Hypertension

Hypertension is an abnormal elevation in arterial pressure that can be fatal if sustained and untreated. People with hypertension may not display symptoms for many years but eventually can experience symptomatic damage to several target organs, including kidneys, heart, brain, and eyes. In adults, a sustained systolic blood pressure of 140 mm Hg or greater and/or a sustained diastolic blood pressure of 90 mm Hg or greater is defi ned as hypertension. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) provided several revisions to the previous 1997 guidelines1 (Table 3-1). These new guidelines include an updated classifi cation that redefi nes "normal" blood pressure as □120/80 mm Hg and introduces a new category of "prehypertension" (120-139/80-89 mm Hg), which encompasses the previously designated categories of "normal" and "borderline" hypertension. This reflects the findings that health risks are increased with blood pressures as low as 115/75 mm Hg and that lowering blood pressure in patients with what was formerly considered "normal" or "borderline" blood pressure can

result in decreased adverse vascular events such as stroke and myocardial infarction (MI). In addition, the previously designated stages 2 and 3 of hypertension were combined into a single stage 2 category because treatment for both groups is essentially the same.

The dental health professional can play a significant role in the detection and control of hypertension and may well be the first to detect a patient with an elevation in blood pressure or with symptoms of hypertensive disease. Along with detection, monitoring is an equally valuable service because patients who are receiving treatment for hypertension but may not be adequately controlled because of poor compliance or inappropriate drug selection or dosing. The dentist, however,

should detect abnormal blood pressure measurements, which then become the basis for referral to or consultation with a physician. The dental patient with hypertension poses several potentially significant management considerations. These include identification of disease, monitoring, stress and anxiety reduction, prevention of drug interactions, and awareness and management of drug adverse effects.

Etiology

About 90% of patients have no identifiable cause for their disease, which is referred to as *essential, primary,* or *idiopathic* hypertension. For the remaining 10% of patients, an underlying cause or condition may be identified; for these patients, the term *secondary* hypertension is applied. The most common cause of secondary hypertension is renal parenchymal disease, followed by reno-vascular disease and various adrenal disorders.8 Most conditions that cause secondary hypertension lead to an elevation in diastolic and systolic blood pressure. Lifestyle can play an important role in the severity and progression of hypertension; obesity, excessive alcohol intake, excessive dietary sodium, and physical inactivity are significant contributing factors. Many patients with secondary hypertension may be cured with treatment of the underlying condition. Patients with secondary hypertension caused by unilateral renal disease such as renal artery obstruction or pyelonephritis may be cured by surgical correction of the defect or removal of the diseased kidney. In a few patients with secondary hypertension, a pheochromocytoma of the adrenal medulla has been found to be responsible. This lesion is surgically treatable. Hyperfunction of the adrenal gland caused by a tumor of the adrenal cortex or cortical hyperplasia may cause secondary hypertension in a few cases. These conditions also are amenable to surgery. Recently, obstructive sleep apnea has been recognized as an independent cause of hypertension; it is correctable with successful treatment

BOX 3-1

Identifiable Causes of Hypertension

- Chronic kidney disease
- Coarctation of the aorta
- Cushing's syndrome and other glucocorticoid excess states, including chronic long-term steroid therapy
- Drug-induced or drug-related (e.g., NSAIDs, oral contraceptives, decongestants)
- Obstructive uropathy
- Pheochromocytoma
- Primary aldosteronism and other mineralocorticoid excess states
- Renovascular hypertension
- Sleep apnea
- Thyroid or parathyroid disease

BOX 3-2

Signs and Symptoms of Hypertensive Disease

EARLY

- Elevated blood pressure readings
- Narrowing and sclerosis of retinal arterioles
- Headache
- Dizziness
- Tinnitus

ADVANCED

- Rupture and hemorrhage of retinal arterioles
- Papilledema
- Left ventricular hypertrophy
- Proteinuria
- Congestive heart failure
- Angina pectoris
- Renal failure
- Dementia
- Encephalopathy

CLINICAL PRESENTATION

Signs and Symptoms

Hypertension may remain an asymptomatic disease for many years, with the only sign being elevated blood pressure. Blood pressure is measured with the use of a sphygmomanometer. Pressure at the peak of ventricular contraction is *systolic pressure. Diastolic pressure* represents the total resting resistance in the arterial system after passage of the pulsating force produced by contraction of the left ventricle. The difference between diastolic and systolic pressures is called *pulse pressure. Mean arterial pressure* is roughly defi ned as the sum of the diastolic pressure plus one-third the pulse pressure. Patients are commonly found to have signifi cant variability in blood pressures. *Labile* hypertension is the term that was previously used to describe a subgroup of patients with wide variability in blood pressures; however, this term has fallen into disuse because it is now recognized that variability in blood pressure is the norm rather than the exception. About 15% to 20% of patients with untreated stage 1 hypertension have what is called *white coat hypertension,* which is defi ned as persistently elevated blood pressure only in the presence of a health care

worker but not elsewhere. In these patients, accurate blood pressure readings may require self-measurement at home or 24-hour ambulatory monitoring. These individuals are at lower risk for hypertensive complications than are those with sustained hypertension. Before the age of 50, hypertension is typically characterized by an elevation in both diastolic and systolic pressures. Isolated diastolic hypertension, defined as a systolic pressure 140 and a diastolic pressure ≥90, is uncommon and is most often found in younger adults. Although the prognostic significance of this condition remains unclear and controversial, it appears that it may be relatively benign. Isolated systolic hypertension is defined as a systolic pressure ≥140 and a diastolic blood pressure 90; it is generally found in older

patients and constitutes an important risk factor for cardiovascular disease. Occasionally, isolated systolic blood pressure is found in older children and young adults, often male. This is due to the combination of rapid growth in height and very elastic arteries, which accentuate the normal amplification of the pressure wave between the aorta and the brachial artery, resulting in high systolic pressure in the brachial artery but normal systolic pressure in the aorta. The earliest sign of hypertension is an elevated blood pressure reading; however, funduscopic examination of the eyes may show early changes of hypertension consisting of narrowed arterioles with sclerosis. As indicated earlier, hypertension may remain an asymptomatic disease for many years, but when symptoms do occur, they include headache, tinnitus, and dizziness. These symptoms are not specifi c for hypertension, however, and may be seen just as commonly in normotensive individuals.

Late signs and symptoms are related to involvement of various target organs, including kidney, brain, heart, or eye. In advanced cases, retinal vessel hemorrhage, exudate, and papilledema may occur and are indicative of accelerated-malignant hypertension, which is a medical emergency and requires immediate intervention. Hypertensive encephalopathy is characterized by headache, irritability, alterations in consciousness, and other signs of central nervous system (CNS) dysfunction.8 Also, in advanced cases, the left ventricle may be enlarged and cardiac function may be impaired, leading to congestive heart failure. Renal involvement can result in hematuria, proteinuria, and renal failure. Persons with hypertension may report fatigue and coldness in the legs that result from peripheral arterial changes that may occur in advanced hypertension. Patients with hypertension often have an accelerated cognitive decline with aging. Although these findings may be seen in patients with both essential and secondary hypertension,

additional signs or symptoms may be present in secondary hypertension associated with underlying disease.

Laboratory Findings

The patients who have sustained hypertension should be screened through routine laboratory tests, including electrocardiogram, urinalysis, blood glucose, hematocrit, and a serum potassium, creatinine, calcium, and lipid profile. These tests serve as baseline laboratory values that the physician should obtain before initiating therapy. Additional tests should be ordered if clinical and laboratory findings suggest the presence of an underlying cause for hypertension.

MEDICAL MANAGEMENT

Evaluation of a patient with hypertension includes a thorough medical history, a complete physical examination, and routine laboratory tests as described earlier. Additional diagnostic tests or procedures may be performed to detect secondary causes of hypertension or to make a definitive diagnosis. Patients found to have an identifiable cause for their hypertension should be treated for that disorder. Those without an identifiable cause are diagnosed with essential hypertension. Classification and diagnosis of blood pressure are based on an average of two or more properly measured, seated blood pressure readings on each of two or more office visits.

Measurement of blood pressure is most commonly achieved through the auscultatory method with a mercury, aneroid, or hybrid sphygmomanometer. Mercury sphygmomanometers have long been considered the most accurate of devices and the gold standard; however, because of increasing concern about mercury and the risk of breakage and spill, their use may be limited in the future. Aneroid devices are the type most commonly used in dental offices. They are easy to use; however, they require regular calibration. Automatic digital devices for the

arm, wrist, or finger have become popular for use both in the office and at home. They are very convenient and easy to use; however, it is critical that they be regularly calibrated to ensure their accuracy. Patients given a diagnosis of prehypertension are not candidates for drug therapy but rather are encouraged to adopt lifestyle modifications to decrease their risk of developing the disease. Prehypertension is not a disease but rather a designation that reflects the fact that these patients are at increased risk of developing hypertension. Lifestyle modifications include losing weight; adopting a diet rich in vegetables, fruits, and low-fat dairy products; reducing cholesterol and saturated fats; decreasing sodium intake; limiting alcohol intake; and engaging in daily aerobic physical activity . It is considered essential that patients with prehypertension as well as those with diagnosed hypertension follow these recommendations because lifestyle modifications have been shown to effectively reduce blood pressure, prevent or delay the incidence of hypertension, enhance antihypertensive drug therapy, and decrease cardiovascular risk. If lifestyle modifications are found to be inadequate for achieving desired blood pressure reduction, drug therapy is initiated. The people with hypertension— stages 1 and 2—should be treated. The treatment goal for most patients with hypertension is to reduce blood pressure to 140/90 mm Hg. However, for hypertensive patients with diabetes or kidney disease, the goal is 130/80 mm Hg. Evidence demonstrates the clear benefits of aggressive treatment of hypertension. In clinical trials, antihypertensive therapy resulted in an average reduction in stroke incidence of 35% to 40%; MI, 20% to 25%; and heart failure, 50%.. Many drugs are currently available to treat hypertension. Those most commonly used include thiazide diuretics, angiotensin-converting enzyme inhibitors (ACEIs), angiotensive receptor blockers (ARBs), beta blockers (BBs), and calcium channel blockers (CCBs). Other drugs that are less frequently used include alpha1 blockers, central alpha2 agonists and other centrally acting drugs, and direct vasodilators. If lifestyle

modifi cation is ineffective at lowering blood pressure adequately, then thiazide diuretics are most often the first drugs of choice, given either alone or in combination with ACEIs, ARBs, BBs, or CCBs, depending on the degree of elevation of blood pressure. For stage 1 hypertension, single-drug therapy may be effective; however, for stage 2 hypertension, two drug combinations are recommended. Additional drugs may be added as needed. Most people require more than one drug to effectively lower their blood pressure. The presence of certain comorbid conditions such as heart failure, post MI, diabetes, or kidney disease may be a compelling reason to select specific drugs or classes of drugs that have been found beneficial in clinical trials. Severe hypertension, defined as blood pressure ≥180/120, may be classified as an emergency or urgency. Hypertensive emergencies are characterized by a severe elevation in blood pressure *with* evidence of impending or progressive target organ dysfunction such as hypertensive encephalopathy, intracerebral hemorrhage, acute MI, left ventricular failure with pulmonary edema, or unstable angina pectoris. Patients require immediate blood pressure reduction (within 1 hour) and should be admitted to an intensive care unit (ICU). Patients with severe hypertension but with less ominous symptoms such as headache, shortness of breath, nosebleeds, or severe anxiety require urgent treatment but do not constitute an emergency. These patients are most often found to be noncompliant or are inadequately medicated. They should receive timely treatment to reduce blood pressure but without the immediacy of concern associated with evidence of progressive target organ damage. Treatment may include the administration of a short-acting oral antihypertensive agent followed by several hours of observation and subsequent adjustments in medications. Patients typically do not require admission to the ICU. It is interesting to note that failure to aggressively lower the blood pressure of these patients in the emergency room has not been shown to increase short-term risks to the patient. This further supports the

fact that emergency treatment is not critical for these patients. It should be noted that in another group of patients, severe or uncontrolled hypertension occurs with complete absence of symptoms. These patients should likewise receive timely medical treatment, but this is not considered an emergent or urgent situation.

Figure 3-1. Standard blood pressure cuff (sphygmomanometer) and stethoscope.

Classification of Blood Pressure in Adults and Recommendations for Follow-up

BP Classification	Systolic BP (mm Hg)	Diastolic BP (mm Hg)	Recommended Follow-up
Normal	<120	*and* <80	Recheck in 2 years
Prehypertension	120-139	*or* 80-89	Recheck in 1 year
Stage 1 hypertension	140-159	*or* 90-99	Confirm within 2 months
Stage 2 hypertension	≥160	*or* ≥100	Evaluate or refer to source of care within 1 month. For those with higher pressures (e.g., >180/110 mm Hg), evaluate and treat immediately or within 1 week, depending on the clinical situation and complications

DENTAL MANAGEMENT

Medical Considerations

The first task of the dentist is to identify patients with hypertension, both diagnosed and undiagnosed. A medical history, including the diagnosis of hypertension, how it is being treated, identification of antihypertensive drugs, compliance of the patient, the presence of symptoms associated with hypertension, and the level of stability of the disease, should be obtained. On occasion, patients may fail to report that they have been given a diagnosis of hypertension; however, they may report taking medications, including herbal medications, that are typically used to treat high blood pressure. This may be the only way for the clinician to uncover information revealing that the patient has hypertension. Patients also may be receiving treatment for complications of hypertensive disease, such as congestive heart failure, cerebrovascular disease, MI, renal disease, peripheral vascular disease, and diabetes mellitus. These problems should be identified as well because they may necessitate modification of the dental management plan. In addition to a medical history, all patients should undergo blood pressure measurement. Blood pressure measurements should be routinely performed for all new patients and at recall appointments**.** More frequent blood pressure measurements are indicated for patients who are not compliant with treatment, who are poorly controlled, or who have comorbid conditions such as heart failure, previous MI, or stroke. Patients who are being treated for hypertension but who have blood pressures above normal are most often noncompliant or inadequately treated; they should be encouraged to return to their physician. The patient who has not been given a diagnosis of hypertension but who has an abnormally elevated blood pressure should also be encouraged to see his or her physician. When a patient with upper level stage 2 blood pressure is treated, consideration should be given to leaving the blood pressure cuff on the patient's arm and periodically checking pressure during the appointment. The dentist should not

make a diagnosis of hypertension but rather should tell the patient that his or her blood pressure reading is elevated, and that a physician should evaluate the condition. The primary concern when one is providing dental treatment for a patient with hypertension is that during the course of treatment, the patient might experience an acute elevation in blood pressure that could lead to a serious outcome such as stroke or MI. This acute elevation in blood pressure could result from the release of endogenous catecholamines in response to stress and anxiety, from injection of exogenous catecholamines in the form of vasoconstrictors in the local anesthetic, or from absorption of a vasoconstrictor from the gingival retraction cord. Other concerns include potential drug interactions between the patient's antihypertensive medications and the drugs prescribed and oral adverse effects that might be caused by antihypertensive medications.

The following two questions should be answered before dental treatment is provided for a patient with hypertension:

1. What is the risk if a patient with high blood pressure is treated?
2. At what level of blood pressure is it unsafe to treat a patient?

The American College of Cardiology and the American Heart Association have published practice guidelines for the preoperative evaluation of patients with various types of cardiovascular disease who are undergoing noncardiac surgery that can be used to help answer these questions. These guidelines assess the risk of occurrence of a serious event such as stroke, MI, acute heart failure, or sudden death if a patient with cardiovascular disease undergoes some form of noncardiac surgery. Oral and maxillofacial surgery and periodontal surgery are both forms of noncardiac surgery; thus these guidelines are directly applicable. In addition, the guidelines may be applied to nonsurgical dental treatment. Determination of risk includes the evaluation of three factors: the risk imposed by the patient's cardiovascular disease, the risk imposed by the surgery or procedure, and the risk imposed by the functional

reserve or capacity of the patient. The risk imposed by the presence of a specific cardiovascular condition or disease is stratified into major, intermediate, and minor risks for the intraoperative occurrence of an untoward event. Uncontrolled blood pressure, defined as ≥180/110 mm Hg, is classified as a *minor* risk condition, but a statement is included that blood pressure should be brought under control before any surgery is performed. It should be recalled that the JNC classification recommends immediate treatment for patients with blood pressures ≥180/110. The JNC further identifies *severe* hypertension as blood pressure ≥180/120 mm Hg and bases the need for emergency treatment on the presence of progressive target organ dysfunction. Risk imposed by the type of surgery (or procedure) is also stratified into high (5% risk), intermediate (5% risk), and low (1% risk). In general, risk is greatest with elderly patients, emergency surgery, lengthy procedures, and excessive blood loss. Head and neck surgery, which may include major oral and maxillofacial procedures and extensive periodontal procedures, is classified as *intermediate* risk. Superficial surgical procedures, which include minor oral and periodontal surgery and nonsurgical dental procedures, are classified as *low* risk. The third factor involved in risk assessment is determination of the functional capacity or cardiopulmonary reserve of the patient, defined as metabolic equivalents (METs) Perioperative cardiac risk is increased in patients who are unable to meet a 4-MET demand during most normal daily activities, which is equivalent to climbing a flight of stairs. Thus a patient who reports an inability to climb a flight of stairs while carrying a bag of groceries without chest pain, shortness of breath, or fatigue would be at increased, but *minor,* risk during a procedure. Thus it is apparent that the risk of providing routine dental treatment for most patients with high blood pressure is very low. In summary, patients with blood pressure less than 180/110 can undergo any necessary dental treatment, both surgical and nonsurgical, with very little risk of an adverse outcome. For patients found to have asymptomatic blood pressure

≥180/110 mm Hg (uncontrolled hypertension), elective dental care should be deferred and the patient referred to a physician as soon as possible for evaluation and treatment. Patients with elevated blood pressure with symptoms such as headache, shortness of breath, chest pain, nosebleeds, or severe anxiety (severe hypertension) may require more urgent medical attention. In patients with uncontrolled or severe hypertension, the need for urgent dental treatment (pain, infection, or bleeding) may necessitate treatment. In this instance, the patient should be managed in consultation with the physician, and measures such as intraoperative blood pressure monitoring, electrocardiogram monitoring, establishment of an intravenous line, and sedation may be used. The decision must always be made as to whether the benefit of proposed treatment outweighs the potential risks.

Once it has been determined that the hypertensive patient can be safely treated, a management plan should be developed . For all patients, the dentist should make every effort to reduce as much as possible the stress and anxiety associated with dental treatment. This is of particular importance when treating the patient with hypertension. A critical factor in providing ananxiety-free situation is the relationship established among the dentist, office staff, and patient. Patients should be encouraged to express and discuss their fears, concerns, and questions about dental treatment. Stress management is important for patients with hypertension to lessen the chances of endogenous release of catecholamines during the appointment. Long or stressful appointments are best avoided. Short morning appointments seem best tolerated. If the patient becomes anxious or apprehensive during the appointment, the appointment may be terminated and rescheduled for another day. Anxiety can be reduced for many patients by oral premedication with a short-acting benzodiazepine such as triazolam (Halcion; Pharmacia & Upjohn, Kalamazoo, Mich). An effective approach is to prescribe a dose at bedtime the night before and another dose 1 hour before the dental appointment. Dose is dictated by the age and

size of the patient and by prescribing guidelines for the agent selected. Nitrous oxide plus oxygen inhalation sedation is an excellent intraoperative anxiolytic for use in patients with hypertension. Care should be used to ensure adequate oxygenation at all times, especially at the termination of administration. Hypoxia is to be avoided because of the resultant elevation in blood pressure that may occur. When patients with upper level stage 2 hypertension are treated, it may be advisable to leave the blood pressure cuff on the patient's arm, and to periodically check the pressure during treatment. If the blood pressure rises above 179/109, the appointment should be terminated and the patient rescheduled. Because some antihypertensive agents tend to produce orthostatic hypotension, sudden changes in chair position during dental treatment should be avoided. When treatment has concluded for that appointment, the dental chair should be returned slowly to an upright position. After patients have had time to adjust to the change in posture, they should be physically supported while slowly getting out of the chair and should have obtained good balance and stability. If they complain of dizziness or lightheadedness, they should sit back down until they recover equilibrium. Ambulatory (outpatient) general anesthesia in the dental offi ce is generally recommended only for patients with classifi cation by the American Society of Anesthesiologists (ASA) as ASA I (healthy, normal patient) or ASA II (mild to moderate systemic disease). Some patients with severe hypertension may be excluded. ***Use of Vasoconstrictors.*** Profound local anesthesia is critical for pain and anxiety control and is especially important in patients with hypertension or other cardiovascular disease to decrease endogenous catecholamine release. The effectiveness of local anesthesia is enhanced by the inclusion of a vasoconstrictor in the local anesthetic solution that delays systemic absorption, increases the duration of anesthesia, and provides local hemostasis. These properties allow for enhanced quality and duration of pain control and markedly facilitate performance of the technical procedures. Thus the

advantages of including a vasoconstrictor in the local anesthetic are obvious. Concerns, however, have been associated with the use of a vasoconstrictor. The potential danger in administering a local anesthetic containing epinephrine or another vasoconstrictor to a patient with hypertension or other cardiovascular disease lies in the potential to cause an acute increase in blood pressure or an arrhythmia.To make rational decisions regarding the use of vasoconstrictors in patients who are hypertensive or otherwise medically compromised, the dentist should first understand the physiology of adrenergic receptors. The two basic types of adrenergic receptors are alpha and beta, which are further divided into alpha1 and alpha2, and beta1 and beta2. These receptors are found throughout the body in most tissues and organs; however, usually one type predominates. Of particular interest are their effects on blood vessels and the heart. Alpha1 receptors predominate in peripheral arterioles and cause vasoconstriction, beta1 receptors predominate in the heart and cause an increase in cardiac output and heart rate, and beta2 receptors predominate in arterioles in skeletal muscle, causing vasodilatation. Alpha2 receptors act in concert with alpha1 receptors. Drugs that stimulate adrenergic receptors are called *sympathomimetic* or *adrenergic* drugs. Vasoconstrictors, which are examples of these drugs, include epinephrine, norepinephrine, and levonordefrin. These drugs stimulate adrenergic receptors to varying degrees, and their effects are dose dependent. Epinephrine is potent stimulator of alpha and beta receptors, with a predominance of beta2 activation. Norepinephrine is a potent stimulator of alpha1 and beta1 receptors but has little effect on beta2. As a result, norepinephrine may cause a significant rise in systolic and diastolic blood pressures. Levonordefrin is similar to norepinephrine in action but has somewhat less alpha1 potency and slightly more beta2 potency. Norepinephrine is not available for use as a vasoconstrictor in the United States. The cardiovascular response to conventional doses of injected epinephrine in patients who are healthy and in those with

hypertension is usually of little concern. A meta-analysis of several clinical studies determined that the mean resting venous plasma epinephrine concentration is 39 pg/mL; this is approximately doubled by the intraoral injection of a single cartridge of 2% lidocaine with 1 : 100;000 epinephrine.20 This elevation in plasma epinephrine is linear and dose dependent. Although large doses of epinephrine may cause a significant rise in blood pressure and heart rate, small doses such as those contained in one or two cartridges of lidocaine with 1 : 100,000 epinephrine may cause minimal pharmacologic change. This fact is due to a preponderance of action among beta2 receptors and a decrease in diastolic pressure; thus, mean arterial pressure is essentially unchanged with only a minimal increase in heart rate. Several clinical investigations have evaluated changes in plasma epinephrine concentration and hemodynamic parameters in healthy patients after dental injections of 2% lidocaine with 1 : 100,000 epinephrine. After injection of 1.8 mL (one cartridge), plasma levels increased twofold to threefold, but no signifi cant changes were observed in heart rate or blood pressure. With 5.4 mL of solution (three cartridges), however, plasma levels increased five fold to six fold; these changes were accompanied by a significant increase in heart rate and systolic blood pressure with no adverse symptoms or sequelae. The critical question is how does a patient with hypertension or other cardiovascular disease react to these dose challenges of epinephrine? This question was addressed empirically in 1955 by the New York Heart Association, which recommended that a maximum of 0.2 mg of epinephrine (11 cartridges of 1 : 100,000 epinephrine with procaine) be used during a single session in dental patients with heart disease. In 1964, a Working Conference of the American Dental Association and the American Heart Association concluded, “Concentrations of vasoconstrictors normally used in dental local anesthetic solutions are not contraindicated in patients with cardiovascular disease when administered carefully and with preliminary aspiration.” Contrary to these

recommendations, Abraham-Inpijn et al found that patients with hypertension undergoing dental extractions had a greater increase in blood pressure than did patients thought to be normotensive after injection of 2% lidocaine with 1 : 80,000 epinephrine. In addition, 7.5% of patients with hypertension developed significant arrhythmias. In a similar study, however, in which the responses of patients who were normotensive and hypertensive were compared using lidocaine plain, with 1 : 100,000 epinephrine, and 1 : 20,000 norepinephrine during extractions, no significant differences were noted in heart rate or blood pressure between plain lidocaine and lidocaine with epinephrine. However, lidocaine with norepinephrine produced a significant increase in blood pressure and decreased heart rate. Another study of dental patients who were undergoing oral surgery found no difference in the blood pressures of patients with hypertension who received 2% lidocaine with 1 : 80,000 epinephrine. Of particular interest is a study that evaluated epinephrine infusion used as a stress test in 39 patients suspected of having coronary artery disease in whom epinephrine was injected intravenously in progressively increasing doses from 2.1 to 21.0 mg per minute over a 30-minute period. (A total of 18 mg of epinephrine is found in one cartridge of 1 : 100,000 epinephrine.) Of 24 patients who were subsequently found not to have coronary artery disease, none developed electrocardiographic changes, and none had symptoms over the course of 30 minutes. Of 15 patients in whom coronary artery disease was diagnosed, however, 7 developed significant arrhythmias, 7 had chest pain, and 4 had shortness of breath or other symptoms. In spite of the symptoms and hemodynamic changes, no test had to be terminated, and all symptoms subsided after the test without sequelae. A systematic review of the literature on the cardiovascular effects of epinephrine on hypertensive dental patients32 concluded that although the quantity and quality of pertinent articles were problematic, the increased risk for adverse events among uncontrolled hypertensive patients was low, and the reported occurrence of adverse

events associated with the use of epinephrine in local anesthetics was minimal. This review was cited by the JNC 7 report and supported its conclusions.Another recent review of the subject noted an absence of adverse case reports involving epinephrine in local anesthetics and cited the numerous studies that demonstrated the safety and effi cacy of these preparations.33 Thus, from the existing evidence, it would appear that one or two cartridges of 2% lidocaine with 1 : 100,000 epinephrine are of little clinical signifi cance in most patients with hypertension; the benefi ts of its use far outweigh any potential disadvantages or risks. Use of more than this amount may well be tolerated but with increasing risk for adverse hemodynamic changes. Norepinephrine and levonordefrin should be avoided in patients with hypertension because of their comparative excessive alpha1 stimulation. The use of epinephrine is generally not advised in patients with uncontrolled or severe hypertension, and indeed, elective dental care should be deferred. However, if urgent treatment becomes necessary, a decision must be made about the use of epinephrine, which will be dictated by the situation. From all available evidence, it would seem that the benefi ts of its use outweigh the increased risks, as long as modest doses are used and care is taken to avoid inadvertent intravascular injections. It is advisable to consult with the patient's physician prior to making a decision. An additional concern when patients with hypertension are treated is the potential for adverse drug interactions between vasoconstrictors and antihypertensive drugs, specifi cally, the adrenergic blocking agents. The basis for concern with nonselective beta-adrenergic blocking agents (e.g., propranolol) is that the normal compensatory vasodilatation of skeletal muscle vasculature mediated by beta2 receptors is inhibited by these drugs, and injection of epinephrine, levonordefrin, or any other pressor agent may result in uncompensated peripheral vasoconstriction because of unopposed stimulation of alpha1 receptors. This may cause a significant elevation in blood pressure and a compensatory bradycardia. Several cases of this interaction have been reported in

the literature, but it appears to be dose dependent. Adverse interactions are less likely to occur in patients who take cardioselective beta blockers. Peripheral adrenergic antagonists, such as reserpine and guanethidine, also present the potential for adverse interaction with vasoconstrictors because of enhanced receptor sensitivity to direct-acting sympathomimetics, resulting in reports of enhanced systemic response to vasoconstrictors. Although the potential exists for adverse interactions between vasoconstrictors and the nonselective betablocking agents or peripheral adrenergic antagonists, available reports and clinical experience suggest that epinephrine in small doses of one to two cartridges containing 1 : 100,000 epinephrine can be used safely in most patients. Jastak et al suggest that a small test dose (1 mL of the 1 : 100,000 epinephrine solution) should be given to patients taking these drugs and that blood pressure should be monitored every minute for at least 5 minutes. If no significant change in blood pressure is noted during this period, epinephrine can be safely used in modest amounts. Topical vasoconstrictors generally should not be used for local hemostasis in patients with hypertension. When performing crown and bridge procedures for patients with hypertension, the dentist should avoid using gingival retraction cord that contains epinephrine because these cords contain highly concentrated epinephrine, which can be quickly absorbed through the gingival sulcular tissues, resulting in tachycardia and elevated blood pressure. As an alternative, one study reported that tetrahydrozoline (Visine; Pfi zer Inc, New York, NY), oxymetazoline (Afrin; Schering-Plough, Summit, NJ), and phenylephrine (Neo-Synephrine; Bayer, Morristown, NJ) may be used to soak the cord, providing similar hemostatic effects as epinephrine but with minimal cardiovascular effects. Several other effects are of concern with antihypertensive agents and dentistry. Some antihypertensive agents, especially alpha blockers, alpha/beta blockers, and diuretics, may predispose patients to orthostatic hypotension and potentiate the actions of anxiolytic and sedative drugs. Anxiolytics

and sedatives may be used for patients who take these antihypertensive medications; however, their usual dosage may have to be reduced. The efficacy of antihypertensive drugs may be decreased by the prolonged use of nonsteroidal antiinflammatory drugs, which should be considered if these drugs are used for analgesia, although the use of nonsteroidal antiinflammatory drugs for a few days is of little practical concern. Some antihypertensive agents may produce a tendency for nausea and vomiting, and excessive stimulation of the gag reflex during dental treatment may precipitate nausea or vomiting. Another concern is the patient, with or without hypertension, who may be using cocaine. Cocaine may cause hypertension and tachycardia, and this effect can be magnified if epinephrine-containing local anesthetic is inadvertently injected intravascularly. Therefore, whenever possible, local anesthetics that contain vasopressors should not be administered to patients who have used cocaine on the day of their dental appointment.

Figure 3-4. Gingival hyperplasia in a patient taking a calcium channel blocker. (Courtesy Dr. Terry Wright.)

BOX 3-3

Lifestyle Modifications for the Prevention and Reduction of High Blood Pressure

- Weight loss
- DASH (Dietary Approaches to Stop Hypertension) Diet
  - Fruits
  - Vegetables
  - Low-fat dairy products
- Reduce cholesterol
- Reduce saturated and total fat
- Reduce sodium to <2.4 g/day
- Regular aerobic physical activity on most days (30 minutes of brisk walking)
- Limited alcohol intake to no more than 1 oz/day (2 drinks for men and 1 drink for women)

BOX 3-4

Clinical Predictors of Increased Perioperative Cardiovascular Risk (myocardial infarction, heart failure, death)

MAJOR
- Unstable coronary syndromes
- Acute or recent myocardial infarction (*) with evidence of important ischemic risk in clinical symptoms or noninvasive study
- Unstable or severe angina (Canadian Class III or IV)††
- Decompensated heart failure
- Significant arrhythmias
- High-grade atrioventricular block
- Symptomatic ventricular arrhythmias in the presence of underlying heart disease
- Supraventricular arrhythmias with uncontrolled ventricular rate
- Severe valvular disease

INTERMEDIATE
- Mild angina pectoris (Canadian Class I or II)†
- Previous myocardial infarction by history or pathological Q waves
- Compensated or prior heart failure
- Diabetes mellitus (particularly insulin-dependent)
- Renal insufficiency

MINOR
- Advanced age
- Abnormal ECG (left ventricular hypertrophy, left bundle-branch block, ST-T abnormalities)
- Rhythm other than sinus (e.g., atrial fibrillation)
- Low functional capacity (e.g., inability to climb one flight of stairs with a bag of groceries)
- History of stroke
- Uncontrolled systemic hypertension (≥180/110 mm Hg)

BOX 3-5

Cardiac Risk* Stratification for Noncardiac Surgical Procedures

HIGH (REPORTED CARDIAC RISK OFTEN GREATER THAN 5%)
- Emergent major operations, particularly in the elderly
- Aortic and other major vascular surgery
- Peripheral vascular surgery
- Anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss

INTERMEDIATE (REPORTED CARDIAC RISK GENERALLY LESS THAN 5%)
- Carotid endarterectomy
- Head and neck surgery
- Intraperitoneal and intrathoracic surgery
- Orthopaedic surgery
- Prostate surgery

LOW (REPORTED CARDIAC RISK GENERALLY LESS THAN 1%)
- Endoscopic procedures
- Superficial procedures
- Cataract surgery
- Breast surgery

Dental Management and Follow-up Recommendations Based on Blood Pressure

Blood Pressure	Dental Treatment Recommendation	Referral to Physician
≤120/80	Any required	No
≥120/80 but <140/90	Any required	Encourage patient to see physician
≥140/90 but <160/100	Any required	Encourage patient to see physician
≥160/100 but <180/110	Any required; consider intraoperative monitoring of blood pressure for upper level stage 2	Refer patient to physician promptly (within 1 month)
≥180/110	Defer elective treatment	Refer to physician as soon as possible; if patient is symptomatic, refer immediately

BOX 3-6

Dental Management Recommendations for Patients With Hypertension

- Stress/anxiety reduction
- Establishment of good rapport
- Short, morning appointments
- Consider premedication with sedative/anxiolytic
- Consider intraoperative use of nitrous oxide/oxygen
- Obtain excellent local anesthesia; OK to use epinephrine in modest amounts
- Cautious use of epinephrine in local anesthetic in patients taking non-selective β-beta blockers or peripheral adrenergic antagonists
- Avoid the use of epinephrine-impregnated gingival retraction cord
- Consider periodic intraoperative BP monitoring for patients with upper level stage 2 hypertension; terminate appointment if BP rises above 179/109
- Slow position changes to prevent orthostatic hypotension

BP, Blood pressure.

Suggestive Reading

James W Little, Craig S Miller, Nelson L Rhodus. Dental management of medically compromised patient, 9th edition, Elsevier, 2018