



Acute cardiovascular complications in patients with diabetes and hypertension: management consideration for minor oral surgery

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Objectives: Medically compromised patients often fear required dental surgical procedures that can increase the risk of medical emergency when combined with reduced tolerance for stress. A stress reduction protocol (SRP) helps doctors minimize treatment-related stress and improves patient management with minimum complications. Diabetes and co-morbid hypertension carry 4-fold risk of aggravation of cardiovascular emergencies and 7.2-fold risk of mortality. Diabetic neuropathy can result in difficult diagnosis of myocardial infarction and reduces chances of surviving a myocardial infarction compared with a non-diabetic person. The aim of the study was to assess the feasibility of a protocol for management of patients having both diabetes and hypertension who required minor oral surgery to minimize the rate of cardiovascular emergencies.

Materials and Methods: A prospective study was conducted in 140 patients having both diabetes and hypertension who required minor oral surgical procedures. A systematic approachable protocol was designed for management of such patients.

Results: Among 140 patients, 6 patients (4.3%) had cardiovascular complications, while 3 patients (1 with syncope and 2 with hypertension) did not require any intervention other than observation. Two patients were managed with aspirin and nitroglycerin, and 1 patient had possible myocardial infarction (overall incidence 0.7%) with chest pain, S-T segment elevation on electrocardiogram, and troponin level of 0.60 ng/mL.

Conclusion: The proposed protocol helps to improve management of patients having both diabetes and hypertension. We recommend that patients with uncontrolled diabetes and uncontrolled hypertension and/or patients having history of cardiovascular complication should be treated in a medical facility with a readily available cardiology unit. This facilitates prompt response to emergency and instant implementation of treatment, helping to reduce morbidity and mortality.

Key words: Diabetes, Hypertension, Cardiovascular complications, Oral surgery

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I. Introduction

Medically compromised patients often fear dental treatment, particularly that involving a surgical procedure that can increase the risk of a medical emergency when combined with their reduced tolerance for stress. A stress reduction protocol (SRP) helps doctors minimize treatment-related

stress and improves patient management in both fearful and medically compromised patients, with minimum complications¹. The most commonly followed SRP in dentistry is that described by McCarthy².

Diabetes mellitus (DM) alone tends to have high risk for cardiovascular emergency due to accelerated and more extensive coronary atherosclerotic lesion compared with non-diabetic patients³. A meta-analysis of 102 prospective studies showed that DM confers two-fold higher risk for coronary heart disease, major stroke, and death⁴.

The risk of cardiovascular disease is higher when patients also have hypertension (HPTN), with an approximately 4 times higher risk than nondiabetic and non-hypertensive patients^{3,5}. In follow-up studies, diabetic patients without prior myocardial infarction (MI) have similar risk for fatal coronary heart disease to nondiabetic patients with prior MI. The Framingham cohort study showed that much of this excess

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risk is attributable to coexistent HPTN in diabetic individuals⁶. Diabetes with blood pressure acts as a double-edged sword, and presence of HPTN is responsible for a 7.2-fold increase in mortality in patients with diabetes^{7,8}.

Therefore, diabetic patients with concomitant HPTN carry a high risk of aggravation of emergencies like angina, rise in blood pressure, and MI either during a procedure in the dental office or postoperatively at home. This risk demands additional close observation compared to a patient with diabetes or HPTN alone. Moreover, when an emergency occurs in the dental office, medical service is required, and this carries a risk of delay in treatment. Under such conditions, prompt diagnosis and immediate treatment are mandatory, especially when a patient is medically compromised. The goal of such an operation is prevention, identification, and immediate implementation of treatment of cardiovascular complication to reduce morbidity and mortality. Dentists are in a dilemma whether to operate on such patients or to refer the patients to a higher care centre where an intensive care unit is available.

The aim of the study was to establish a separate protocol for management of patients having both DM and HPTN who required minor oral surgery to minimize rates of cardiovascular emergencies and complications. The protocol comprises a combination of various protocols for DM and HPTN and the individual experience of senior oral and maxillofacial surgeons.

II. Materials and Methods

A prospective study was carried out from June 2013 to June 2017 at Aurangabad, Maharashtra, India, involving 140 patients diagnosed with both DM and HPTN who required minor oral surgical procedures including extraction of multiple teeth, removal of impacted tooth, drainage of maxillofacial abscesses, alveoloplasty, and placement of one or two implants. A protocol was established for management of such patients based on modification of previous studies.

The following three-step protocol was implemented for management of patients with diabetes and HPTN requiring minor oral surgery.

Step 1: Categorization of patient. This simplifies understanding of risk and reclassifying patients per American Society of Anesthesiologist (ASA) physical status. (Tables 1, 2) Categorization also assists in deciding whether a procedure can safely be performed in an isolated dental clinic or requires admission to a hospital with an intensive care unit.

We hypothesise that patients with both uncontrolled diabetes and HPTN and patients with history of any cardiovascular complications irrespective of blood sugar level and blood pressure should be hospitalized where dental and intensive care units are available. The presence of an expert intensivist to treat cardiovascular complication facilitates better and early management of patients. Admitted patients were observed for 24 hours after surgery to minimize post-complication morbidity and mortality.

Step 2: Follow the general guidelines of the protocol. General guidelines to be followed:

- 1) Preoperative
 - Perform medical consultation
 - Laboratory investigation
 - Complete blood count
 - Bleeding time: should not be more than 18 seconds.
 - Prothrombin time and international normalized ratio (INR): should be within a range of 2.5 to 3.5.
 - Blood glucose level: recommended blood sugar level should be equal to or less than 200 mg/dL.
 - Consider use of prophylactic antibiotics for elective procedures and therapeutic antibiotics for infections.
 - Early morning appointments
 - Consider use of tranquilizers one day before and/or 2 hours prior to the procedure.
 - Explain the procedure, its outcomes, probable complications, and management.

Table 1. Recommended American Society of Anaesthesiologists (ASA) physical status classification of patient having both diabetes mellitus (DM) and hypertension (HPTN)

Group	Category of patient	ASA physical status classification	Recommended ASA physical status
Group 1.1	Patients with both controlled DM and HPTN	ASA-2	ASA-3
Group 1.2	Patients with controlled HPTN but uncontrolled DM	ASA-3	ASA-3
Group 1.3	Patients with controlled DM but uncontrolled HPTN (stage-II)	ASA-3	ASA-4
Group 1.4	Patients with both uncontrolled DM and HPTN	ASA-3	ASA-4
Group 2	Patients with history of cardiovascular complications attributable to DM and HPTN	ASA-4	ASA-4

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Table 2. Criteria for categorization of patients with both diabetes mellitus (DM) and hypertension (HPTN) and specific instructions to follow during a minor oral surgical procedure

Group	Description	Criteria	Specific instructions for each group in addition to a general protocol ¹
Group 1	1. Patients with both controlled DM and HPTN	BSL <200 mg/dL, BP <120/80 mmHg	- Procedure can be performed in a dental clinic.
	2. Patients with controlled HPTN but uncontrolled DM	BSL >200 mg/dL, BP up to 159/99 mmHg	- Procedure can be performed in a dental clinic. - Elective procedures should be postponed until control of sugar level. - Emergency procedures can be performed with physician consent (physicians may alter the dosage of oral hypoglycaemic agent or insulin).
	3. Patients with controlled DM but uncontrolled HPTN	BSL <200 mg/dL, BP >159/99 mmHg ¹	- Procedure can be performed in a dental clinic. - Elective procedures should be postponed until control of blood pressure below 159/99 mmHg. - Emergency procedures can be performed under hospitalization and supervision of an intensivist.
	4. Patients with both uncontrolled DM and HPTN	BSL >200 mg/dL, BP >159/99 mmHg	- Hospitalize the patient and perform the procedure under supervision of an intensivist.
Group 2	Patients with history of cardiovascular complications attributable to DM and HPTN	Complications such as myocardial infarction, cerebrovascular stroke within last 6 months or earlier and patients with compromised cardiac function like left ventricular failure, fibrillation, congestive cardiac failure irrespective of their status of controlled BP and sugar level	- Hospitalize the patient and perform the procedure under supervision of an intensivist. - Use of antiplatelets like aspirin or clopidogrel or both does not need to be stopped. - Use of heparin must be stopped six hours before surgery and can be reinstated after surgery. - In case patient is under oral anticoagulants therapy like warfarin, surgical procedure can be performed safely if international normalised ratio is within the range of 2 to 3.5. - Use of a local haemostatic agent like ethamsylate, botropause, abgel, pressure pack, or tight sutures must be considered.

(BSL: blood sugar level, BP: blood pressure)

¹Specific instructions for each group are further described in detail in the Discussion section.

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2) Intraoperative guidelines

- Monitor and record vital signs, e.g., pulse rate, blood pressure, respiratory rate
- Cautious use of local anaesthetic with adrenaline (preferably 1:180,000 or 1:200,000)
- Adequate pain control
- Consider use of local haemostatic agents like sutures, pressure pack, absorbable gel, and gelatine sponges.
- Length of procedure must not exceed more than 45 minutes.

3) Postoperative

- Monitor and record vital signs
- Explain proper postoperative instructions to patient and accompanying person.
- Explain potential postoperative systemic complications attributable to DM and HPTN and informing the hospital in case any cardiovascular emergency arises.
- Consider the use of local haemostatic gargle of ethamsyl-

ate or tranexamic acid.

Step 3: Follow the specific instructions for each group in addition to the general protocol.(Table 2)

All patients were managed with this protocol and were observed perioperatively for incidence of cardiovascular complications and time of treatment.

III. Results

A total of 140 patients including 86 males and 54 females and with a mean age of 51.20 years was involved in the study. Among 140 patients, 6 patients (4.3%) had cardiovascular complications, while 3 (1 with syncope and 2 with HPTN) did not require intervention other than observation. Two patients with chest pain attributed to anginal pain were managed with aspirin and nitroglycerine, as electrocardiogram (ECG) changes suggestive of MI were not seen. One patient had a possible MI (overall incidence 0.7%) with chest pain, S-T segment elevation on ECG, and troponin level of 0.60

Table 3. Incidence of cardiovascular complications occurring during minor surgical procedures in patients with both diabetes mellitus (DM) and hypertension (HPTN)

Group	Category	No. of patients	Complications occurred (No. of patients)
Group 1	1. Patients with both controlled DM and HPTN (BSL <200 mg/dL, BP=120/80 mmHg)	31	Syncope (1) (recovered after 5 minutes kept under observation, procedure continued without any further complication)
	2. Patients with controlled HPTN but uncontrolled DM (BSL <200 mg/dL, BP up to 159/99 mmHg)	40	Raised blood pressure (1) (observation showed normotensivity)
	3. Patients with controlled DM but uncontrolled HPTN (BSL <200 mg/dL, BP up to 159/99 mmHg)	26	Raised blood Pressure (1) (observation showed normotensivity) Mild chest pain relieved on nitroglycerine (1) (needed 24-hour admission, ECG changes were not seen)
	4. Patients with both uncontrolled DM and HPTN (BSL >200 mg/dL, BP >159/99 mmHg)	24	Severe chest pain (1) (patient was treated by an intensivist. ECG changes were noted with S-T segment elevation, suggestive of myocardial infarction, troponin level 0.6 ng/mL)
Group 2	Patients with history of cardiovascular complications attributable to DM and HPTN	19	Mild Chest pain relieved on nitroglycerine (1) (needed 24-hour observation but ECG changes were not seen)
Total		140	6

(BSL: blood sugar level, BP: blood pressure, ECG: electrocardiogram)

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ng/mL and required thrombolysis and further treatment by an intensivist.(Table 3)

Cardiovascular complication occurred in nearly all types of minor surgical procedure, but the most significant complication of chest pain occurred during impacted tooth removal and abscess drainage.(Table 4) All 3 patients who had chest pain had been admitted for surgery performed under the observation of an intensivist, facilitating immediate treatment. This helped to prevent further adverse complications. Among patients who had chest pain, 2 recovered after sublingual nitro-glycerine and aspirin, while 1 showed ECG changes and was diagnosed with MI. Further treatment was performed by an intensivist.

IV. Discussion

Uncontrolled diabetes leads to acute or chronic complications attributed to blood glucose concentration. Abnormally high blood glucose can have life-threatening impact if it triggers conditions like diabetic ketoacidosis in type-1 and type-2 diabetes and hyperosmolar coma in type-2 diabetes. Abnormally low glucose can occur in all types of diabetes and may result in seizure and loss of consciousness and can occur after skipping a meal or exercising more than usual or if the dosage of hypoglycaemic agents is too high⁹. Chronic complications of diabetes include coronary insufficiency and stroke¹⁰.

Chronic HPTN precedes the onset of vascular changes in the kidney, heart, and brain and leads to clinical complica-

Table 4. Number of patients who underwent a minor surgical procedure, patient category, and complications

Surgical procedure	No. of patients	Cardiovascular complication (No. of patients)	Category of patient
Alveoloplasty	32	Syncope (1)	Group 1.1
Multiple tooth extraction	46	Raised blood pressure (1)	Group 1.2
		Raised blood pressure (1)	Group 1.3
Impacted tooth removal	26	Mild chest pain (1)	Group 1.3
		Severe chest pain (1)	Group 1.4
Implant placement	17	-	-
Abscess drainage	19	Mild chest pain (1)	Group 2
Total	140	6	

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tions including renal failure, stroke, coronary insufficiency, MI, congestive heart failure, dementia, encephalopathy, and blindness¹¹.

Patients suffering from DM and HPTN must be considered unique due to following factors. About two-thirds of patients with diabetes have high blood pressure and have 2 to 4-fold greater risk for MI and stroke than persons without diabetes. These patients have less chance of surviving a MI than a typical non-diabetic person^{12,13}.

Diabetes with blood pressure acts as a double-edged sword, and such patients carry significant high risk for premature microvascular and macrovascular complications. According to a recent study, presence of HPTN is responsible for 7.2-fold increase in mortality in patients with diabetes⁷. Further, autonomic neuropathy may predispose to infarction and result in

atypical presenting symptoms in diabetic patients, complicating diagnosis and delaying treatment. The clinical course of MI is frequently complicated and carries a higher mortality rate in diabetic patients⁸.

ASA physical status classification is universally followed to identify risk in medically compromised patients. Normally, a patient with type-2 diabetes well controlled with oral hypoglycaemic agents and diet is categorised as ASA-2, and those under control with insulin and diet are categorised as ASA-3¹⁴. Owing to increased risk and severity of cardiovascular complications, we propose that a patient having well controlled diabetes with HPTN should be categorised as ASA-3. The category of patient with both uncontrolled diabetes and HPTN should be considered ASA-4, a patient with severe systemic disease with constant threat to life. In addition, a patient with angina, previous MI, cerebrovascular accident, and other cardiovascular complications should be categorised as ASA-4.(Table 4)

Specific guidelines for each group and rationale are discussed below in detail.

1. Group 1,1: Patients with controlled DM and HPTN

These patients should be regarded as ASA-3, and general guidelines should be followed.

2. Group 1,2: Patients with controlled HPTN but uncontrolled DM

These patients should be considered ASA-3.

Elective procedures should be postponed until control of sugar level.

Emergency procedures can be performed with physician consent. Physicians may alter the dosage of oral hypoglycaemics or insulin.

3. Group 1,3: Patients with controlled DM but uncontrolled HPTN

Classified as ASA-3 for elective procedures but must be considered as ASA-4 for emergency procedures.

Elective procedures can be postponed until control of blood pressure below 159/99 mmHg.

Emergency procedures can be performed if blood pressure is in stage 1 (systolic \leq 159 and diastolic \leq 99) using general guidelines.

A blood pressure measurement of 180/110 mmHg as the

absolute cut-off for any dental treatment has been well published¹⁵. Studies have shown no increased risk for adverse outcomes for patients undergoing treatment with blood pressure $<$ 180/110 mmHg¹⁶.

However, we hypothesise and suggest that optimum level of blood pressure for minor oral surgical procedure should be $<$ 160 systolic and $<$ 99 mmHg diastolic because such patients require judicious monitoring⁷.

We propose hospitalization of such patients with an available intensive care unit along rather than undertaking procedures in an isolated dental clinic.

4. Group 1,4: Patients with uncontrolled diabetes and uncontrolled HPTN

These patients must be categorised as ASA-4 because they carry the highest risk of aggravation of cardiovascular complications.

Elective procedures can best be postponed until control of both DM and HPTN.

Emergency procedures: such patients are highly prone for systemic complications such as diabetic ketoacidosis, unconsciousness due to low or high blood glucose concentration, stroke, angina, or acute MI. In addition, there are chances of local surgical complications such as excessive primary or secondary haemorrhage and delayed wound healing¹⁷. We strongly advocate hospitalizing such patients in a facility with a both a dental clinic and intensive care unit.

5. Group 2: Patients with diabetes and coexistent HPTN along with complications

Such patients have a compromised cardiovascular system with a constant threat of aggravation and further complications. These patients previously experienced complications like angina pectoris, MI and other cardiomyopathy, cerebrovascular accidents, or target organ complications of kidney or retina. In addition, they are on multiple drug therapies such as insulin, oral hypoglycaemics, or a combination of both; anti-hypertensives; anticoagulants; and antiplatelet drugs. Patient compliance must be considered while prescribing drugs for such patients.

According to ASA classification, a patient with MI or cerebrovascular accident 6 months prior without no or minimal residual damage is considered as ASA-3, but concurrent HPTN and diabetes increases risk of cardiovascular complications. Thus, we hypothesise that such patients must be

considered as ASA-4, irrespective of blood sugar and blood pressure.

We recommend that minor oral surgical procedures be performed after hospitalization and under observation of an intensivist because of constant threat of life. The following factors must be considered when treating these patients.

1) Time of surgery

The safest time to perform a dental surgical procedure is 6 months or more following MI or stroke. In emergencies, such a procedure can be performed as early as 30 days following MI¹⁸.

2) Pain control

If pain control is required, it should be as conservative as possible and directed primarily towards pain relief and infection control¹⁹.

Nonsteroidal anti-inflammatory drugs must be prescribed cautiously according to a finding that extensive use of rofecoxib, celecoxib, and diclofenac increases the risk of acute MI, but similar use of ibuprofen and naproxen does not²⁰.

3) Local anaesthesia

A local anaesthetic without adrenaline is preferable, but if a vasoconstrictor is required, a patient taking a nonselective beta blocker can safely be given up to 0.036 mg epinephrine at one appointment. In addition, modest quantities of vasoconstrictor (1:200,000) can be used safely even in high risk patients when accompanied by oxygen, sedation, nitro-glycerine, and excellent pain control measures^{18,19}. When injecting local anaesthetic, a double aspiration technique should be performed to prevent intravascular injection.

4) Patients on warfarin

In patients on anticoagulant therapy like warfarin, minor oral surgery can be performed without altering or stopping warfarin provided that INR is within the therapeutic range of 2 to 3.5²¹. There is a little or no indication for altering anticoagulation therapy before minor oral surgical procedures when the patient's INR is <3.5¹⁹.

5) Patients on heparin

Heparin should be stopped six hours prior to surgery and can be reinstated after surgery until a desirable INR level has been reached²².

6) Patients on antiplatelet drugs

All patients with coronary artery disease are on antiplatelet therapy, either aspirin alone or dual antiplatelet therapy (e.g., aspirin and clopidogrel), which increases the risk of excessive bleeding during surgical procedure. Discontinuation of antiplatelet therapy has been significantly associated with adverse cardiac events, such as MI or death, especially after placement of a bare metal stent or drug-eluting stents. As the risk of bleeding from anything other than highly invasive oral surgery is small and post-extraction bleeding is relatively easy to manage, antiplatelet therapy should not be discontinued²³. Lee²⁴ systematically described the management of patients on antiplatelet drugs such as oral aspirin alone, dual antiplatelet therapy, and oral or injectable anticoagulants. He also advised at the consensus meeting on antithrombotic agents held on March 24, 2018 at Seoul National University Dental Hospital by the Korean Association of Oral and Maxillofacial Surgeons that a future consensus paper on dental management of patients on antithrombotic medication is needed. In our study, we followed similar guidelines in medically compromised patients undergoing minor oral surgical procedures like multiple tooth removal, implant placement, and third molar surgery associated with high risk for bleeding. Our study revealed promising results of management of patients on antithrombotic treatment, favourable to the review study of Lee²⁴. In such patients, the use of local haemostatic measures such as placing gelatine sponges, oxidised cellulose, or suturing gauze sponge for pressure packs and postoperative tranexamic acid mouth rinses are recommended.

There is little study on dental management of patients with both diabetes and HPTN. These 2 conditions contribute to the most frequent cardiovascular emergencies, and their concurrence is the largest risk factor of aggravation of emergencies.

McCarthy²⁵ stated that implementation of a complete system of physical evaluation for all prospective dental patients could prevent up to 90% of life-threatening situations. The remaining 10% would occur despite preventive efforts.

Yoon et al.²⁶ in 2001 evaluated the influences of epinephrine and pain on changes of blood pressure and pulse rates in mandibular third molar removal. A total of 80 patients with medically compromised condition was selected. Forty patients were treated with 2% lignocaine with 1:100,000, and the others were treated with lignocaine without adrenaline. Digital monitoring of blood pressure and heart rate occurred perioperatively. He concluded that local anaesthetic with epinephrine is better at decreasing pain and preventing severe elevation of systolic blood pressure than local anaesthetic

without epinephrine²⁵. Similar findings were reported in our study, where blood pressure was elevated only in 2 patients²⁶.

In the current study with a modified SRP for patients with both diabetes and HPTN, the incidence of cardiovascular emergencies was reduced by up to 4.3%, with no patient death. Interestingly, all significant emergencies occurred in patients who were hospitalized for procedures performed under observation of an intensivist. This facilitated early identification and immediate implementation of treatment.

V. Conclusion

We conclude that diabetic patients with concurrent HPTN carry 4-fold risk of aggravation of cardiovascular emergencies and 7.2-fold risk of mortality and have less chance of surviving a MI than a typical non-diabetic person.

We also conclude that a systematically designed protocol for these patients helps in proper assessment of risk and close observation of patients, reducing incidence of medical emergencies up to 4.3%. The study recommends that some of these patients with uncontrolled diabetes and uncontrolled HPTN and/or patients having history of cardiovascular complication should be treated in a medical facility with a readily available cardiology unit. Hospitalization of these patients not only helps in reduction of cardiovascular emergencies, but also assists in prompt diagnosis and instant implementation of treatment by an intensivist/cardiologist, thereby reducing morbidity and mortality. The protocol is suggested to offer better management of such patients.

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Authors' Contributions

A.N.J. contributed towards study design, data analysis, and manuscript preparation. P.R.T. involved in data collection, co-ordination, and drafting of manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Given the non-interventional and descriptive observational nature of the study, approval was exempted by the institu-

tional review board. However, all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional committee, the 1964 Helsinki declaration, and its later amendments or comparable ethical standards.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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