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ENDODONTIC CONSIDERATIONS IN CARDIOVASCULAR PATIENTS

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ABSTRACT
Oral health is mirror of general health. Oral health care professionals must be able to identify patients with systemic diseases, compromising conditions, and disabilities that have an impact on and can be impacted by, oral and maxillofacial health care. The ability to properly practice dentistry within the context of the larger health care system is often a challenge for the dental practitioner Inappropriate identification of a patient with a compromising systemic condition through improper history taking and interpretation, can create ineffective, or even detrimental, oral health care. The common medical conditions encountered by the dentist in daily practice include patients with cardiac diseases, pulmonary diseases, hypertension, diabetes, bleeding disorders, pregnant patients and patients undergoing radiation therapy**.**

KEY WORDS: Cardiovascular disease; Ischemic Heart Disease; Myocardial Infarction; Hypertension; Infective Endocarditis.

INTRODUCTION
Cardiovascular diseases (CVD) comprise of a group of diseases of the heart and vascular system affecting majority of individuals worldwide. Ischemic heart disease, Hypertension, Dysrhythmias, and Infective Endocarditis are some of the cardiovascular conditions most commonly seen among the population. Co-existent cardiovascular disease is the most frequently cited medical condition for patient referral from general dental practitioners to hospital departments, which reflects widespread concern over potential problems during treatment.[1]

In addition, many CVD patients have other systemic diseases that increase the morbidity and mortality of each disease. There are numerous well-known risk factors, and evidence is building to connect periodontal disease and chronic inflammation to CVD.[2-4] It is important for patients with CVD to have optimum oral health to reduce the potential for pain that in turn may elevate endogenous epinephrine and add stress to the cardiovascular system. CVD pain may also be confused with pain of dental origin.

PATHOGENESIS / ETIOLOGY OF CARDIOVASCULAR DISORDER
Ischemic heart disease
Ischemic heart disease (IHD) exists because of myocardial oxygen delivery that is insufficient in relation to myocardial oxygen demand. Coronary atherosclerotic disease, by progressively narrowing the lumen of the epicardial coronary blood vessels, is the most common cause. Other significant mechanisms producing myocardial ischemia include increased myocardial oxygen demand resulting from left ventricular hypertrophy, which is often seen in patients with chronic hypertension, and decreased oxygen carrying capacity of the blood, which is seen in patients with severe anemia.[5]

Dental professionals managing patients with potentially clinically significant IHD are wise to take note of the presence of major risk factors for IHD in their patients.[6] Factors related to family history, gender, and age cannot be modified. Family history of IHD is especially important because the presence of IHD at an early age in a patient's parents significantly increases the risk of IHD in the patient and the risk that IHD will occur at a relatively young age. Gender as a risk factor has its greatest impact between ages 25 and 64, when men have

a three times greater incidence of cardiovascular diseaseand five fold higher mortality rate than women of a similar age.[7]

The most critical modifiable risk factors include total serum cholesterol levels, systolic and diastolic blood pressure (BP), cigarette smoking, and diabetes mellitus.[8] Total cholesterol $\geq$240 mg/dL is closely associated with the development of IHD. Other forms of dyslipidemia that are relevant include elevated low-density lipoprotein cholesterol levels, low high-density lipoprotein (HDL) levels, or increased total-to-HDL cholesterol ratio, hypertriglyceridemia, and increased levels of lipoprotein a.[9] Similarly, hypertension is a risk factor that can be controlled. Systolic BP of $\geq$140 or diastolic BP $\geq$90 increases the likelihood of IHD.[8] Diabetes is the other major modifiable risk factor and recent reports confirm that tight control of serum glucose levels decreases the risk of IHD in patients.[10]

Coronary artery disease
Coronary artery disease (CAD) specifies inadequate blood supply to the blood vessels in the heart. Symptoms may include fatigue or shortness of breath, or there may be none at all. Angina pectoris (AP) is defined as sudden- onset, substernal, or precordial chest pain due to myocardial ischemia, but without infarction (necrosis). The pain often radiates to the left arm, neck, jaw, or back.
Angina is classified as stable, unstable.

- Stable angina is predictable, induced by exercise or exertion, and lasts for less than 15 min.
- Unstable angina can occur at any time, is more severe, and lasts longer.

Physicians often classify anginal pain according to its functional severity. The Canadian system of classification is widely used for this as shown in table 1.[11] Other less common causes of angina include aortic stenosis, arrhythmias, myocarditis, mitral valve prolapse, and hypertrophic cardiomyopathy.

Myocardial infarction
Myocardial infarction, like angina, is related to the formation of atherosclerotic lesions. A myocardial infarction (MI) stems from an ulceration or rupture of the fibrous cap covering the plaque. The exposed contents of the plaque triggers the deposition of platelets and the clotting of adjacent blood at the site of an atherosclerotic lesion. If this clotting is significant, a thrombus forms. If and when the thrombus becomes large enough, it obstructs blood flow and myocardial tissue downstream from the obstruction begins to suffer ischemia.[13]

MIs are evaluated using two criteria: depth and location. If the infarct involves the full thickness of the ventricular wall, it is termed transmural, a subendocardial infarct is limited to the inner one-third to one-half of the ventricular wall. Location is reported by wall or coronary artery involvement; for example, antero-septal infarct,

left ventricular anterior wall infarct, and left anterior descending coronary infarct. Clinical evaluation of patients with MIs by ECG shows two types: those with ST elevation MI or non-ST elevation MI.[14]

Hypertension
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 defined as hypertension (HTN). HTN is also a risk factor in many diseases, including CVD, stroke, renal failure, and heart failure (HF).The great majority of patients with HTN (90%) have no primary cause, thus the term essential HTN. The remaining 10% have an identified etiology such as pheochromocytoma, aortic regurgitation, renal artery stenosis, and preeclampsia, or are drug induced by corticosteroids, nonsteroidal anti-inflammatory drugs, or oral contraceptives.

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) published HTN guidelines in 2003.[15] The term Pre-hypertension was introduced to draw attention to those patients whose BP was at increased risk of developing into HTN. This classification of systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg was developed to encourage people to adopt healthy lifestyles. Dentists were specifically included in this report to help with surveillance, as most patients with HTN may have no symptoms. The earlier that patients can be diagnosed and treated, the less the extent of lasting effects.[16]

- ❖ Normal Bp For Adults, <120/80 mmHg
- ❖ Prehypertension, 120–139/80–89 mmHg
- ❖ Stage 1 HTN, 140–159/90–99 mmHg
- ❖ Stage 2 HTN, >160/100 mmHg

The Eighth Report (JNC 8)[17] was published in December 2013 and relies on clinical evidence to support higher goals in the treatment of HTN for some patients:

- in patients 60 years or older, who do not have diabetes or chronic kidney disease, the BP goal is now <150/90 mmHg
- for patients 18–59 without comorbidities and those over 60 with diabetes, chronic kidney disease, or both, the goal is <140/90 mmHg.

Heart failure
Heart failure occurs when the heart can no longer maintain circulation that is adequate for body tissues to function. Congestive HF describes the clinical signs of pulmonary and/ or peripheral edema in addition to the inadequate circulation. Symptoms may include shortness of breath, orthopnea, fatigue, and inability to cope with physical activity.
The pathophysiology has two components:

- Pump failure (weakness or inefficiency of ventricular contraction)
- Increased workload

Congenital heart disease

Congenital heart disease or defects are evident from birth. Some examples include atrial–septal defects, patent ductus arteriosus, atrioventricular (AV) septal defects, tetralogy of Fallot, transposition of the great arteries, hypoplastic left heart syndrome, and coarctation of the aorta.

Infective endocarditis

Infective endocarditis (IE) is a microbial infection of the endothelial surface of the heart or heart valves that most often occurs in proximity to congenital or acquired cardiac defects.

Vegetations form on the valves that consist of organisms, usually *streptococci* or *staphylococci*, fibrin, and inflammatory cells. Erosions, valve perforations, and abscesses in the myocardium can occur. Symptoms are similar to HF. Most patients recover from the infection, but injury to one or more valves persists. Rarely, other complications result; for example, septic emboli to the brain, spleen, or kidneys.

Cardiac arrhythmias

A cardiac arrhythmia can be described as an abnormality in rate, regularity, or site of origin of the cardiac impulse. In addition, conduction of the impulse within the heart may be abnormal.[18] Thedisruption may be due to an area of infarction, ischemia, electrolyte imbalance, or medication. Many patients have no symptoms of arrhythmia; however, some patients have HF secondary to the arrhythmia with symptoms that can be very severe.

COORDINATION OF CARE BETWEEN DENTIST AND PHYSICIAN

Patients with CVD will need elective and urgent dental care. The dentist must be able to ask the right questions of the physician regarding the patient's ability to tolerate the stress of dental treatment, as well as understand the information provided by the physician. Certain medications have oral adverse drug reactions that can be managed by the dentist. Other medications cause increased bleeding. For patients with acute or severe CVD, hospital-based dental care may be necessary. For some patients, the dentist may observe signs of CVD during a dental appointment. Reviewing the patient's medical history and measuring the BP and assessing the heart rate and rhythm (pulse) may identify contraindications or the need for modifications in the provision of dental care.

MEDICAL MANAGEMENT

Identifcation: Many cases of CVD develop very insidiously so that patients are unaware of the severity until a catastrophic event happens. Ideally, everyone would have simple tests related to the cardiovascular system done on a regular basis: BP measurement, ECG, stress test, blood lipids, blood chemistry,and so on.

Medical History: The patient who knows that they he/she has CVD should identify his/her specifc problems upon review of his/her medical history. Other observations may lead the endodontist to understand the severity of the problems, and the degree of control or management of the problem:

- elevated BP
- irregular or abnormal heart rate
- abnormal respiratory rate
- shortness of breath upon exertion
- patient is uncomfortable in supine position
- prolonged bleeding/easy bruising

Surgical or cardiac procedural history will reveal patients who have received coronary artery angioplasty and stents, coronary artery bypass grafts (CABGs), heart valve repair or prosthetic valve replacements, repair of congenital heart defects, removal of excess heart muscle, pacemakers or implantable cardioverter–defibrillator (ICD) or heart transplantation.

Physical Examination

When treating the patient with CVD, the endodontist should check the BP and heart rate before any invasive procedures, and before injecting local anesthetic. Comparing these data with baseline values may reveal a disease that is worsening, problems with medication compliance, or development of tolerance to a medication.

ENDODONTIC TREATMENT MODIFCATIONS IN CARDIOVASCULAR DISORDER PATIENT
All patients

The American Society of Anesthesiologists developed a physical status classification system to predict the risk of general anesthesia. This scale has been applied to the provision of dental care.

HTN

No patient in dental clinics should be treated when diastolic pressure is over 100 mmHg and systolic pressure is above 180 mmHg. Routine dental treatment should be deferred until acceptable blood pressure levels are achieved, and the patient should be referred for medical evaluation.[19]

The prescription of anxiolytic agents may prove necessary in particularly anxious patients (5-10 mg of diazepam the night before and 1-2 hours before the appointment) before dental treatment, or alternatively sedation with nitrous oxide may be considered.

A good local anesthetic technique should be performed, avoiding intravascular injection and using a maximum of two anesthetic carpules with vasoconstrictor. If more anesthesia is needed, it should be provided without vasoconstrictor. Absorbable suture are to be avoided with adrenalin.[16] During treatment, sudden changes in body position should be avoided, as they can cause orthostatic hypotension as a side effect of the blood pressure lowering drugs.

Certain non steroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, indomethacin or the naproxen, can interact with antihypertensive drugs (beta-blockers, diuretics, ACEIs), thereby lowering their antihypertensive action.[20] Normally more than five days of treatment with both types of drugs are required for interactions to manifest; as a result, NSAIDs should not be prescribed for longer than this five-day period.[20,21]

Local anesthesia with vasoconstrictor
The existing controversy over the use of local anesthesia with a vasoconstrictor is explained by the possible adverse effects of these substances upon blood pressure and/or heart rate.[6] Patients with cardiovascular disease are at a greater risk of massive endogenous adrenalin release secondary to deficient local anesthesia than of reaction to the small amount of vasoconstrictor used in local anesthetics.

Nevertheless, vasoconstrictor use should be limited, taking care not to exceed 0.04 mg of adrenaline (2 carpules containing 1.8 ml of anesthetic with adrenalin 1: 100,000).[22]

Hypertensive emergencies
In the case of a hypertensive emergency (>210/120 mmHg), the emergency service should be activated and furosemide should be administered (40mg, via the oral route). If this proves insuffcient to restore pressure control, captopril should be administered (25 mg via the oral or sublingual route). If the blood pressure fails to decrease within 30 minutes after these measures, the patient should be referred to the nearest Hospital Emergency Department.

Heart failure
Consultation with the supervising physician is advised in order to know the current condition of the patient and the medication prescribed. Anxiety and stress are to be avoided during the visits, which in turn should be brief (less than 30 minutes) and are to be programmed for the morning hours. The patient should be placed in the semi-supine position in a chair, with control of body movements (which should be slow), in order to avoid orthostatic hypotension. In patients administered digitalis agents (digoxin, methyldigoxin), the vasoconstrictor dose is to be limited to two anesthetic carpules, since this drug combination can favor the appearance of arrhythmias.

In the event of an emergency (i.e., lung edema), and after contacting the emergency service, the patient should be placed seated with the legs lowered, and receiving nasal oxygen at a rate of 4-6 liters/minute. Sublingual nitroglycerin tablets are indicated (0.4-0.8 mg), and the dose may be repeated every 5 or 10 minutes if blood pressure is maintained.[22]

Cardiac dysrhythmias /arrhythmias
Many antiarrhythmic drugs have side effects such as gingival hyperplasia or xerostomia. Short visits in the morning are to be preferred. Patient monitoring, with recording of the pulse, is indicated before starting treatment. It is very important to limit the use of a vasoconstrictor in local anesthesia, with the administration of no more than two carpules. The treatment planned should not be too long or complicated. According to Becker,[23] although modern pacemakers are more resistant to electromagnetic interferences, caution is required when using electrical devices (e.g., ultrasound and electric scalpels) that might interfere with pacemakers particularly the older models, since most such devices developed in the last 30 years are bipolar and are generally not affected by the small electromagnetic fields generated by dentalequipment.[18] If arrhythmia develops during dental treatment, the procedure should be suspended, oxygen is to be provided, and the patient vital signs are to be assessed. The patient should be placed in the Trendelenburg position, with vagal maneuvering where necessary (Valsalva maneuver, massage in the carotid pulse region, etc.).

Myocardial infarction
A minimum safety period of 6 months should be established before any oral surgical procedure can be carried out. At present, the evaluation of exercise testing in the first 6 days after infarction is considered essential for risk assessment and prognosis. If such testing is well tolerated by the patient, the risk is taken to be low.[24] No ideal minimum time has been established, though many authors consider 4-6 weeks after infarction to be a prudent period. In this time, dental treatment should be limited to emergency procedures aimed at affording pain relief: extractions, the drainage of abscesses and pulpectomies, preferably carried out in the hospital setting. See table 2.

If the patient is receiving anticoagulants, the international normalized ratio (INR) on the day of treatment should be determined, and treatment should be provided within the recommended limits (< 3.5), with local hemostasis if surgery is planned.[25] If the patient is receiving antiplatelet medication, excessive local bleeding is to be controlled. Thelocal hemostatic measures that can be used comprise bone wax, sutures, gelatin of animal origin (gelfoam®), regenerated oxidized cellulose (Surgicel®), collagen, platelet rich plasma, thrombin (Thrombostat®).

If the patient develops chest pain during dental treatment, the procedure should be suspended immediately, and a sublingual nitrite tablet should be administered (0.4-0.8mg), together with nasal oxygen (3 liters/minute). If the pain subsequently subsides, continuation of treatment can be considered, or alternatively an appointment can be made for some other day. If the pain does not subside after 5 minutes, a second sublingual tablet should be administered. If the pain does not disappear 15 minutes after onset, acute myocardial infarction is to be

suspected, and the patient must be transferred to a hospital center.[18,24]

Infective Endocarditis

Infective endocarditis is not an emergency condition inthe dental clinic, though its associated mortality is high. The disease is to be suspected when the patient presents unexplained fever for over one week together with heart murmurs.

The most widely accepted Endocarditis prevention protocols are those of the American Heart Association (AHA) and the British Society of Antimicrobial Chemotherapy (BSAC) see table 3. According to the AHA,[26] antibiotic prophylaxis for dental procedures is only indicated in patients with heart disorders related to a very high risk of developing endocarditis:

- Prosthetic heart valves.
- Previous infectious endocarditis.
- Congenital heart disease, only in the following situations:
⇨ Untreated cyanotic congenital heart disease, including shunts and ducts.
⇨ Congenital heart defects fully repaired with material or prostheses placed through surgery or with

catheters, during the first 6 months after the operation.
⇨ Repaired congenital heart disease, though with residual defects associated to prosthetic materials
- Heart transplant patients who develop cardiac valve disease.

Prophylaxis is recommended in all dental procedures involving the manipulation of gingival tissue, the periapical region of the teeth, or perforations of the oral mucosa, such as extractions, endodontic treatment surpassing the periapical limits, the placement of retraction sutures, biopsies, suture removal. Prophylaxis in turn is not recommended in the routine injection of anesthetic solutions in non-infected tissues, dental X-rays.

It is advisable to perform rinses with 0.12% chlorhexidine for at least 30 seconds, before any dental treatment, since this produces an important reduction in bacteremia of oral origin.[27] Although not based on scientific evidence, the American College of Cardiology recommends that "individuals at risk of developing bacterial endocarditis should observe the best hygiene possible".[28]

Table 1: Canadian Cardiovascular Society grading of angina pectoris.

Canadian Cardiovascular Society grading of angina pectoris	
Grade	Description
Grade I	Ordinary physical activity does not cause angina, such as walkingand climbing stairs. Angina with strenuous or rapid or prolongedexertion at work or recreation
Grade II	Slight limitation of ordinary activity. Walking or climbing stairsrapidly, walking uphill, walking or stair climbing after meals, or in cold, or in wind, or under emotional stress, or only during the few hours after awakening. Walking more than two blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal conditions
Grade III	Marked limitation of ordinary physical activity. Walking one or two blocks on the level and climbing one flight of stairs in normal conditions and at normal pace
Grade IV	Inability to carry on any physical activity without discomfort, anginal syndrome may be present at rest

Table 2: Dental management in patients with ischemic heart disease.

Dental management in patients with ischemic heart disease
❖ Consultation → type of heart disease, severity, time elapsed from the cardiological event, clinical complications, treatment received.   • Take the prescribed medication as usual   • If nitrates are used, the patient should bring them Take as a preventive measure before local anesthesia Take in case chest pain develops   If surgery Anticoagulated patient → determine INR on the day of treatment needed   Antiplatelet patient → local hemostatic measures   ❖ Before 4-6 weeks after infarction → only emergency procedures   ❖ Very anxious patients → premedication (5-10 mg of diazepam the night before and 1-2 hours before treatment)   ❖ Brief visits (less than 30 minutes) → avoiding early morning hours and late afternoon hours   ❖ Anesthesia → not to inject into a blood vessel a maximum of two carpules with vc   If anesthetic reinforcement is needed: anesthesia without vc   ❖ Patient in semi-supine position   ❖ Patient should get up carefully → to avoid orthostatic hypotension   ❖ Monitoring may be required: blood pressure and pulsioxymetric

Table 3: Recommendations of the American Heart Association for antiobiotic prophylaxis of bacterial Endocarditis.[26]

Situation	Agent	Regimen —Single Dose 30-60 minutes before procedure	
		Adults	**Children**
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin **OR**	2 g IM or IV*	50 mg/kg IM or IV
	Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillins or ampicillin— Oral regimen	Cephalexin	2 g	50 mg/kg
	OR		
	Clindamycin	600 mg	20 mg/kg
	OR		
	Azithromycin or clarithromycin	500 mg	15 mg/kg
Allergic to penicillins or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
	OR Clindamycin	600 mg IM or IV	20 mg/kg IM or IV

CONCLUSION

Wide variety of cardiovascular diseases patients are frequently encountered in dental practice and it is necessary to treat them. Safe and effective dental management of such patients requires close medical and dental coordination, an understanding of the potential hazards during dental treatment, knowledge of drugs used in treatment of cardiovascular diseases. Successful management of such patients on a dental Chair is thus based on knowing the patient, understanding the disease process, and judicious use of pharmacologic agents designed to produce a state of relaxation, decrease anxiety, and control the factors which may induce or contribute to the initiation of these cardiovascular diseases.

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