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Review Article

Impact of Diabetes Mellitus in Oral and Maxillofacial Surgery: A Guide to Diagnose and Management

Jyoti Chopra*

Maharishi Markandeshwar College of Dental Sciences and Research, Maharishi Markandeshwar University, Mullana, Haryana, India

***Corresponding Author**: Jyoti Chopra, Maharishi Markandeshwar College of Dental Sciences and Research, Maharishi Markandeshwar University, Mullana, Haryana, India.

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Abstract

Few of the worse consequences of Diabetes are associated with an increased necessity of medical attention, particularly surgical procedures that too with high mortality and morbidity postoperatively. Peri-operative ketoacidosis or hyperosmolar syndrome can occur due to osmotic dieresis, hyperglycemia and hypoinsulinemia which are the consequences of stress response to surgery. Also, hyperglycemia can lead to impaired wound healing and leukocyte function. The overall goal of management remains around the optimization of metabolic control by any way through close monitoring, adequate caloric and fluid repletion with/without judicious use of insulin. It is very critical to manage glycemic levels in perioperative phase, more specifically in diabetic patients. Anaesthesia and surgical stress effect blood glucose levels uniquely and that should be considered while maintaining glycemia at optimum level. Severity and duration of surgery comes with unique challenges in optimising glucose levels at adequate level. Also, special operative conditions have been discussed that may require particular glycemia management protocols. But, in literature, there is no consensus or strategy for the management of perioperative glycemia in diabetic patients. The aim of this study to outline the most significant factors that is required in the formulation of perioperative glycemic control regimen. Although data collected from recent outcomes are not sufficient, but there is a hope from advances in anaesthesiology, surgical sciences and intensive/ critical care medicine so that it may improve the perioperative condition of diabetic patients in present or in future.

Keywords: *Diabetes Mellitus; Oral and Maxillofacial Surgery; Glycemic Control*

Introduction and Background

Diabetes mellitus (DM) refers to a group of common metabolic disorders contributing to hyperglycemia, due to reduced insulin secretion, decreased glucose utilization, or increased glucose production [1]. It is classified on the basis of the pathophysiology into two broad categories of DM as type 1 and type 2. Other aetiologies for DM include specific genetic defects in insulin secretion or action, metabolic abnormalities that impair insulin secretion, and conditions that impair glucose tolerance, such as pancreatic exocrine disease, endocrinopathies such as acromegaly and Cushing's disease, viral infections [1]. Polyuria, a common clinical finding, is secondary to hyperglycemia and glycosuria [2]. Other disturbances include retinopathy, cataract formation, or glaucoma, systolic or diastolic hypertension, or both and neuropathy [2].

Diagnostic modalities for diabetic patients include urine glucose testing, glycosylated haemoglobin (Haemoglobin A1C), home capillary glucose monitoring [2]. Diet remains the cornerstone in the management of diabetes mellitus. Oral hypoglycaemic agents have been available for the treatment of patients with type 2 diabetes. Insulin is available in three species types (human, beef, and pork) and is classified according to its duration of action and absorption characteristics. Surgery elicits a response of stress-adaptive hormones, which elevates plasma glucose and decreases tissue sensitivity to insulin [2]. Therefore, preoperative management of diabetic patient should be directed toward glycemia monitoring and avoiding hypoglycaemia [2].

In moderate surgical procedures, requiring intravenous sedation or ambulatory general anesthesia, the oral antihyperglycemic-controlled patient should discontinue oral hypoglycaemic therapy the day before surgery [3]. Fasting plasma glucose concentrations should be lower than 140 mg/dL. Intraoperative fluids should consist of 5% dextrose in normal saline. The diet-controlled diabetic requires no specific management considerations [2].

Diabetic patients may require emergency surgery over their lifetime [3]. Initial evaluation must include a thorough medical history and physical examination. And immediately, secure the intravenous access and assessment of glucose level as well as blood electrolytes should be done. Blood glucose should be monitored hourly, and insulin, glucose, and potassium infusion should be administered [4,5].

Therapeutic surgery is a frequent requirement for diabetic patients and in the past has been associated with increased morbidity and mortality [3]. Clinicians are encouraged to continue to give careful attention to metabolic control in surgical patients with diabetes [3].

Stephenson E, Haug R, Murphy T in 1995 reviewed about the management of the diabetic oral and maxillofacial surgery patient and observed that Diabetes Mellitus is a complex syndrome of disordered metabolism and elevated blood glucose [2]. It results from an absolute deficiency of insulin secretion (type I), or a combination of insulin resistance and inadequate insulin secretion (type II). The etiology is not completely understood, but heredity plays an important role in both types of diabetes. The oral and maxillofacial surgeon will frequently be required to treat patients with this disease. This review describes the pathophysiology, classification, clinical symptoms, diagnostic modalities, treatment regimens, and medical management considerations for the oral and maxillofacial surgery patient with diabetes mellitus.

Gabir M., *et al.* 2000 reviewed the World Health Organization criteria for hyperglycemia in the diagnosis and prediction of diabetes and concluded that the prevalence and incidence of diabetes are somewhat lower with the ADA criteria than with the 1985 or 1999 WHO criteria [6]. The intermediate categories of glycaemia differ substantially. IFG defines a smaller number of people who are at higher risk of developing diabetes than those with IGT. More people at high risk of diabetes could be identified by using either IFG or IGT, as recommended by the 1999 WHO criteria, or by using the FPG concentration alone, but with a lower cut-off value.

Ata A., *et al.* in 2010 studied postoperative surgical site infection (SSI) with Postoperative hyperglycemia as an independent causing factor and concluded that postoperative hyperglycemia may be the most important risk factor for SSI. Aggressive early postoperative glycemic control should reduce the incidence of SSI [7].

Pathophysiology

Type 1 diabetes mellitus

Although other islet cell types [alpha cells (glucagon-producing), delta cells (somatostatin-producing), or PP cells (pancreatic polypeptide-producing)] are functionally and embryologically similar to beta cells and express most of the same proteins as beta cells, they are spared from the autoimmune destruction. On pathology backgrounds, there is lymphocytic infiltration in the pancreatic islets (or

insulitis) [7]. when all beta cells are destroyed, there is progressive slow in the inflammatory process, the islets of pancreas becomes atrophic sequentially, and at most, immunological markers disappear. Pathologically, the pancreatic islets are infiltrated with lymphocytes (a process termed insulitis) [7]. After all beta cells are destroyed, the inflammatory process abates, the islets become atrophic, and most immunologic markers disappear. Although, the exact mechanisms are not known for the death of beta cells, but it is believed that it may comprise of nitric oxide metabolites formation, direct CD8+ T cell cytotoxicity [8].

Type 2 diabetes mellitus

Insulin resistance, impaired insulin secretion, excessive hepatic glucose production and sometimes, abnormal fat metabolism are the main components of Type 2 Diabetes Mellitus. Despite of insulin resistance during the initial phases of disorder, glucose tolerance remains at the near-normal range as the pancreatic beta cells have tendency to compensate the above by increasing insulin production. But with the progress of compensatory hyperinsulinemia and insulin resistance, there is inability to sustain the required hyperinsulinemic state by pancreatic islets in certain patients. There develops a stage, Insulin Glucose Tolerance which is characterised by postprandial glucose elevations. It is this time, when if there is further decline in the secretion of insulin and an elevation in the production of hepatic glucose can lead to overt diabetic stage with fasting hyperglycemia. Finally, at end, failure of beta cells occur [7].

Clinical Findings

Polyuria, a common clinical finding, is secondary to hyperglycemia and glycosuria. The increased urine osmolarity induces an osmotic diuresis. This occurs at the patient's renal glucose threshold of approximately 180 to 250 ml/dL. Obligatory water loss combined with hyperosmolarity tends to deplete intracellular water and stimulate osmoreceptors in the brain's thirst center, which manifests as polydipsia [2].

Visual disturbances in diabetics may take the form of retinopathy, cataract formation, or glaucoma. Blindness is 10 times more common in the diabetic population than in the nondiabetic population. Retinopathy is the most common form of disturbance and is divided into two categories: background and proliferative. Clinically, background retinopathy produces retinal haemorrhages, retinal exudates, edema, venous dilations, microaneurysms, and thickening of retinal capillaries (microangiopathy). In proliferative retinopathy, neovascularization is the hallmark clinical finding. Proliferative retinopathy is more likely to produce blindness; 25% of diabetics with proliferative changes are blind [9].

Hypertension is well documented to be increased in diabetics compared with nondiabetics. The risk of cardiovascular death in a diabetic person is roughly doubled by the coexistence of hypertension. Patients may have manifestations of systolic or diastolic hypertension, or both [2].

Neuropathy may be the presenting symptom of diabetes mellitus, and is generally seen in poorly controlled diabetics. Peripheral neuropathy results in decreased conduction velocity of nerve impulses, lower extremities involved commonly. It sometimes affects motor function, but most often affects sensory nerves. Clinically, this results in a "stocking-glove" distribution of numbness and paraesthesia, Cutaneous manifestations of diabetes include skin infections, xanthoma diabeticorum, and necrobiosis lipoidica diabeticorum. Clinically, xanthoma appears as firm, nontender, yellowish nodules that contain lipid filled macrophages. Necrobiosis lipoidica diabeticorum manifests as a focal necrotic area within the dermis and subcutaneous tissues anywhere on the body. Dermatologic infections are the most common of the cutaneous manifestations [10].

Acute complications of diabetes mellitus

Diabetic ketoacidosis (DKA) and hyperglycaemic hyperosmolar state (HHS) are acute complications of diabetes. DKA was formerly considered a hallmark of type 1 DM, but also occurs in individuals who lack immunologic features of type 1 DM and who can sometimes subsequently be treated with oral glucose-lowering agents. The initial management of DKA is similar. HHS is primarily seen in individuals with type 2 DM. Both disorders are associated with absolute or relative insulin deficiency, volume depletion, and acid-base abnormalities. DKA and HHS exist along a continuum of hyperglycemia, with or without ketosis [11].

Chronic complications of diabetes mellitus

Chronic stage of the disease affects multiple organs and is primarily responsible for morbidity and mortality of the patients suffering from the disease. These complications have been divided into vascular and nonvascular types. Further, these vascular complications are subdivided into microvascular and macrovascular components. Microvascular complications include retinopathy, neuropathy and nephropathy and on the other side, coronary heart disease, peripheral arterial disease, cerebrovaular disease are major macrovascular complications [9].

Management of diabetes (Principles of treatment)

Overall Principles

The goals of therapy for type 1 or type 2 DM are to (1) eliminate symptoms related to hyperglycemia, (2) reduce or eliminate the long-term microvascular and macrovascular complications of DM, and (3) allow the patient to achieve as normal a lifestyle as possible. To reach these goals, the physician should identify a target level of glycemic control for each patient, provide the patient with the educational and pharmacologic resources necessary to reach this level, and monitor/treat DM-related complications. Symptoms of diabetes usually resolve when the plasma glucose is < 11.1 mmol/L (200 mg/dL) and thus most DM treatment focuses on achieving the second and third goals [1,7,10].

The care of an individual with either type 1 or type 2 DM requires a multidisciplinary team. Central to the success of this team are the patient's participation, input, and enthusiasm, all of which are essential for optimal diabetes management. Members of the health care team include the primary care provider and/or the endocrinologist or diabetologist, a certified diabetes educator, and a nutritionist. In addition, when the complications of DM arise, subspecialists (including neurologists, nephrologists, vascular surgeons, cardiologists, ophthalmologists, and podiatrists) with experience in DM-related complications are essential [1,7,10].

Management of surgical patient

Medical Management of the Surgical Patient

Surgery elicits a response of stress-adaptive hormones (catecholamines, cortisol, growth hormone, and glucagon), which elevates plasma glucose and decreases tissue sensitivity to insulin. Therefore, preoperative management of the diabetic patient should be directed toward euglycemia and avoiding hypoglycemia. Accurate physical assessment of complications related to diabetes is necessary preoperatively. Increased mortality and morbidity in diabetics undergoing surgery are related mainly to cardiovascular complications, infection, and reduced rates of wound healing. Due to these consequences, after any minor surgery, any diabetic patient usually experiences 30 - 50% more time of hospitalization than non-diabetic patient. Adept management for this group of patients by the oral and maxillofacial surgeon is as important as the development of an effective liaison between the primary care physician and anesthesiologist [2,11].

Management in the Hospitalized Patient

Virtually all medical and surgical subspecialties are involved in the care of hospitalized patients with diabetes. Hyperglycemia, whether in a patient with known diabetes or in someone without known diabetes, appears to be a predictor of poor outcome in hospitalized patients. General anesthesia, surgery, infection, or concurrent illness raises the levels of counter regulatory hormones (cortisol, growth hormone, catecholamines, and glucagon) and cytokines that may lead to transient insulin resistance and hyperglycemia. These factors increase insulin requirements by increasing glucose production and impairing glucose utilization and thus may worsen glycemic control. The concurrent illness or surgical procedure may lead to variable insulin absorption and also prevent the patient with DM from eating normally and, thus, may promote hypoglycemia. Glycemic control should be assessed on admission using the A1C. Electrolytes, renal function, and intravascular volume status should be assessed as well. The high prevalence of cardiovascular disease in individuals with DM (especially in type 2 DM) may require preoperative cardiovascular evaluation [1,10].

The goals of diabetes management during hospitalization are near-normoglycemia, avoidance of hypoglycemia, and transition back to the outpatient diabetes treatment regimen. Glycemic control appears to improve the clinical outcomes in a variety of settings, but optimal glycemic goals for the hospitalized patient are incompletely defined. In a number of cross-sectional studies of patients with diabetes, a greater degree of hyperglycemia was associated with worse cardiac, neurologic, and infectious outcomes. In some studies, patients who do not have pre-existing diabetes but who develop modest blood glucose elevations during their hospitalization appear to benefit from achieving near-normoglycemia using insulin treatment. However, a large randomized clinical trial (NICE-SUGAR) of individuals in the intensive care unit (most of whom were receiving mechanical ventilation) found an increased mortality rate and a greater number of episodes of severe hypoglycemia with very strict glycemic control [target BG of 4.5 - 6 mmol/L or 81 - 108 mg/dL] compared to individuals with a more moderate glycemic goal (mean blood glucose of 8 mmol/L or 144 mg/dL). As per the current literature, most of the data demonstrates that strict glycemia control in severely ill patients has more tendency to worsen the outcomes and hypoglycaemic episodes frequently [7,11].

Management approaches

As per general rule, each type 1 DM patient undergoing major or minor surgery and type 2 DM patient undergoing major surgery is considered as appropriate candidates for perioperative diabetes management intensively. Inclusion of insulin therapy with combination of dextrose and potassium infusion is mandatory. Rest, type 2 DM patients who are undergoing minor surgery are classically managed through their usual diabetes regimen, their glycemic control nature and severity of surgery and/or expertise availability [1,4,9,11].

Management with Diet only

Those patients who have well controlled diabetes status through diet modification regimen and physical activity are exempted from any special pre- or peri-operative intervention. If the duration of surgery is > 1 hour, then FBS (Fasting Blood Glucose) should be measured on the same morning g of the surgery and intraoperative monitoring of blood glucose level is desirable. If either diabetes is poorly controlled or surgery is major one, an intravenous dextrose or insulin infusion should be considered and intraoperative glucose monitoring every hourly is recommended [3,7].

Management with oral antidiabetic agents

As per evident literature, 2nd generation sulfonylureas should be stopped day prior to surgery except chlorpropamide that should be discontinued 2 - 3 days prior to surgery. There is no harm in continuation of other oral agents till the surgery. As metformin has half-life of approximate 6 hours, it is safe to withhold the therapy temporarily from -2 days prior to operative day and that too especially in severely ill patients and in patients undergoing surgical procedures that has tendency to increase the risk level tissue hypoxia, lactate accumulation and renal hypoperfusion [3,10].

As a general rule, there should be monitoring of blood glucose level in all the patients prior to and immediately after surgery. And there should be hourly glucose monitoring in those patients who are planned for extensive surgical procedures, even bedside capillary glucometer is adequate. However, in the cases of extremely low or high values, investigations should be repeated to rule out false results and specimen should also be sent for laboratory corroboration [10,11].

Emergency management of diabetic patients

Emergency Surgery

Approximately 5% of people with diabetes will require emergency surgery over their lifetime. The commonly performed surgeries include such as extraction, abscess drainage, ulcer care. Particular measures should be taken to rule out DKA and other similar conditions that can be mistakenly taken as surgical emergencies as many patients with DKA and dominant abdominal symptoms have experienced intensive surgical procedures for an absent acute abdominal emergency. So, a diabetic patient with a suspected emergency should undergo a thorough medical history with complete physical examination avoiding all mentioned diagnostic pitfalls [3].

Conclusion

Therapeutic surgical management in the diabetic patients have tendency to come up with the worse consequences of Diabetes and that are associated with an increased necessity of medical attention, particularly surgical procedures that too with high mortality and morbidity postoperatively. Although data collected from recent outcomes are not sufficient, but there is a hope from advances in anaesthesiology, surgical sciences and intensive/critical care medicine so that it may improve the perioperative condition of diabetic patients in present or in future. It will come up with the joint effect from increased awareness and appropriate medical intervention at right time that may provide improved perioperative fate of diabetic patients.

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