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Review Article

Diabetic Patient Management in Dentistry

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Abstract:

Diabetes is a common chronic disease. Complications associated with diabetes are substantial for the affected individuals. Periodontal disease, cavities, and loss of teeth are frequent consequences. This article presents an analysis of the bidirectional relationship between diabetes and oral health, mainly focusing on periodontal disease. There is substantial evidence demonstrating the fact that diabetes, associated with poorly controlled glycaemia, represents a significant risk factor for the onset of periodontitis in a bi-directional manner. However, further studies are necessary to establish how periodontal treatment can contribute to glycaemia control and vice versa. This study also highlights the clinical protocols for management of diabetic patients. Uncontrolled or poorly controlled diabetes is associated with increased vulnerability to oral infections, including periodontitis. Well controlled patients are good candidates for periodontal treatment and vice versa periodontal treatment has beneficial effects on metabolic control of diabetic patients. We explored the connection between periodontitis and diabetes mellitus, hoping to provide general dentists with the knowledge to support their diabetic patients.

***Keywords:** Diabetes, Periodontal Disease, Dental Treatment*

Introduction

Diabetes mellitus is a complex metabolic disease characterized by chronic hyperglycemia due to decreased insulin production, weakened insulin action, or a combination of the two, which results in the inability of transferring glucose from the blood stream to the tissues, with consequent high glucose levels in the blood and sugar secretion in the urine. Diabetic patients also display altered lipid or protein metabolism. The primary complications resulting from lack of proper long-term metabolic control of the disease are microvascular issues (retinopathy, nephropathy and neuropathy), macrovascular issues (cardiovascular and cerebrovascular problems), and increased vulnerability to infections with more difficult healing of wounds (1).

The main types of diabetes are type 1 and type 2, but there are also a few less common types.

Type 1 Diabetes

Type 1 Diabetes Mellitus, also known as Insulin-Dependent Diabetes Mellitus (IDDM) is caused by an autoimmune destruction of the β cells, located in the pancreas and specifically in the islets of Langherans, which are responsible for insulin production. The onset of this type of diabetes, which determines significant insulin deficiency and affects 5-10% of the overall number of diabetic patients, is more frequent in children and young adults. Type 1 diabetes is clinically very unstable and difficult to control, shows a substantial tendency towards ketosis and coma, is not preceded by obesity, and requires insulin injections. Patients with this type of diabetes present symptoms traditionally associated with diabetes, such as polyphagia, polydipsia, polyuria, and proneness to infections.

Type 2 Diabetes

Type 2 Diabetes Mellitus, also known as Non-Insulin-Dependent Diabetes Mellitus (NIDDM) is caused by a peripheral resistance to the function of insulin, with a consequent increase in glucose production in the liver.

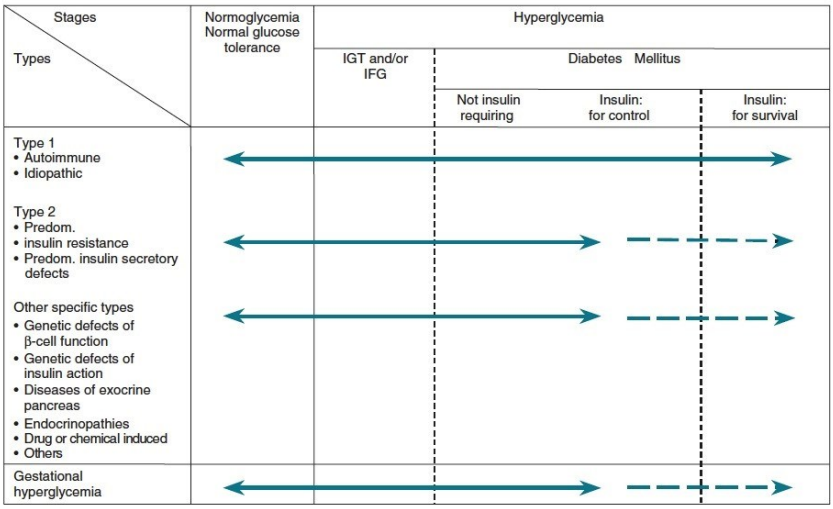
Pancreatic β cells, which produce insulin, are not destroyed by the autoimmune reaction. Type 2 diabetes is the most common type and it affects 90-95% of patients, with more frequent onset in adulthood. Often patients are not aware of being sick and the disease is only diagnosed as result of severe symptoms or complications. Type 2 diabetes usually affects obese individuals and can often be successfully controlled through diet or hypoglycemic drugs. This type can present the same symptoms as type 1 diabetes but in a less severe form, whereas it only rarely results in ketosis or coma (2).

Other Types of Diabetes

An additional diabetes category is the one secondary to other diseases or systemic conditions. An example is gestational diabetes associated to pregnancy. Gestational diabetes affects between 2% and 5% of pregnancies and usually disappears after delivery. Women affected by it are at a higher risk of developing type 2 diabetes at some point in the course of their life (3).

Other secondary types of diabetes are those associated with diseases that affect the pancreas and entail the destruction of insulin-producing cells (4). These groups include endocrine diseases, such as acromegaly, Cushing Syndrome, pancreatic cancers, pancreatectomy, and drugs and chemical products that alter insulin levels (5).

(**Table 1**)



2. Diagnostic Criteria

The main methods used to diagnose diabetes are described in table II.

Glycated hemoglobin indicates the quantity of glucose irreversibly bound to hemoglobin molecules. This value is proportional to glucose levels in the blood and therefore provides a measure of the state of blood glucose during the half-life of erythrocytes (from 30 to 90 days). There are two types of tests, hemoglobin A1 test (HbA1) and hemoglobin A1c test (Hb1Ac); normal ranges are within 8% for the first one and between 6% and 6.5% for the second one (23).
The glycated hemoglobin test is useful to assess whether for the previous three months, patients have been prescribed an adequate drug treatment and complying with a specific diet.
At an international level, three tests are being currently used to diagnose diabetes:

ADA Criteria for the diagnosis of diabetes

Table 3—*Criteria for the diagnosis of diabetes*

1. A1C ≥ 6.5%. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*
   OR
2. FPG ≥ 126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 h.*
   OR
3. 2-h plasma glucose ≥200 mg/dl (11.1 mmol/l) during an OGTT. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*
   OR
4. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/l).

*In the absence of unequivocal hyperglycemia, criteria 1–3 should be confirmed by repeat testing.

- Test no. 1: plasma glucose levels ≥200 mg/dl (11.1 mmol/l). The blood sample can be collected at any time of the day regardless of meal consumption;

- Test no. 2: FPG [*Fasting Plasma Glucose*] (assessment of fasting plasma glucose levels) ≥126 mg/dl (7.0 mmol/l). This test has to be performed with no calorie intake for the previous eight hours;

- Test no. 3: 2-h PG (plasma glucose levels two hours after oral glucose consumption) ≥200 mg/dl (11.1 mmol/l) after an oral glucose loading test.

This test is performed according to the guidelines provided by WHO, using a 75g glucose load dissolved in water. Blood samples are taken from the arm prior to consuming the glucose and then after half hour, one hour, two hours, and three hours from the glucose intake. Normally, the patient's urine is also tested.

3. Oral Conditions in Diabetic Patients

Several studies suggest that out-of-control or poorly controlled is associated with increased vulnerability to and gravity of oral infections.

Diabetic patients have been described as suffering from numerous oral conditions, including cheilitis, dryness and fissures of the oral mucosa, burning of mouth and tongue, decreased salivation, and modifications of the oral microflora, with particular predominance of Candida Albicans, hemolytic streptococci, and staphylococci (14). Decreased salivation is a common oral characteristic of diabetes mellitus and can include symptoms of burning mouth syndrome with concurrent swelling of the parotid gland (24). Dryness of the oral mucosa and the consequent diabetes-related xerostomia can weaken oral tissues, making them more susceptible to damages caused by trauma and more vulnerable to opportunistic infections, like candidiasis (16). Studies on both humans and animals have shown an increased incidence of cavities in diabetic patients, who were poorly managed or not managed at all from a metabolic perspective (25-27). Finally, a link between lichen planus and diabetes has been suggested but not yet totally confirmed, and it is possible that the increased incidence of said lesions among diabetic patients can be attributable to secondary lichenoid reactions to drugs used to treat diabetes (28, 29).

Xerostomia

Polyuria, a frequent symptom among diabetic patients, reduces the quantity of extracellular fluid, thus also determining a decrease in saliva production. This is one of the causes for xerostomia in the oral cavity, a sign and symptom often reported by diabetic patients. This explains how a decrease in saliva can determine a series of oral problems, since essential elements for teeth lubrication and protection are no longer present. In fact, saliva composition includes elements able to control acidity levels in the saliva itself and neutralize bacterial toxins, destroy microorganisms and stop their adherence, thus maintaining the integrity of the teeth and mucosa. Without these factors, the oral cavity becomes more susceptible to the accumulation of plaque and therefore to cavities, bacterial and viral infections, and/or mycoses (30).

4. Diabetes and Periodontal Disease

Diabetes represents a proven risk factor for periodontal disease. Said correlation increases with the age of the patient and with the worsening of systemic conditions; if diabetic patients keep their metabolic levels under control, in time, they are less likely to develop periodontal diseases compared to patients who manage their metabolic values less effectively (31).

Diabetes as Risk Factor

The most apparent issues in poorly controlled diabetes are a weaker immune response and a greater vulnerability to infections that can also lead to destructive periodontal disease.
From a clinical perspective, diabetic patients can suffer from greater loss of attachment (CAL [*Clinical Attachment Level*]), increased bleeding when probing (BOL [*Buccal Occlusal Lingual*]), and greater tooth mobility. It should be noted that these issues are not always present and are not specific or pathognomonic to diabetes and, in any case, they occur with less frequency in patients whose diabetes is well controlled and who have normal tissue response (5).

In addition to genetic predisposition, the increased incidence of periodontal disease in diabetic patients is also linked to vascular modifications and altered collagen metabolism, as well as to reduced cellular proliferation and bone matrix production (10, 30). Individuals with out-of-control diabetes often also suffer from advanced or aggressive chronic periodontal disease, with frequent periodontal abscesses resulting in the rapid deterioration of support tissue.

This is due both to the direct effects of hyperglycemia and the indirect action mediated by certain substances called Irreversible Advanced Glycation End Products (AGEs).Glycation of proteins, lipids, and nucleic acids in diabetic patients results in the accumulation of glycated proteins in small and large blood vessels. These products also form in non-diabetic individuals, but their accumulation is substantially more in diabetic patients.

AGEs have been directly linked to the development of diabetes-related complications, because their accumulation in the tissues tends to significantly alter the microstructural composition of the tissues themselves and therefore compromise the functionality of the periodontium. The continuous accumulation of AGEs in proteins with a long half-life, such as those of the subendothelial nasal membrane, could play an important role in the development of vascular complications associated with diabetes.AGEs-modified collagen, present in blood vessels, creates covalent cross links with low-density lipoproteins and significantly contributes to the onset of arteriosclerosis (31).

The interaction of AGEs with endothelial cells and mononuclear phagocytes impairs cellular characteristics that are potentially significant in the pathogenesis of vascular lesions. For example, culture incubation of AGEs with endothelial cells increases the permeability of said elements, causes tissue factor activation (6), stimulates cell growth, and entails reduced vasodilatory capacity of the epithelium (by inhibiting the release of nitric oxide). Monocytes accumulate right in the sites where AGEs are active (7); in such context, these cells are activated in response to growth factors like PGDF [*Platelet-derived Growth Factor*] (8) and cytokines. Furthermore, given the AGEs' ability to generate free radicals, their tight connection to the cell surface might create real oxidative stress on endothelial cells. Furthermore, it is a well-known fact that certain receptors for the final products of glycation, called RAGEs [*Receptors for Advanced Glycation End Products*], have been isolated and cloned on endothelial cells and monocytes (9). These receptors belong to the immunoglobulin superfamily and are able to transduce signals inside the cells. Hyperglycemia determines an increase in the activity of said receptors and in the interaction between AGEs and RAGEs. The effect on endothelial cells is an increase in vascular permeability and the formation of thrombi (32). In fact the interaction of AGEs with their receptors might generate oxygen radicals and activate the transcription factor NF-kB, thus modulating endothelial physiology and contributing to macroangiopathic complications.

Microbiological Characteristics

It has been hypothesized that the vulnerability of diabetic patients to periodontal pathogenic bacteria is the result of polymorphonuclear leucocyte (PMN) defects, with the consequent effect of weakened chemiotaxis, defective phagocytosis, or compromised adherence.
Diabetes also affects the level of subgingival biofilm. In type 1 diabetes, Capnocytophaga bacteria can reach a much higher percentage (24%), and so can Prevotella Intermedia and Actinobacillus Actinomycetemcomitans, often resulting in aggressive periodontitis. In type 2 diabetes instead, periodontitis becomes more of a chronic condition and in cases that are metabolically poorly controlled, spirochetes can frequently be detected. Chemiotaxis becomes less efficient whereas collagenase activity increases; elevated values of IL-1 [*Interleukin-1*], PGE [*Prostaglandin E2*] and TNF [*Tumor Necrosis Factor*] in the crevicular fluid and high AGEs concentration in tissues can be observed; partly due to less efficient macrophage activity, this results in the activation of a destructive phenotype, which is able to repair wounds to a lesser extent (11).

Bidirectional Relationship Diabetes ↔ Periodontal Disease

Periodontal disease can interfere with the metabolic management of diabetes, thus causing an increase in the need for insulin or oral hypoglycemic drugs and/or a deterioration of metabolic balance in previously stable patients.

Whether with or without loss of teeth, periodontal disease makes chewing difficult and painful, resulting in bad eating habits. Diabetes increases the incidence and severity of periodontal lesions; infections can in turn worsen the metabolism of diabetic patients by creating insulin-resistance (through LPS [*Lipopolysaccharides*] and cytokines), and therefore cause hyperglycemia (18).

Diabetes → Periodontal Disease

The relationship between diabetes and periodontal disease has been extensively investigated. Epidemiologic research clearly shows that diabetes increases the risk and severity of periodontal disease (13, 20, and 37). The increased incidence and severity of periodontal disease in diabetic patients, especially in those with poor metabolic control, has led to define periodontal disease as the "sixth complication of diabetes", in addition to the other five "classic" complications (retinopathy, nephropathy, neuropathy, macrovascular diseases, and more difficult healing of wounds). The American Diabetes Association has officially acknowledged that periodontal disease occurs frequently in diabetic patients and in fact the clinical standards of diabetes include the history of past and present dental infections as part of the medical examination (38).

The most obvious consequences of poorly controlled diabetes are a reduced immune response and an increased vulnerability to those infections that result in destructive periodontal disease. A variety of other conditions have also been described, such as the tendency to develop gingival hyperplasia, sessile or pedunculated gingival polyps, gingival polypoid proliferation, abscesses, and loose teeth.

Gram (-) periodontal infection, increased insulin resistance, worsened glycemic control
Periodontal treatment (reduction of inflammation), improvement of insulin sensitivity, improvement of glycemic control

Table: 3 Potential effects of periodontal infection and periodontal therapy on blood glucose level in diabetic patients

Type 1 Diabetes Mellitus

In type 1diabetes, periodontitis can start when patients are around 12 years old. Incidence of periodontal disease has been observed in 9.8% of cases between 13 and 18 years of age, with an increase to 39% of cases after 19 years of age.

Advanced gum inflammation, deep periodontal pockets, rapid bone loss, and frequent periodontal abscesses often occur in diabetic patients practicing poor oral hygiene.
Children with type 1 diabetes tend to have greater deterioration around the first molars and incisors and are often subject to a rapidly progressive disease (44).

Type 2 Diabetes Mellitus

Around 40% of adults in the Pima tribe of Arizona suffer from type 2 diabetes.
A comparison has been made between diabetes patients and healthy individuals within this Native American tribe; said study showed a higher incidence of periodontitis, with greater loss of clinical and bone adhesion and a higher number of lost teeth, among diabetic patients.

Periodontal Disease → Diabetes

Although numerous studies have examined the effects of diabetes on the oral cavity, a much smaller number of studies have tried to analyze the effects of periodontal infection on diabetes management. The following questions are still open:

- does the presence or severity of periodontal disease affect the metabolic state of diabetic patients?
- does periodontal treatment have a measurable effect on diabetes? In a longitudinal study of type 2 diabetic patients, severe periodontitis has been associated to significant worsening of long-term control of glycaemia (39). The individuals, who suffered from severe periodontitis at the time of the initial exam, developed, in a period of 2-3 years, more significant glycemic level deterioration than the individuals that did not suffer from periodontitis at the time of the initial exam.

Furthermore, adult diabetic patients, suffering from severe periodontitis at the time of the initial exam, showed greater incidence of kidney and macrovascular complications than the adult diabetic patients who only had gingivitis or mild periodontitis (40). This occurred even though glycaemia levels were similarly controlled in both groups. One or more cardiovascular complications occurred in 82% of patients with severe periodontitis, compared to 21% of patients with no severe periodontitis. In these individuals, severe periodontitis preceded the onset of diabetes complications. For patients suffering from periodontitis, periodontal treatment can be beneficial in managing glycaemia levels (41). This is especially true in the case of patients with relatively poor glycemic control and more advanced periodontal deterioration prior to starting treatment (41).

In a study conducted on poorly managed individuals suffering from both type 2 diabetes and severe periodontitis, mechanical non-surgical removal of infected sites combined with a 14-day treatment with systemic doxycycline was compared with a similar mechanical treatment combined with a systemic placebo (42). All groups of patients exhibited a significant improvement of their periodontal condition, with reduced probing depth and bleeding. Those treated with doxycycline enjoyed greater reduction in the incidence of Porphyromonas Gingivalis for a longer period of time. Patients treated with doxycycline also displayed a significant improvement in glycemic control three months after treatment, to then gradually return to the original levels at the time of the initial exam, six months later. The individuals treated with the placebo never showed significant improvement of glycemic control. These studies suggest that the combination of mechanical removal and systemic antibiotic treatment can result in a short-term improvement of glycemic levels in diabetic patients with severe periodontitis and poor metabolic management (44). The reasons why the combination of antibiotics and mechanical treatment brings positive changes in controlling glycaemia levels are still not fully known. Systemic antibiotics can eliminate residual bacteria after scaling and radicular polishing, thus further eliminating bacterial attack on the body. The fact that tetracycline suppresses protein glycation and decreases the activity of tissue-degrading enzymes, such as matrix metalloproteinase, is well known. Said change can contribute to improving metabolic control of diabetes (table III).

5. Diabetic Patient Management in Dentistry

In order to assess diabetic patients in the best possible way, dentists must be aware of all oral and general diabetes symptoms and signs that their patients might experience. It is therefore necessary to conduct a full medical history assessment, including the type of diabetes, age at onset, duration of the disease, previous diabetic complications, medications, and manner of administration. Dentists must be fully aware of patients' compliance with managing this systemic disease and must also clearly understand the assessment methods used for metabolic control, making sure to record all most recent lab results and possibly contacting a diabetes specialist if necessary (33).

It might be useful for dentists to have the means to monitor glycaemia in their office, by using a small device that collects a few drops of blood from the patient's finger and places them on a paper strip with special reactants that allow an immediate reading of the patient's glycaemia levels. If the value exceeds 140 ml/dl, a diabetes specialist should be contacted prior to perform the scheduled dental procedure. Sessions with this type of patients should be short and as atraumatic as possible, while trying to reduce any stress component.

No medications should be stopped during dental treatment and the diet prescribed by the doctor should be continued, as well as the monitoring of glycaemia levels. It is advisable to schedule sessions in the morning because endogenous corticosteroid levels tend to be higher. The patient should not arrive on an empty stomach, but should eat as normal. In the majority of cases, the treatment of patients with well-managed type 1 or 2 diabetes is comparable from a periodontal perspective to the treatment of systemically healthy patients.

A dental and periodontal visit is obviously the foundation of a correct diagnosis and adequate treatment plan.
Ordinary dental treatments and small periodontal surgical procedures under local anesthesia can be performed without any particular precautions, still keeping into account possible dietary interferences. The small adrenaline dose contained in the anesthetic vial rarely increases plasma glucose levels. In order to prevent hypoglycemic episodes, it is preferable to schedule appointments first thing in the morning, after having breakfast and after taking the prescribed medications. Ideal glycaemia values should be between 120 and 180 mg/dl.

Imbalanced Diabetic Patients

Patients with uncontrolled or poorly controlled diabetes should not undergo any periodontal treatment until their systemic condition has been stabilized.

In these cases in fact, diabetes might compromise treatment results, given the patient's diminished immune response and longer healing time for wounds. In the event of emergency dental treatments, a preventive antibiotic cycle must be administered in order to minimize the occurrence of post-op infections.

Diabetic Patients Treated Only with Diet

These patients are usually elderly and obese, with little tendency to ketosis; if properly managed, many of them can well tolerate minor surgical procedures, such as single extractions under local anesthesia. A brief session under general anesthesia can also be scheduled with no particular precautions, while still monitoring glucose levels in the urine prior to the procedure and every two hours during post-op recovery. These patients should undergo general anesthesia in a hospital setting, so that in case of an onset of ketonuria, plasma glucose levels can be quickly assessed.

Not all of these types of patients can be well managed and in some cases, they need to be hospitalized prior to the procedure for a pre-op assessment and possible insulin administration to stabilize their condition. Plasma glucose levels must be monitored before and after the procedure.

Diabetic Patients Treated With Diet and Hypoglycemic Oral Drugs

Among available hypoglycemic drugs, sulfonylureas are recommended for patients who still retain residual cell functionality and therefore who have type 2 diabetes (34); on the other hand, these drugs induce insulin production and therefore can cause hypoglycemia (35).
In order to avoid said complications, non-sulfonylureas drugs (metformin, troglitazone) have been introduced and can be used alone or in connection with other hypoglycemic drugs or with insulin.
Diabetics treated with oral hypoglycemic drugs can tolerate minor procedures with local anesthesia. Well controlled patients can undergo short surgical procedures under general anesthesia in a hospital setting, without having to resort to insulin, but monitoring plasma glucose levels every two hours.
If instead the diabetes is poorly controlled, if the patient has to take high doses of hypoglycemic drugs, or if the surgical procedure is particularly challenging, the ideal protocol includes the following:

1) Chlorpropamide must be stopped at least three days, or even better one week, before the procedure, due to its long-lasting effect, and replaced with tolbutamide or glyburide; replacing oral hypoglycemic drugs with insulin administered three times a day would be even safer;

2) Metformin must be stopped at least two days before the procedure, since it increases the chances of developing lactic acidosis;
3) Hospitalization should include a two-day assessment before the procedure;
4) Between 8:00 and 9:00 AM on the morning of the procedure, plasma glucose levels should be assessed and from that moment on, the patient should maintain a readily accesible vein so that his/her blood levels can be quickly adjusted with glucose or insulin, if needed.

Diabetic Patients Treated with Insulin

Insulin is used as the primary drug for type 1 diabetes and as replacement treatment for type 2 diabetes resistant to diet and oral hypoglycemic drugs (47).

Insulins are classified by the timing of their action and are divided into fast-acting, intermediate-acting, and long-acting; each category has an onset, a peak, and duration, and injections are scheduled to have the maximum plasma levels coincide with post-prandial glucose peaks.

Clinicians should know the characteristics of each medication and periodontal treatment should be performed in a way to avoid insulin peaks and any possible hypoglycemic episodes (36).

If the patient's diabetes is under control, minor periodontal surgical procedures can be normally scheduled and performed with local anesthesia, without any modification to the course of treatment. As a precaution, a normal diet should be allowed after the surgical procedure, which should normally be performed two hours after breakfast and after the first insulin injection. In well managed patients, more challenging surgical procedures can be performed under general anesthesia, making sure to postpone food intake and insulin administration to after the procedure.

More complex procedures, such as the insertion of multiple implants must be performed in a hospital setting and the following precautions must be followed:
1) The patient must be hospitalized prior to the surgical procedure in order to be assessed;
2) Prior to the procedure, the patient must undergo a new fast-acting insulin treatment. Insulin can be administered two or three times a day and the situation must be monitored and assessed by testing plasma glucose levels (on an empty stomach, at noon, and before dinner);
3) The procedure must be performed early in the morning so that any surgical complications that might arise are not going to excessively delay insulin administration and therefore management of the disease;
4) Between 8:00 and 9:00 AM on the day of the procedure, plasma glucose levels must be assessed; afterwards, the patient must receive an infusion with a 10% glucose solution containing two units of insulin and two mmol/l of potassium, until a normal diet can be resumed; at that point, the insulin regiment used prior to the procedure will be resumed;
5) Plasma glucose levels must be monitored every 3-4 hours until a normal diet can be resumed.

5.1 Surgical Procedures

A few additional observations should be made in regard to the treatment and care required by diabetic patients undergoing more complex surgical procedures. Periodontal surgical procedures can be performed only if the patient is able to sustain a normal diet during the post-op recovery using, if necessary, dietary supplements. In some cases, the daily intermediate doses of insulin are omitted, making sure that the patient receives an intravenous glucose infusion and that glucose levels, constantly monitored, are used to determine the need for any additional insulin doses.
The precautions that need to be taken during an oral surgery performed on a diabetic patient are based on the following:

- the type and severity of diabetes and the complications linked to sympathetic neuropathy (with risk of hypotension episodes and cardiac arrest);
- type of anesthetic used;
- type and degree of interference with the patient's dietary habits.

5.2 Periodontal Maintenance Treatment

The majority of patients suffering from periodontitis can be monitored by effective and efficient primary prevention and adequate periodontal maintenance treatment. However, for some patients, treatment is not effective. For these patients, periodontal disease progression can only be slowed. The preferable type of treatment for this type of patients is initially nonsurgical, consisting of scaling and/or root planning, and subsequently it entails a maintenance plan with follow-up sessions no more than every 2-3 months.
In diabetic patients, the probing depth and inflammatory index tend to evolve faster: this is why risk factors, such as smoking, alcohol, and caffeinated drinks should be avoided (19).
The education of diabetic patients to plaque control is essential, because these individuals are often subject to modifications of the oral microflora that can favor the development of the potentially most pathogenic bacteria (22).

6. Implant Treatment in Diabetic Patients

The use of implants in diabetic patients remains controversial to this day (43). In fact, there are no guidelines regarding the type of diabetes, the age at onset, long-term control levels (HgA1c), and often the only diagnostic and therapeutic parameters are based on subjective clinical judgements.

On the other hand, the use of implants in patients with well controlled diabetes has been abundantly documented. The main bone changes observed in poorly controlled diabetic patients are as follows: inhibition of collagen matrix formation, protein synthesis modifications, increase of materialization lag time of the osteoid matrix, reduction of the number of osteoblasts and osteoclasts with related decrease of bone turnover and of osteocalcin production (46). An interesting study conducted on this subject is absolutely worth mentioning (43).

The purpose of said study was to evaluate the success and survival rates of dental implants in diabetic patients. As part of this retrospective analysis, 215 implants installed on 40 patients in two different clinics have been assessed. Medical and implant data have been collected by reexamining medical charts and conducting interviews. The analysis showed that there had been 31 failed cases, for a total success percentage of 85.6%. Of the failed cases, 24 took place within the first year of functional loading. The average functional loading time was 4.05 ± 2.6 years. The analysis of the success rate based on the position of the implant showed an 85.5% success for the maxilla and an 85.7% success for the mandible. For the anterior and posterior regions, the success percentage was 83.5% and 85.6% respectively. The analysis of the implant survival chart showed an 85.7% overall success after 6.5 years of use. Based on this data, the survival rate of dental implants in patients whose diabetes is well controlled is less than the one documented for the general population, but it is still a reasonable success rate.

The increase in survival rate takes place in the first year after implant loading. Diabetic patients who undergo implant treatment are not subject to a higher failure rate than the normal population if their plasma glucose levels are under control and within normal parameters.

7. Management of Medical Emergencies

Emergency situations, when glycaemia levels are extremely low, cause an insulin imbalance. This hypoglycemic state must be addressed promptly in order to avoid progressive worsening of the patient's condition that can ultimately result in a coma.

Symptoms of hypoglycemia are pallor, sweating, tachycardia, sensation of hunger, headache, difficulty concentrating, nervousness, fatigue, vertigo, blurred vision, mental confusion, and abdominal pain. One or more of these symptoms are enough to suspect a hypoglycemic episode. In this case, the patient should be administered sugar cubes, or two teaspoons of tea, or fruit juice and then wait 5-10 minutes; if the situation does not improve, the treatment should be repeated. If hypoglycemia caused a loss of consciousness or convulsions, a sugar cube should be placed between the teeth and cheek of the patient, avoiding liquids for risk of chocking. If after 5-10 minutes from the second treatment, there is still no improvement, a glucagon injection should be administered, if available, or the patient should be transported to the nearest hospital (21).

Hyperosmolar coma is normally a complication of type 2 diabetes mellitus and is the result of severe dehydration caused by prolonged hyperglycemia-related osmotic diuresis and no replenishing of lost fluids. Symptoms are epileptic seizures, infections, and thrombotic complications due to increased blood viscosity. In this case, the patient should be immediately hospitalized.

Conclusions

There is substantial evidence demonstrating the fact that diabetes, associated with poorly controlled glycaemia, represents a significant risk factor for the onset of periodontitis in a bi-directional manner. Complications associated with diabetes are substantial for the affected individuals. Periodontal disease, cavities, and loss of teeth are common consequences.

Given the frequency of oral complications in diabetic patients, dentists are often among the first specialists to deal with a disease not yet diagnosed or well controlled. Therefore, given the high incidence of diabetes mellitus in people, dentists must be familiar with the different problems associated with dental treatment of diabetic patients and with ways to confront possible emergencies. The majority of patients with well controlled diabetes are good candidates for complete periodontal treatment, even though the possible onset of medical complications associated with diabetes should be carefully evaluated. If diabetes is not well controlled, a diabetes specialist should be consulted in order to schedule the surgical procedure while maintaining the best metabolic control possible. Once diabetes is diagnosed, it is important to make patients understand the importance of implementing good preventive oral hygiene and to have them follow a regiment of frequent check-ups by their regular dentists, with appropriate periodontal treatment and periodic follow-ups.

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