Review Article

Cardiovascular risk of epinephrine use in hypertensive dental patient

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ABSTRACT

Epinephrine is widely used as an additive in local anesthetics (typically in concentrations of 1:100,000) to improve the depth and duration of the anesthesia, as well as to reduce bleeding in the operative field. Epinephrine counteracts the anesthetic's localized vasodilator effects in subcutaneous and submucosal vessels, thereby reducing the risk of anesthetic toxicity by decreasing the rate of systemic absorption from the site of injection. Epinephrine is also impregnated in the cotton cord that is inserted into the sulcus between a tooth and the surrounding gingiva, as a gingival retraction cord improving access for tooth preparation and allowing dental impression material to more readily flow into the sulcus to record details of teeth prepared for crowns. The epinephrine likewise tightens the blood supply to contiguous tissue, in this manner allowing the impression to be secured without contamination by bleeding. Hypertension affects nearly 50 million people in the United States and underlies most cardiovascular disease; its diagnosis and control should be of concerned to all health-care providers. Many people have undetected hypertension, and current levels of detection and control need to be improved. Clinical implications: All health-care providers, including dentists and members of the dental team, need to be involved in the detection and management of this important public health problem. The dentist can play an important role in the detection and management of hypertension.

KEY WORDS: Cardiovascular disease, Epinephrine, Extraction, Hemodynamic changes, Hypertensive patient

INTRODUCTION

Epinephrine is commonly used in health-care applications as lifesavers such as in the management of anaphylaxis and cardiac arrest. The drug is produced in the human body from an adrenal gland above the kidney. Although it is produced in our system, their requirements in emergency procedures are high and always there is a confusion regarding dose limits for epinephrine, especially when it is administered in patients with cardiovascular diseases (CVD). Epinephrine was first added to the local anesthetic ester-procaine over 100 years ago, which is not in current practices. It is one of the widely used vasoconstrictors in dentistry. However, the use of local anesthetics containing epinephrine in a cardiac compromised patient during dental procedures has been controversial. Epinephrine has been argued as a potential risk factor that can cause cardiovascular complications. Hence, many studies have been conducted to evaluate the safety of epinephrine in dental treatment.

There are numerous physiological effects of epinephrine, as it is the reason for the reaction "flight or fight" in all mammals. Some variations in this response depend on the predominant type of androgenic receptors in the target organ.[1] Epinephrine increases the heart rate and the force of ventricular contraction, which eventually increases cardiac output. This increased cardiac workload simultaneously increases myocardial oxygen consumption. This should be concerned in an individual suffering from cardiac disease, particularly given that the beneficial coronary vasodilatory effect of epinephrine is diminished or absent in the presence of coronary vessel atherosclerosis. Those risk to the cardiac patient is the potential of epinephrine to irritate cardiac pacemaker cells and results in dysrhythmias. Thus, the imprudent use of epinephrine can be harmful to a patient with cardiac disease.[2]

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EPINEPHRINE IN DENTISTRY

Epinephrine is a commonly used drug in cases of a medical emergency situation. In the case of dentistry, it has two uses. First, it is a constituent of local anesthetic solution commonly used in dentistry. Second, it is used as a hemostatic agent in gingival retraction cord.[3] Although epinephrine has these use, which may not be as readily achievable through use of non-epinephrine preparations, the clinical impact of cardiovascular and hemodynamic changes caused by the introduction of exogenous epinephrine makes its use among hypertensive individuals has some controversies in dentistry. The added risks produced by the use of epinephrine in hypertensive patients include:

Through the action of the epinephrine-greater probability of acute hypertensive crisis (seriously high blood pressure [BP]), angina pectoris and myocardial infarction, as well as cardiac arrhythmias.

Risk of a drug interaction of epinephrine and some antihypertensive medication can lead to acute hypertensive or hypotensive crisis.[4] Administrating epinephrine in patients should be done with care as frequent monitoring of BP is essential due to its pharmacological actions. Epinephrine produces two types of effects in patients. One effect is pronounced on the heart due to its beta-1 effects, and other effect is on skeletal muscle blood vessels due to its beta-2 effects. This results in an increased BP and heart rate (HR).[5]

HYPERTENSION

Hypertension is one of the most frequently encountered systemic diseases in patients visiting dental clinics, due to its high prevalence worldwide. It is defined as the values >140 mmHg systolic BP (SBP) and values >90 mmHg diastolic BP (DBP). It is also called as "silent killer" because it often affects target organs such as brain, heart, kidneys, and eyes before the appearance of clinical symptoms. A permanent high BP affects blood vessels in heart, kidney, and brain which increases the chances of renal, coronary heart disease, and stroke.[6] Joint National Committee (JNC) 7 introduces a category called "prehypertensive" to describe people with SBP of 120–139 mm Hg or a DBP of 80–89 mm Hg. People with prehypertension are at increased risk of progressing to hypertension and require health-promoting lifestyle modifications to prevent CVD.[7] One of the reasons that the concept of prehypertension was developed is to provide a wake-up call for affected people to encourage them to make appropriate lifestyle choices. A critical aspect in the prevention and management of hypertension is the adoption of healthy lifestyles. Without lifestyle modifications, BP may not be controlled adequately despite sufficient doses of antihypertensive drugs or appropriate combinations of drugs. Recommended modifications are weight reduction for overweight patients, dietary sodium reduction, appropriate physical activity, and moderation in consumption of alcohol. Furthermore, the consumption of a diet rich in fruits, vegetables, and low-fat dairy products such as recommended in the Dietary Approaches to Stop Hypertension.[8,9]

A greater awareness of hypertension recorded in the present study could be due to the lifestyle and some other factors compared to the general population. The risk factors associated with hypertension are similar to that seen in other studies which were done in the general population. Hence, health-care providers should recognize the increased risk of prehypertension and should seek to identify and treat the modifiable risk factors in these persons especially among undergraduate students who are country's young generation.[10]

ETIOLOGY, CLASSIFICATION, AND PATHOGENESIS OF HYPERTENSION

Hypertension is the most common primary diagnosis in the United States, affecting >50 million population and also in developing countries such as India and China. Etiological factors correlated with hypertension in adults have also been associated with BP elevations in youth. Intrauterine malnutrition, family history of hypertension, obesity, particularly excess abdominal fat, insulin resistance, high dietary sodium intakes, low dietary intakes of calcium, potassium and magnesium, physical inactivity, high alcohol intakes, tobacco use, drug use (e.g., cocaine, ecstasy, and anabolic steroids), emotional stress, diet pill use, and oral contraceptives are the factors associated with development of hypertension.[11]

Hypertension is classified as primary or essential hypertension and secondary hypertension.

Primary hypertension is the most common form of hypertension where the level of hypertension is medium to high for a long time without a known cause.[12] Secondary hypertension is the one which occurs with an organic cause which includes renal, endocrine, neurological, and others such as drugs induced and pregnancy toxemia. The Seventh Report of the JNC on Prevention, Detection, Evaluation, and Treatment of High BP (JNC 7) introduced in 2003 the category of prehypertension in which the patients with this condition are at increased risk of developing hypertension.[13] Pathogenesis of hypertension results from a complex interaction between genetic factors and the environment. Some of them are age, family

history of premature CVD, smoking, increased consumption of alcohol, and cholesterol-rich diet.[14]

HYPERTENSION AND CVD

Hypertension is found to have a link in many CVD. Some of them are Arterial hypertension is an important health problem as it causes risks of CVD such as chest pain, myocardial infarction, and cerebrovascular event.[15] In such cases, patient's BP is frequently monitored before dental treatment to make the BP under control to manage this condition. Heart failure is defined as the incapacity of heart to function properly, pumping insufficient blood toward the tissues and leading to fluid accumulation within the lungs, liver, and peripheral tissues. It is of two types.

I. Acute heart failure: The most common causes of heart failure are severe and prolonged arterial hypertension, valve disease, and ischemic heart disease. This typically manifests as acute lung edema.[16]
II. Chronic heart failure: The most common cause of this type of heart failure is that this is also associated with arterial hypertension.

Hypertensive emergency: It is defined as elevated BP with signs and symptoms of target organ damage. The BP should be acutely lowered, or else tissue perfusion in brain heart can occur which is regulated by (Mean arterial pressure) MAP.[17-19]

EPINEPHRINE AND ASSOCIATED RISK OF CVD

Various studies have revealed the fact that DBP decreased and HR increased in both normotensive and hypertensive patients during dental treatment with epinephrine-containing local anesthetic. These changes were small and unlikely to be clinically significant. SBP rose slightly in hypertensive patients but not in normotensive individuals when epinephrine containing local anesthetics were injected; this was proved by Little *et al.* in 1960s.[20] He stated that patients who received lidocaine with epinephrine and underwent subsequent tooth extraction presented clinical evidence of diminished post-operative bleeding from the socket wound. This was determined from the condition of the gauze sponges placed over the sockets. In addition, the patients so studied attested to the depth and duration of anesthesia produced. It has been stated many times in the past that the use of local anesthetic solutions without epinephrine is unrealistic since the oral operations that follow are often associated with pain. This pain, in turn, will produce more epinephrine from natural secretion (adrenal medulla) than does the 1:50,000 or 1:100,000 epinephrine normally used in local anesthetic solutions. It is true that the depth of anesthesia is desirable. However, as has been demonstrated in 26 patients, both normotensive and hypertensive, an anesthetic properly placed by infiltration or by the block method will produce satisfactory anesthesia for routine dental procedures within 5 min. The pressor response related to fear of the injection and the impending dental surgery was so evident in this experiment and also in those reported by Cheraskin and Prasertsuntarasai that premeditation should become routine. When local anesthesia for dental procedures involving trauma is anticipated for patients with hypertension, CVD, and anxiety states. These patients are greater operative risks, and care should be taken to see that their physical abnormalities are recognized. The care of patients with this type of abnormalities needs close cooperation between the physician and the dentist. Anxiety, pain, fear, or prolonged traumatic operation should be avoided. Adequate pre-operative medication, usually with barbiturates as the drugs of choice is, therefore, important to ensure a smoother and safer surgical procedure.

MANAGEMENT

While managing a hypertensive patient in the dental office, the dentist must take efforts to perform the dental procedures with optimum pain control, reduced stress, and anxiety. To perform safe dental procedures in hypertensive patients, the operator must follow certain guidelines. The dentist must monitor the BP carefully before and after the administration of local anesthesia. Pre-operative reassurance with the use of effective local anesthesia (with or without epinephrine) may help in alleviating the related anxiety and reduced the chances of increased BP. The risky patients should be advised to seek medical attention, during dental treatment. Epinephrine can be used in the management of hypertension by giving two 1.8 ml cartridges of lignocaine containing 1:100,000 epinephrine which is considered a safer dose for these hypertensive patients.[5]

In 1964, a Working Conference of the American Dental Association and the American Heart Association[18] stated that the concentrations of vasoconstrictors normally used in dental local anesthetic solutions were not contraindicated in patients with CVD when administered carefully and with preliminary aspiration. Malamed recommended a much smaller maximal dose of vasoconstrictor (no >40 µg of epinephrine at one appointment) for patients with severe CVD. Little *et al.*[20] recommend that one, and probably two, and cartridges of 2% lidocaine with 1:100,000 epinephrine (18–36 µg of epinephrine) were of little clinical significance to most patients with hypertension or other CVD.[21] Kaneko[5] recommended that the total dose of epinephrine should be limited to <40 µg in moderate cases or 20 µg in serious cases, with epinephrine concentrations of 1:100,000 or less. Current clinical

practice has tacitly accepted the safety of epinephrine use in patients with CVD. There have been several reports of the hemodynamic effects of epinephrine in patients with CVD. Cintron *et al.* reported that dental anesthesia with 1.0 mL of 2% lidocaine with 1:100,000 epinephrine caused no significant changes in HR or BP and was well tolerated by patients with recent myocardial infarction. Middlehurst and Coulthard reported that approximately 5 mL of 2% lidocaine with 1:50,000 epinephrine and 0.25 IU/mL of vasopressin did not cause ischemic changes in patients with heart disease. When excessive concentration or dose of epinephrine is administered in patients with a normal heart, s*troke volume* (SV) and cardiac output are further elevated due to the β1 effect of epinephrine, leading to a prominent rise in BP. Consequently, rate pressure product, indexes of myocardial oxygen consumption, and left ventricular stroke work (the product of MAP and SV), representing the level of work by the left ventricle, also increase. Although a normal heart can apparently withstand these great demands, in failing or ischemic heart, cardiac functions may be impaired by these changes. The possibility of adverse interactions between epinephrine and nonselective β-blocking agents has been suggested. Epinephrine production may lead to an exaggerated increase in BP in patients taking a non-specific β-blocking agent such as propranolol. However, the possibility of a hypertensive interaction occurring with epinephrine should be considered when epinephrine is used in patients taking a non-specific β-blocking agent. This study provides documentation that 1.8 mL of L-E is safe and has few, if any, hemodynamic consequences in patients with CVD. We concluded that a low dose of epinephrine (22.5 µg) in local dental anesthesia was well tolerated by cardiovascular patients.[22]

CONCLUSION

Dentistry has played a cardinal role in the detection of patients with hypertension. Patients suspected to have high BP should be referred to medical diagnosis. In the dental office, medical emergencies do occur to which dentist has to be prepared to overcome those difficulties. Early detection of hypertension by the dentist can lead to prompt treatment in the dental office.

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