Dental management considerations for the patient with diabetes mellitus

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ABSTRACT

Background. The prevalence of diabetes mellitus, or DM, in the United States is increasing steadily. The increasing longevity of the American population and more effective diagnostic protocols mean that the dental practitioner will be treating an increasing number of patients with the disease.

Methods. The authors present relevant information about DM, including a recently revised nomenclature system, pathophysiology, complications, new diagnostic criteria, medical and dental management considerations, and associated oral conditions.

Conclusions. There are many important medical and dental management issues that dentists should consider when treating patients with DM.

Clinical Implications. The information presented in this report should help general dentists deliver optimum treatment to patients with DM.

Diabetes mellitus, or DM, is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both.[1] The prevalence of DM in the United States has been increasing steadily. An estimated 16 million people, or 6 percent of the U.S. population, have DM. Approximately 800,000 new cases are diagnosed each year. Almost 20 percent of adults older than 65 years have DM.[2] With the increasing longevity of the American population and more effective diagnostic protocols, the dental practitioner will be treating more patients with DM. Therefore, it is important for dentists to be aware of medical and dental management considerations for this expanding patient population.

Diabetes mellitus can have a significant impact on the delivery of dental care.

ETIOLOGIC CLASSIFICATION OF DM

In 1999, the American Diabetes Association's Expert Committee on the Diagnosis and Classification of Diabetes Mellitus approved the following revised nomenclature and classification system, which is based on disease etiology rather than the specific type of treatment used to manage the disease[1]:

Type 1 DM. This class of diabetes, which constitutes 5 to 10 percent of DM cases, usually results from autoimmune destruction of the insulin-producing beta cells of the pancreas. Immune-mediated DM commonly occurs in childhood and adolescence, but it can occur at any age. It usually leads to absolute insulin deficiency, and patients have a high incidence of severe complications, including ketoacidosis. Patients with type 1 DM also are prone to other autoimmune disorders, such as Graves' disease, Hashimoto's thyroiditis and Addison's disease. Some forms of type 1 DM have no known cause, and may be related to viral infections or environmental factors that still are poorly defined.

Type 2 DM. This form of diabetes constitutes 90 to 95 percent of DM cases, and results from impaired insulin function (insulin resistance). People with type 2 DM usually have relative rather than absolute insulin deficiency. Although the specific causes of this form of diabetes are not known, autoimmune destruction of beta cells does not occur. Ketoacidosis is uncommon, but hyperosmolar nonketotic acidosis may result from prolonged hyperglycemia. The risk of developing type 2 DM increases with age, obesity and lack of physical activity. Type 2 DM also is more prevalent in people with hypertension or dyslipidemia. There often is a strong genetic predisposition, and the disease is more common among African-American, Hispanic and American Indian populations.

Other specific types. These are relatively uncommon. Possible causes include genetic defects of beta-cell function or insulin action, diseases of the exocrine pancreas, endocrinopathies, drug or chemical use, infections and certain genetic syndromes. Excess amounts of cortisol, glucagon, epinephrine and growth hormone can cause DM in people with pre-existing defects in insulin secretion. Hyperglycemia usually resolves when the excess hormone is removed. Drugs such as glucocorticoids, thiazides, dilantin and interferon-α can impair insulin secretion. Certain viruses, including cytomegalovirus, mumps and coxsackievirus, have been associated with beta-cell destruction.

Gestational diabetes mellitus, or GDM. This is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. GDM complicates approximately 4 percent of all pregnancies in the United States. In the majority of cases, glucose regulation will return to normal after delivery. However, women who have had GDM are at increased risk of developing type 2 DM later in life.

It is important to note that the terms "juvenile-onset diabetes," "adult-onset diabetes," "insulin-dependent diabetes mellitus" and "non–insulin-dependent diabetes mellitus" and the acronyms IDDM and NIDDM no longer are used. The terms "type 1 DM" and "type 2 DM" are retained, and are written with Arabic rather than Roman numerals.

People with diabetes mellitus have an increased incidence of both microvascular and macrovascular complications.

PATHOPHYSIOLOGY

In healthy people, blood glucose levels usually are maintained within a range of 60 to 150 milligrams per deciliter, or mg/dL, throughout the day. Insulin serves a critical role in the regulation of blood glucose. It is synthesized in the beta cells of the pancreas and is secreted rapidly into the blood in response to elevations in blood sugar, such as after a meal. Insulin usually maintains glucose homeostasis by promoting uptake of glucose from the blood into cells and by its storage in the liver as glycogen. Insulin also promotes the uptake of fatty acids and amino acids, as well as their subsequent conversion into triglyceride and protein stores.

A lack of insulin or insulin resistance, as seen in DM, results in an inability of insulin-dependent cells to use blood glucose as an energy source. Stored triglycerides are broken down into fatty acids, which serve as an alternate source of fuel, and an elevation in blood ketones leads to diabetic ketoacidosis. As blood glucose levels become elevated (hyperglycemia), glucose is excreted in the urine and excessive urination (polyuria) occurs because of osmotic diuresis. Increased fluid loss leads to dehydration and excessive thirst (polydipsia). Since cells are starved of glucose, the patient experiences increased hunger (polyphagia). Paradoxically, the diabetic patient often loses weight, since the cells are unable to take up glucose. These are the classic signs and symptoms of DM.

COMPLICATIONS

People with DM have an increased incidence of both microvascular and macrovascular complications. Long-term sequelae of DM may include retinopathy, with potential loss of vision, and nephropathy leading to renal failure. Hypertension, hyperlipidemia, atherosclerotic cardiovascular disease, peripheral vascular disease and cerebrovascular disease also are common. Some people experience peripheral and autonomic neuropathies such as numbness and tingling of extremities, oral paresthesia and burning. People with poorly controlled DM also may have impaired wound healing and increased susceptibility to infections. Among the mechanisms thought to produce the tissue damage associated with chronic hyperglycemia are glycation of tissue proteins and excess production of polyol compounds from glucose.[1]

DIAGNOSIS

The American Diabetes Association's Expert Committee on the Diagnosis and Classification of Diabetes Mellitus also recently approved new criteria for the diagnosis of DM.[1,3]

- a casual plasma glucose level (taken at any time of day) of 200 mg/dL (11.1 millimolar) or greater when the symptoms of diabetes are present. Classic symptoms of diabetes include polydipsia, polyuria and unexplained weight loss.
- a fasting plasma glucose level of 126 mg/dL (7.0 mmol/L) or greater.
- an oral glucose tolerance test value in the blood of 200 mg/dL or greater when measured at the two-hour interval.

These criteria are expected to lead to a further

increase in the number of patients diagnosed as having DM. The normal fasting plasma glucose level is now defined as less than 110 mg/dL. Included in the current classification system are the terms "impaired glucose tolerance," or IGT, and "impaired fasting glucose," or IFG, which refer to a metabolic stage between the stages of normal glucose homeostasis and DM. This stage includes people with fasting plasma glucose levels of 110 mg/dL or greater but less than 126 mg/dL.[1] Because early detection and prompt treatment may reduce the burden and complications of type 2 DM, the American Diabetes Association recommends that all people older than age 45 years be screened every three years, and that screening should be earlier and more frequent in high-risk people, including those with previously identified IGT or IFG.

TABLE 1

INSULIN PREPARATIONS.*

TYPE OF PREPARATION	ONSET OF ACTIVITY	PEAK ACTIVITY	EFFECTIVE DURATION
Rapid-Acting Lispro	< 15 minutes	45-90 minutes	3-4 hours
Short-Acting Regular	30 minutes	2-5 hours	5-8 hours
Intermediate-Acting NPH†, Lente	1-3 hours	6-12 hours	16-24 hours
Long-Acting Ultralente	4-6 hours	8-20 hours	24-28 hours

* Source: Medicines for people with diabetes.[6]
† NPH: Neutral protamine Hagedorn.

MEDICAL MANAGEMENT

The objective of medical management in all patients with DM is to maintain blood glucose levels as close to normal as possible. The Diabetes Control and Complications Trial conclusively demonstrated that good glycemic control inhibits the onset and delays the progression of complications of type 1 DM.[4] Considerable evidence indicates a similar relationship for type 2 DM.[5] The glycated hemoglobin assay (HbA_{1c}) reflects mean glycemia levels over the preceding two to three months, and currently is used to assess whether a patient's metabolic control has remained within the target range (normal value, < 7 percent). The glycated hemoglobin value also has been shown to be a predictor for the development of chronic complications in patients with DM. Intensive treatment programs and comprehensive education in self-management—including diet control, exercise and frequent self-monitoring of blood glucose levels—are essential components of disease management.

It is important for clinicians to assess glycemic control at the initial appointment.

Insulin. Insulin is used in the medical management of all patients with type 1 DM and in some patients with type 2 DM. It is available in rapid-, short-, intermediate- and long-acting forms that usually are administered by the patient via subcutaneous injection. Alternatively, continuous subcutaneous insulin infusion by means of a computerized external pump may be used. Insulin preparations with a predetermined amount of regular insulin mixed with neutral protamine Hagedorn, or NPH, are considered intermediate-acting. The most commonly used insulin strength in the United States is 100 units per milliliter of fluid (U100). Table 1 lists the commonly used human insulin preparations and their periods of activity.[6]

Oral antidiabetic agents. These are used in the management of mild-to-moderate type 2 DM. Because the drugs act in different ways to lower blood sugar, they often are used in combination. Table 2 lists the common classes of oral antidiabetic agents and their mechanisms of action.

DENTAL MANAGEMENT CONSIDERATIONS

To minimize the risk of an intraoperative emergency, clinicians need to consider a number of management issues before initiating dental treatment.

Medical history. It is important for clinicians to take a good medical history and assess glycemic control at the initial appointment. They should ask patients about recent blood glucose levels and frequency of hypoglycemic episodes. Antidiabetic medications, dosages and times of administration should be determined. A variety of

TABLE 2

ANTIDIABETIC MEDICATIONS.

DRUG CLASS	GENERIC (TRADE) DRUG NAMES*	MECHANISM OF ACTION
Sulfonylureas	Chlorpropamide (Diabinese) Glipizide (Glucotrol) Glyburide (DiaBeta, Micronase) Glimepiride (Amaryl)	Stimulate insulin secretion
Meglitinides	Repaglinide (Prandin)	Stimulate insulin secretion
Biguanides	Metformin (Glucophage)	Decrease glycogenolysis and hepatic glucose production
α-Glucosidase Inhibitors	Acarbose (Precose) Miglitol (Glyset)	Decrease gastrointestinal absorption of carbohydrates
Thiazolidinediones	Rosiglitazone maleate (Avandia) Pioglitazone (Actos)	Enhance tissue sensitivity to insulin

* Diabinese is manufactured by Pfizer Inc., New York; Glucotrol, Pfizer Inc.; DiaBeta, Aventis Pharmaceuticals Inc., Bridgewater, N.J.; Micronase, Pharmacia and Upjohn, Peapack, N.J.; Amaryl, Aventis Pharmaceuticals Inc.; Prandin, Novo Nordisk, Princeton, N.J.; Glucophage, Bristol-Myers Squibb, New York; Precose, Bayer Corp., Pittsburgh; Glyset, Pharmacia and Upjohn; Avandia, GlaxoSmithKline, Research Triangle Park, N.C., and Philadelphia; and Actos, Takeda Chemical Industries Ltd., Osaka, Japan.

other concomitantly prescribed medications may alter glucose control through interference with insulin or carbohydrate metabolism. The hypoglycemic action of sulfonylureas may be potentiated by drugs that are highly protein-bound, such as salicylates, dicumerol, β-adrenergic blockers, monoamine oxidase inhibitors, sulfonamides and angiotensin-converting enzyme inhibitors. Epinephrine, corticosteroids, thiazides, oral contraceptives, phenytoin, thyroid products and calcium channel–blocking drugs have hyperglycemic effects.

Patients undergoing major surgical procedures may require adjustment of insulin dosages or oral antidiabetic drug regimens. Any complications of DM, such as cardiovascular or renal disease, will have their own effects on dental treatment planning. If necessary, the dentist should consult with the patient's physician.

Scheduling of visits. In general, morning appointments are advisable since endogenous cortisol levels are generally higher at this time (cortisol increases blood sugar levels). For patients receiving insulin therapy, appointments should be scheduled so that they do not coincide with peaks of insulin activity, since that is the period of maximal risk of developing hypoglycemia.

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Diet. It is important for clinicians to ensure that the patient has eaten normally and taken medications as usual. If the patient skips breakfast owing to the dental appointment but still takes the normal dose of insulin, the risk of a hypoglycemic episode is increased. For certain procedures (for example, conscious sedation), the dentist may request that the patient alter his or her normal diet before the procedure. In such cases, the medication dose may need to be modified in consultation with the patient's physician.

Blood glucose monitoring. Depending on the patient's medical history, medication regimen and procedure to be performed, dentists may need to measure the blood glucose level before beginning a procedure. This can be done using commercially available electronic blood glucose monitors, which are relatively inexpensive and have a high degree of accuracy. Patients with low plasma glucose levels (< 70 mg/dL for most people) should be given an oral carbohydrate before treatment to minimize the risk of a hypoglycemic event. Clinicians should refer patients with significantly elevated blood glucose levels for medical consultation before performing elective dental procedures.

During treatment. The most common complication of DM therapy that can occur in the dental office is a hypoglycemic episode. If insulin or oral antidiabetic drug levels exceed physiological needs, the patient may experience a severe decline in his or her blood sugar level. The maximal risk of developing hypoglycemia generally occurs during peak insulin activity. Initial signs and symptoms include mood changes, decreased spontaneity, hunger and weakness. These may be followed by sweating, incoherence and tachycardia. If untreated, possible consequences include unconsciousness, hypotension, hypothermia, seizures, coma and death.

If the clinician suspects that the patient is experiencing a hypoglycemic episode, he or she should terminate dental treatment and immediately administer 15 grams of a fast-acting oral carbohydrate such as glucose tablets or gel, sugar, candy, soft drinks or juice. It is important to note that the α-glucosidase inhibitors prevent the hydrolysis of sucrose into fructose and glucose. Therefore, a hypoglycemic episode in a patient taking these drugs should be treated with a direct source of glucose. After immediate treatment, dentists should measure blood glucose levels to confirm the diagnosis and determine if repeated carbohydrate dosing is needed. If the patient is unable to swallow or loses consciousness, the dentist should seek medical assistance; 25 to 30 mL of a 50 percent dextrose solution or 1 mg of glucagon should be administered intravenously. Glucagon also can be injected subcutaneously or intramuscularly.[7]

Severe hyperglycemia associated with type 1 ketoacidosis or type 2 hyperosmolar nonketotic state usually has a prolonged onset. Therefore, the risk of a hyperglycemic crisis is much lower than that of a hypoglycemic crisis in a dental practice setting. Ketoacidosis may develop, with nausea, vomiting, abdominal pain and an acetone odor. Definitive management of hyperglycemia requires medical intervention and insulin administration. However, it may be difficult to differentiate between hypoglycemia and hyperglycemia based on symptoms alone. Therefore, the dentist should administer a carbohydrate source to a patient in whom a presumptive diagnosis of hypoglycemia is made. Even if the patient is undergoing a hyperglycemic episode, the small amount of additional sugar is unlikely to cause significant harm.[7] The clinician should measure blood glucose levels after immediate treatment.

After treatment. Clinicians should keep in mind these postoperative considerations. Patients with poorly controlled DM are at greater risk of developing infections and may demonstrate delayed wound healing. Acute infection can adversely affect insulin resistance and glycemic control, which, in turn, may further affect the body's capacity for healing. Therefore, antibiotic coverage may be necessary for patients with overt oral infections or for those undergoing extensive surgical procedures.

If the dentist anticipates that normal dietary intake will be affected after treatment, insulin or oral antidiabetic medication dosages may need to be appropriately adjusted in consultation with the patient's physician. Salicylates increase insulin secretion and sensitivity and can potentiate the effects of sulfonylureas, resulting in hypoglycemia. Therefore, aspirin and aspirin-containing compounds generally should be avoided for patients with DM.[8]

It is important for dentists to educate patients about the oral implications of diabetes mellitus.

DM AND THE MOUTH

A number of oral conditions have been associated with DM, particularly in patients with poor disease control. However, a recent survey has indicated that most patients with DM are unaware of the oral health complications of their disease.[9] Therefore, it is important for dentists to educate patients about the oral implications of DM and the need for proper preventive care (Box, "Dental Management of the Diabetic Dental Patient").

Periodontal disease. In 1999, the American Academy of Periodontology issued a position paper about diabetes and periodontal diseases.[10] This report indicates that DM, especially when poorly controlled, increases the risk of periodontitis. Several contributing factors have been proposed, including reduced polymorphonuclear leukocyte function, abnormalities in collagen metabolism and the formation of advanced glycation end products, or AGE, which adversely affect collagen stability and vascular integrity. AGE binding to macrophage and monocyte receptors also may result in increased secretion of interleukin-1 and tumor necrosis factor-α, resulting in increased susceptibility to tissue destruction.

Some evidence suggests that periodontal infec-

DENTAL MANAGEMENT OF THE DIABETIC DENTAL PATIENT.

POTENTIAL COMPLICATION	PREVENTIVE MEASURES
Hypoglycemia	▬ Thorough medical history and consultation with physician to assess glycemic control, disease severity and medications with hypoglycemic potential ▬ Monitoring of blood glucose level and dietary intake before treatment ▬ Avoidance of peak activity periods of insulin or oral antidiabetic medications ▬ Recognition of signs and symptoms of low blood glucose level, and timely administration of carbohydrate source (oral, intramuscular, intravenous)
Infection and Delayed Wound Healing	▬ Frequent dental visits to assess plaque control and to identify risk factors for periodontal disease, caries and oral candidiasis ▬ Postoperative antibiotic therapy if warranted ▬ Avoidance of smoking
Salivary Gland Dysfunction and Oral Burning	▬ Maintenance of adequate oral hydration (water, ice chips, saliva substitutes, sugarless gum) ▬ Restriction of caffeine and alcohol intake

tion and periodontal treatment have the potential to alter glycemic control.[10] The presence of severe periodontal infection may increase the risk of microvascular and macrovascular diabetic complications. Control of periodontal infection has been shown to have a positive effect on glycemic control.[10] However, further research is required to better understand the pathways through which DM and periodontal disease interact.

Patients with poorly controlled DM have an increased rate of surgical wound infections and poor wound healing, and, therefore, some researchers have recommended that management of periodontal disease be conservative and nonsurgical as much as possible.[11] Since prevention plays a primary role in periodontal disease control in diabetic patients, they may need more frequent plaque control and scaling than nondiabetic patients.[11]

Studies have indicated that smoking increases the risk of periodontal disease severalfold in diabetic patients.[12,13] Therefore, tobacco use cessation counseling should be a part of the management of patients with DM.

Salivary gland dysfunction. Studies have reported xerostomia in 40 to 80 percent of diabetic patients.[14,15] Diabetic patients with poorly controlled disease have been found to have lower stimulated parotid flow rates than people with well-controlled DM and nondiabetic control subjects.[16] Frequent sipping of water or use of sugarless gum may alleviate the dryness.

Asymptomatic, bilateral enlargement of the parotid glands has been reported in 24 to 48 percent of patients with DM, and patients with uncontrolled DM have exhibited a greater propensity for enlargement.[15,17]

Fungal infections. Several authors have reported that diabetic people have an increased predisposition to manifestations of oral candidiasis, including median rhomboid glossitis, denture stomatitis and angular cheilitis. Candidiasis has been found to be associated with poor glycemic control and use of dentures.[15,18,19] This predisposition may be due to xerostomia, increased salivary glucose levels or immune dysregulation.

Mucormycosis is a rare but serious systemic fungal infection that may occur in patients with uncontrolled DM. Oral involvement usually appears as palatal ulceration or necrosis. Patients often have facial cellulitis and anesthesia, nasal discharge, fever, headache and lethargy. Treatment usually includes systemic antifungal therapy.[20]

Oral burning and taste disturbances. In one study of patients with undiagnosed type 2 DM, 37 percent of subjects reported experiencing burning mouth or tongue.[21] Therefore, clinicians should consider DM in the diagnosis of such complaints. The burning may be due to peripheral

neuropathy, xerostomia or candidiasis. Good glycemic control may alleviate the burning sensation. Recent reports have indicated that clonazepam may be beneficial in some patients with complaints of oral burning sensation.[22]

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Perros and colleagues[23] reported that some diabetic patients have a mild impairment of the sweet taste sensation. This may be related to xerostomia or disordered glucose receptors.[24] Taste alterations may be more common in people with uncontrolled DM.[15]

Lichen planus and lichenoid reactions. Petrou-Amerikanou and colleagues[25] reported that the prevalence of oral lichen planus is significantly higher in patients with type 1 DM and slightly higher in patients with type 2 DM than in control subjects. However, this may be a side effect of oral hypoglycemic agents or antihypertensive medications.[26] Furthermore, a recent large study found no evidence of increased prevalence of lichen planus in patients with type 1 DM compared with nondiabetic control subjects.[27]

Dental caries. Some studies have demonstrated that diabetic patients have more active dental caries than control subjects.[28,29] Other studies have shown no increase in prevalence of caries in diabetic patients.[30,31] Elevated salivary glucose levels and xerostomia may predispose this population to caries. However, low-carbohydrate diabetic diets should theoretically reduce caries prevalence.

Traumatic ulcers and irritation fibromas. Guggenheimer and colleagues[27] recently reported that people with type 1 DM have a higher prevalence of oral traumatic ulcers and irritation fibromas than do nondiabetic control subjects. These findings may be related to altered wound healing patterns in these patients.

CONCLUSIONS

Diabetes mellitus can have a significant impact on the delivery of dental care. It is important for dentists to be familiar with the medical management of patients with DM, and to recognize the signs and symptoms of undiagnosed or poorly controlled disease. By taking an active role in the diagnosis and treatment of oral conditions associated with DM, dentists also may contribute to the maintenance of optimum health in patients with this disease. ■

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