *Am J Orthod Dentofacial Orthop.* 2008;133(4):489 e489-414.
- Statistics about diabetes: American Diabetes Association®. [Online]. Available: <http://www.diabetes.org/diabetes-basics/statistics/?referrer=https://www.google.com.eg/>. [Accessed: 04-Nov-2017].
- Pfeffer MA, Claggett B, Diaz R, Dickstein K, Gerstein HC, Kober LV, Lawson FC, et al. Lixisenatide in Patients with Type 2 Diabetes and Acute Coronary Syndrome. *N Engl J Med.* 2015;373(23):2247-2257.
- Streetman BENG, Banerjee SK. Murtagh's general practice, Sixth edn. Australia: Jane Roy, 2015.
- American Diabetes A. Diagnosis and classification of diabetes mellitus. *Diabetes Care.* 2014;37(Suppl 1):S81-90.
- Romesh Khardori GTG. Type 1 diabetes mellitus: practice essentials, background, pathophysiology. [Online]. Available: <https://emedicine.medscape.com/article/117739-overview>. [Accessed: 04-Nov-2017].
- Opeodu OI, Adeyemi BF. Prevalence of coexisting diabetes mellitus and hypertension among dental patients in a tertiary care hospital. *J West Afr Coll Surg.* 2015;5(3):16-35.
- Ojehanon PI, Akhionbare O. Prevalence of undiagnosed diabetes mellitus among dental patients in Edo State, Nigeria. *J Med Biomed Res.* 2006;5(1):24-28.
- Reichert C, Deschner J, Jager A. Influence of diabetes mellitus on the development and treatment of malocclusions - a case report with literature review. *J Orofac Orthop.* 2009;70(2):160-175.
- Burden D, Mullally B, Sandler J. Orthodontic treatment of patients with medical disorders. *Eur J Orthod.* 2001;23(4):363-372.
- Wray L. The diabetic patient and dental treatment: an update. *Br Dent J.* 2011;211(5):209-215.
- Simpson TC, Weldon JC, Worthington HV, Needleman I, Wild SH, Moles DR, Stevenson B, et al. Treatment of periodontal disease for glycaemic control in people with diabetes mellitus. *Cochrane Database Syst Rev.* 2015;11:CD004714.
- Bensch L, Braem M, Van Acker K, Willems G. Orthodon-

- tic treatment considerations in patients with diabetes mellitus. *Am J Orthod Dentofacial Orthop.* 2003;123(1):74-78.
16. Al-Maskari AY, Al-Maskari MY, Al-Sudairy S. Oral manifestations and complications of diabetes mellitus: a review. *Sultan Qaboos Univ Med J.* 2011;11(2):179-186.
 17. Abbassy MA, Watari I, Bakry AS, Hamba H, Hassan AH, Tagami J, Ono T. Diabetes detrimental effects on enamel and dentine formation. *J Dent.* 2015;43(5):589-596.
 18. Braga SM, Taddei SR, Andrade I, Jr., Queiroz-Junior CM, Garlet GP, Repeke CE, Teixeira MM, et al. Effect of diabetes on orthodontic tooth movement in a mouse model. *Eur J Oral Sci.* 2011;119(1):7-14.
 19. Patel A, Burden DJ, Sandler J. Medical disorders and orthodontics. *J Orthod.* 2009;36(Suppl):1-21.
 20. Rizvi S, Pattabiraman V, Pai S, Sabrish S. Diabetes mellitus, a dilemma in orthodontics. *J Orthod.* 2014;2(3):113-117.
 21. Tong DC, Rothwell BR. Antibiotic prophylaxis in dentistry: a review and practice recommendations. *J Am Dent Assoc.* 2000;131(3):366-374.
 22. Ohashi Y, Wolden ML, Hyllested-Winge J, Brod M. Diabetes management and daily functioning burden of non-severe hypoglycemia in Japanese people treated with insulin. *J Diabetes Investig.* 2017;8(6):776-782.
 23. Seaquist ER, Anderson J, Childs B, Cryer P, Dagogo-Jack S, Fish L, Heller SR, et al. Hypoglycemia and diabetes: a report of a workgroup of the American Diabetes Association and the Endocrine Society. *Diabetes Care.* 2013;36(5):1384-1395.
 24. American Diabetes A. 13. Diabetes care in the hospital. *Diabetes Care.* 2016;39(Suppl 1):S99-104.