The phenomenon of hypertension
Part I: Etiology and treatment

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In part 1 of this two part article, the author discusses the major classifications of hypertension as well as the relative incidences, etiologies and treatments for each type. The physiological effects of sustained hypertension along with medical and pharmacological therapies are considered in depth.

The hypertensive patient is frequently encountered by the anesthetist. This patient presents a challenge that encompasses a myriad of potential problems. No discussion of anesthesia and hypertension would be complete without a description of the types of hypertension encountered by the anesthetist. Hypertension falls into three major classifications: (1) primary or essential, (2) secondary, and (3) malignant.

Primary hypertension

Primary hypertension afflicts roughly 10% of the general population, or about 23 million people. There is a slightly higher incidence in the black population. The etiology is unknown. It is felt by some authorities that a derangement in the sympathetic nervous system as well as in baroreceptor reactivity may cause hypertension. Other causes postulated include activation of the renin-angiotensin-aldosterone system with sodium and water alterations resulting in a decreased extracellular fluid volume, as well as vascular hyperreactivity and even hereditary components. Primary or essential hypertension is defined as a casual diastolic pressure at or above 95 torr. There are four major categories of essential hypertension according to Brown. These include (1) borderline/labile, (2) mild, (3) moderate and (4) severe.

The borderline or labile hypertensive patient is generally asymptomatic with no organ damage. There is only a slight increase in cardiac output, peripheral vascular resistance and blood pressure, along with a slight decrease in total blood volume. There is no data to show that these patients are at an increased risk for anesthesia and surgery.

Mild hypertension, the second category, is defined as a sustained diastolic pressure at or greater than 95 torr. There is an increased cardiac output and peripheral vascular resistance. Early signs of cardiac involvement manifest themselves, and include nocturia, dyspnea and mild left ventricular hypertrophy due to increased peripheral vascular resistance. These individuals are at a slightly increased risk for anesthesia and should be classified at a minimum of ASA PS II.

Moderate hypertension, the third type of essential hypertension, is defined as a sustained diastolic pressure at or greater than 100 torr. At this stage, there is detectable organ damage and the patient should be on appropriate medical therapy for control of the hypertension. These patients are certainly at an increased risk for anesthesia and surgery.

The fourth type of essential hypertension is
severe and is defined as a sustained diastolic pressure at or greater than 115 torr. These patients have considerable organ damage with a predisposition towards cerebral vascular accident (CVA), acute renal failure, congestive heart failure (CHF) and myocardial infarction (MI). Myocardial infarction is the leading cause of death in the patient with severe hypertension. These individuals are at a high risk for anesthesia and carry a minimum ASA classification of III to IV.

**Secondary hypertension**

Secondary hypertension is due to many causes. Renal causes include acute nephritis, chronic pyelonephritis, polycystic kidney disease and renal artery stenosis. Endocrine causes include primary hyperaldosteronism, Cushing's syndrome, diabetes mellitus, pheochromocytoma and toxemia of pregnancy. There are some neurogenic causes, including chronic hypercapnea, polio and sympathoadrenal hyperactivity. In brief, secondary hypertension can be caused by any number of conditions and has the same physiological consequences as essential hypertension—the difference being the causative factor. Therapy is aimed at minimizing or eliminating the cause rather than the effects.

**Malignant hypertension**

The last type of hypertension is known as malignant hypertension. This is widespread small vessel disease with actual necrosis in the arterial walls. It is rarely encountered and so will not be discussed in any detail here.

**Physiological concerns**

The patient with primary severe hypertension will be the subject of the following discussion of drug therapies and medical and anesthetic management. Further references to hypertension will refer to the primary, severe type of hypertension.

Sustained hypertension has substantial physiological consequences. Vascular structural adaptation occurs, whereby the arterial walls become damaged due to deposits of fibrin, mucopolysaccharides and collagen in the tunica media. Fibrin is allowed to leak in due to the damage in the arterial wall, which further accentuates vascular thickening. This occurs at the level of the precapillary sphincter. Normally the sphincter can tighten to protect the capillary from increased volume loads, but this ability is lost in the chronically hypertensive patient. There is an increased resistance to blood flow due to decreased intraluminal size with resultant changes in organ perfusion.

Genetic tendency, altered sodium intake, environment and emotional upset all tend to reinforce these vascular changes. Systemic vascular resistance and cardiac output increase while arterial muscle tone remains normal. These individuals can constrict and dilate their arteries in response to stimuli, but they differ from the healthy patient in that their response is greatly exaggerated. This response results because the patient’s ratio of arterial wall thickness to internal radius is much greater than in the normotensive patient. Any stimulus results in a much more exaggerated response. The peaks and valleys of the hypertensive patient’s anesthesia record are testament to this.

The hypertensive patient may also show signs of cardiac failure. The ventricular walls undergo the same type of vascular changes as the peripheral vessels. There is usually some component of coronary artery disease as well. The heart muscle must generate increased force to maintain cardiac output against the increased systemic vascular resistance. Couple this with poor coronary artery flow, and it is no wonder that most of these people succumb to myocardial infarction. The ventricles traditionally become enlarged, thickened and less distensible. Eventually there is only distension with an increased left ventricular end-diastolic pressure. Any acute change in systemic vascular resistance puts a strain on an already overworked ventricle, which can lead to subendocardial ischemia. It is easy to see why MI is a leading cause of death in these patients.

Thirty to sixty percent of patients who have chronic severe hypertension die of MI, while 30-40% die of a CVA. Ten percent die of other causes.

If a patient is greater than forty years of age, he probably has a significant component of coronary artery disease. If his hypertension has been untreated, this tendency is accelerated.

The renin-angiotensin-aldosterone system may also precipitate long-standing hypertension. Renovascular hypertension causes derangement in the renal regulation of salt, water and extracellular fluid balance. Renin levels increase along with angiotensin II levels resulting in hypertension. Therapy is aimed at eliminating the cause through renovascular surgery to restore renal blood flow. Some patients may be treated medically with angiotensin II inhibitors.

The hypertensive patient is certainly at an increased risk based on two factors. First, the liability of the hypertension is evident with any patient stimulation. Any changes in systemic vascular resistance due to alteration in vessel tone cause
blood pressure to increase and decrease in wide swings. Secondly, widespread atherosclerosis subjects all organs to low flow, ischemia and damage. Sudden drops in blood pressure can cause acute renal failure, CVA and MI. Sudden rises in blood pressure may precipitate left ventricular failure, CHF and stroke. Therapy is aimed at maintaining a diastolic at or lower than 100 torr.

**Antihypertensive drugs**

The general aim of pharmacologic treatment of hypertension is to decrease the morbidity and mortality of the disease by preserving organ function and flow. Antihypertensive drugs are classified in eight major categories, all of which will be discussed here.

First are the drugs that act centrally by inhibition of the sympathetic activity and stimulation of the alpha receptors in the brainstem. The net result is an inhibition in the sympathetic outflow. These drugs include reserpine, methyldopa (Aldomet) and clonidine. Reserpine depletes epinephrine and norepinephrine stores which take about six weeks to replenish. There are parkinsonian side effects seen with reserpine which many patients find distressing, and it is not used as frequently as it once was.

Methyldopa’s “false transmitter” activity is well known. It is an alpha blocker which depletes norepinephrine stores by substituting itself as a weaker transmitter, alpha-methyl norepinephrine. This interferes with catechole synthesis with decreased levels of norepinephrine available: should the patient be stressed, there may not be sufficient response. Side effects include hemolytic anemia, impotence and postural hypotension. Its central effect is manifested in lethargy and CNS depression.

Clonidine has a central and peripheral inhibitory effect. If this drug is suddenly withdrawn, there can be a significant rebound hypertension due to a sudden increase in sympathetic nervous system activity and norepinephrine levels. These central acting hypertensives should be continued up to and through surgery.

The second group of antihypertensives, the ganglionic blockers, is not very popular. This group blocks autonomic transmission and thereby decreases blood pressure. Hexamethonium and pentolinium are two such drugs. Side effects include dryness, dizziness, gastrointestinal upset and urinary retention. Needless to say, they are not used with any frequency as more effective drugs with fewer side effects are readily available.

The third group of drugs is the alpha blocking agents. These impair transmission in the post-ganglionic sympathetic nervous system and cause arteriolar dilation. The obvious side effect is postural hypotension. The blockage of circulatory reflexes may cause extreme lability under anesthesia, and the patient may develop tachyphylaxis with prolonged use. Some alpha blockers include guanethidine, bethanidine and depresquione.

The fourth group of antihypertensive drugs is the alpha receptor antagonists. These block the action of epinephrine and norepinephrine at the sympathetic post-ganglionic receptors. Phentolamine and phenoxybenzamine are two such examples. The side effect of postural hypotension is significant and can be somewhat debilitating in many patients. These alpha receptor antagonists may be used in the preoperative evaluation and preparation of the patient with pheochromocytoma. They may also be used to treat the rebound hypertension seen with the cessation of clonidine.

Peripheral vasodilators comprise the fifth group of antihypertensive drugs. They directly relax vascular smooth muscle. Hydralazine, one such drug, is slowly metabolized and causes a lupus-like syndrome which disappears when the drug is discontinued. Hydralazine may be used in combination with beta blockade to decrease the tachycardia seen with its use.

Prazosin, another vasodilator, is a newer drug which causes direct vascular dilation due to a mild alpha blockade. It also causes a reflex tachycardia and is often used in conjunction with a beta blocker.

Diazoxide is analogous to the thiazides in structure but has no effect on sodium metabolism. It is useful when rapid correction of hypertension is needed. Side effects include nausea and hyperglycemia. The hyperglycemia may be treated with oral hypoglycemic agents.

Nitroprusside causes a direct vascular smooth muscle dilation. It works rapidly and must be titrated carefully. There are increased thiocyanate levels with the metabolism of this drug and long-term therapy is dangerous. Nitroprusside is more appropriate for the acute situation.

Minoxidil has the same action as the other peripheral vasodilators. Its side effects include hirsutism and urine retention. Urine retention is easily treatable with furosemide.

The sixth group of antihypertensive agents is the diuretics. These are used to promote sodium and water loss by working in various areas of the kidney. Side effects include extracellular fluid depletion, hypokalemia, hyperuricemia (gout) and nausea. Diuretics are often used in conjunction with other hypertensives.
Beta blockers make up the seventh group of drugs and are employed quite frequently as antihypertensives. They vary in their cardioselectivity; some block beta 1 receptors and some block beta 1 and 2, while some are beta 2 specific. They have an intrinsic sympathomimetic activity and have a membrane-stabilizing (quinidine-like) effect, which makes them valuable for treating arrhythmias. Effects include decreased heart rate, cardiac output and blood pressure as well as decreased myocardial oxygen consumption. Beta blockers antagonize renin and have a questionable central effect. Their use in patients with left ventricular failure is somewhat limited, due to their tendency to increase peripheral vascular resistance. They are also limited in the patient with bronchospastic disease as they do have a bronchoconstrictive effect. Beta blockers may also inhibit hepatic gluconeogenesis with a resultant drop in blood sugar. The commonly used beta blockers include propranolol, metoprolol, orpenolol and labetolol. Of these, only labetolol is beta 1-specific and has less effect on bronchial smooth muscle.

Medical management and approaches to the hypertensive patient include cessation of smoking, losing weight, limiting sodium and animal fat intake, increasing moderate exercise, decreasing stress and beginning pharmacological therapy. If the affliction is hereditary, family members are given thorough examinations and appropriate intervention is taken.

As one can see, the hypertensive patient presents the anesthetist with a real challenge in a number of areas. Pharmacologic interaction of antihypertensive agents with anesthetic agents is a very real problem and requires a thorough knowledge of how these agents are employed and act. The physiological damage caused by hypertension also presents the anesthetist with an individual with little coping ability when stressed, who is also very vulnerable to surgical stress and events. Acute rises and falls in blood pressure are poorly tolerated and can have disastrous physiological effects.

In part II of this article, drug interactions and anesthetic implications will be discussed, as well as various anesthetic approaches to these very sick patients.

REFERENCES

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