Objectives

In this chapter we will study

- aneurysms;
- syncope as a symptom of certain cardiovascular disorders;
- orthostatic hypotension;
- Raynaud phenomenon and Raynaud disease;
- patent ductus arteriosus in infants and children;
- varicose veins; and
- cerebrovascular accidents, or strokes.

Aneurysms

An aneurysm is a weak point in a blood vessel or in the heart where a thin-walled, bulging sac forms and may eventually rupture. Any blood vessel may develop an aneurysm, but the aorta is the most susceptible because it is subjected to the highest blood pressure. An aneurysm frequently results from a combination of atherosclerosis, which weakens the vessel wall, and hypertension, which adds stress to the wall. However, aneurysms can also result from syphilis, collagen diseases, or aging. Cigarette smoking, heredity, and trauma are other risk factors for aneurysm.

A true aneurysm involves the weakening and bulging of all three layers of an artery—the tunica interna, tunica media, and tunica externa. A false aneurysm is one in which blood pools in the wall of a vessel and is held there by a clot. A dissecting aneurysm is a condition in which the tunica interna is torn and blood from the arterial lumen flows into the wall, pooling between the tunica media and tunica externa, thus separating (dissecting) these layers. Dissecting aneurysms tend to develop abruptly, usually in the descending aorta, and they cause intense “tearing” or “ripping” pain, especially in the precordial or interscapular areas.

Aneurysms usually develop slowly and sometimes grow huge without producing any symptoms. They can be seen by X ray, sonography, CT, and other imaging methods, and they produce such signs and symptoms as a cough from pressure on the trachea, dysphagia from pressure on the esophagus, hoarseness from pressure on laryngeal nerves, hemoptysis (spitting up blood), a feeling of abnormal abdominal pulsation, and pain in the sternum, ribs, or spine. Cerebral aneurysms (common in the cerebral arterial circle) cause neurological signs due to increased intracranial pressure.

Aneurysms can cause collateral damage to the brain, lungs, nerves, and other adjacent organs by putting pressure on them, but the principal danger of an aneurysm is hemorrhage. The detection of an aneurysm calls for careful management of blood pressure (to prevent hemorrhage) and surgical repair if warranted by the severity of the aneurysm and permitted by its location. (Cerebral aneurysms may be irreparable.) Small aneurysms are managed with medication, but aneurysms beyond a certain size—and all dissecting aneurysms—demand emergency surgical attention. The diseased segment of artery may require replacement by a synthetic graft.

Syncope

Syncope is fainting, a brief loss of consciousness. It usually results from a drop in cerebral perfusion, due to either venous pooling or reduced cardiac output. It can be induced by heart rates lower than 35 beats per minute or greater than 150 beats per minute because cardiac output is reduced in both cases. Hypovolemia and other causes of reduced venous return can also lead to syncope. The loss of consciousness is often preceded by dizziness, light-headedness, nausea, sweating (diaphoresis), or blurred vision. A person who has fainted typically exhibits shallow breathing, a weak pulse, and low blood pressure.
Syncope itself usually requires no treatment, since the person normally drops to a horizontal position and gravity restores the cerebral blood supply. Recovery can be promoted by raising the subject’s legs—for example, by propping the feet on a stack of books—so that blood from the legs drains back to the heart and restores cardiac output. However, the underlying cause of syncope should be identified and corrected if it is not obviously something minor such as an emotional surprise or shock. Syncope can be a sign of cardiovascular disease, hypovolemia, autonomic dysfunction, or other disorders requiring medical attention.

Orthostatic Hypotension

Orthostatic (postural) hypotension is a rapid drop in blood pressure that occurs when a person stands up. Essentially, it results from failure of the baroreflex to compensate for the sudden downward gravitational pull on the blood, failure of valves in the lower limbs to close and prevent the downflow of blood, or both. As a result, cerebral perfusion drops, and the person may feel dizzy or even faint. Fainting and falling, in turn, presents a risk of bone fractures or other injuries. This is especially serious for the elderly. About 20% of randomly selected elderly people have orthostatic hypotension—fewer in physically active, community-dwelling elderly and more in institutionalized elderly. A hip fracture in old age can mean a long period of immobility or even death from pneumonia and other complications of immobility.

There are two types of orthostatic hypotension—acute and chronic. Acute orthostatic hypotension is temporary, occurs infrequently, and results from a sluggish baroreflex. The underlying causes include some medications (vasodilators and diuretics), prolonged immobility, physical exhaustion, and decreased blood volume. Chronic orthostatic hypotension is of longer duration and occurs more frequently in a given person. It may result from adrenal insufficiency, diabetes mellitus, metabolic disorders, diseases that decrease blood volume, and disorders of the nervous system such as intracranial tumors, diabetic neuropathy, or Guillain-Barré syndrome.

The signs and symptoms of orthostatic hypotension vary with the degree of the decreased cerebral blood flow. Mild to moderate decreases may induce faintness, light-headedness, dizziness, confusion, and blurred vision. More severe decreases may cause syncope or even convulsions.

Orthostatic hypotension is diagnosed by monitoring the blood pressure as body position changes. If hypotension develops upon standing and is relieved by reclining, the patient is diagnosed with orthostatic hypotension. The treatment depends on the underlying cause. For example, if the condition is due to venous pooling in the legs, fitted elastic hose may be used to increase venous return and decrease venous pooling. Patients are also advised to change posture slowly and to sleep with the head elevated. Adrenergic drugs can be used, but require careful attention due to their side effects on other organ systems.

Raynaud Phenomenon and Raynaud Disease

Some people experience occasional spasmodic contractions of the arteries of the digits, especially the fingers. These spasms result in pallor, numbness, and coldness of the digits, typically beginning at the tips of the fingers or toes and progressing proximally. The digits often appear cyanotic at first, and then as normal blood flow returns, they turn red and may exhibit throbbing and paresthesia. In prolonged or severe cases, these repetitive ischemic episodes can lead to brittle nails or even to gangrene of the digits, necessitating amputation.

When these spasms occur for a known reason, the disorder is called the Raynaud phenomenon. Causes include collagen diseases, pulmonary hypertension, and long-term occupational exposure to such conditions as cold or vibrating machinery. Raynaud disease is similar in its symptoms and effects but is idiopathic, occurs especially in young women, and is often triggered by emotional stress or brief exposure to cold.

Attacks can often be prevented by swinging the arms back and forth to drive blood to the fingertips and by avoiding the situations that trigger attacks. Since Raynaud disease is idiopathic, no treatment is available. Extreme cases of Raynaud phenomenon can be treated by administering vasodilators or calcium channel blockers, or by severing the sympathetic nerves.

Patent Ductus Arteriosus

The ductus arteriosus (DA) is a short vessel in the human fetus that connects the pulmonary trunk to the
ascending aorta. Since the lungs perform no respiratory function until after birth, it is pointless for the right ventricle to pump all of its blood through them. The ductus arteriosus allows blood from the right ventricle to bypass the lungs and go directly into the systemic circulation. After birth, inflation of the lungs and changes in blood pressure gradients cause reversal of the blood flow in the ductus arteriosus. The ductus constricts, closes off this connection within 10 to 15 hours, and becomes a fibrous cord, the ligamentum arteriosum, within 2 to 3 weeks.

In some infants, however, the ductus arteriosus fails to constrict. It remains open, or patent, thus presenting the condition called patent ductus arteriosus (PDA). Blood in the aorta (which has recently passed through the lungs) now shunts into the pulmonary trunk and travels to the lungs again. This increases pulmonary blood flow and pressure as well as the workload on the heart. PDA may be asymptomatic, but is often characterized by poor weight gain and frequent respiratory infections, and sometimes by left heart failure.

PDA is detectable from chest X rays showing enlargement of the left heart and a continuous, characteristic murmur heard on auscultation or detected by echocardiography. Indomethacin, a prostaglandin inhibitor, sometimes stimulates the DA to close in premature infants, but if this fails, surgical ligation and bisection of the DA is usually performed (that is, the DA is tied off and then cut). This procedure is virtually always successful and seldom has any fatal complications. Surgical closure of the DA is usually done between the ages of 6 months and 3 years.

**Varicose Veins**

A Varicose vein is a vein that has become distended by pooled blood. The most common sites are the great and small saphenous veins of the lower limb, but any vein can be affected. As a case in point, hemorrhoids are varicose veins of the anal canal. Varicose veins develop as trauma damages the venous valves, long periods of standing stretch the veins with pooled blood, or obesity or pregnancy compresses veins and blocks venous return. For example, when blood pools in the veins of the lower limb, the surrounding tissues become edematous, the veins become dilated and convoluted, and the skin of the foot and ankle becomes hyperpigmented by RBCs that leave the circulation and accumulate in the tissues. Circulation can become so poor that the lower limbs develop pressure ulcers.

Varicose veins are incurable, but they can be treated to improve their appearance and relieve the symptoms. The condition is treated conservatively if possible by having the patient wear lightweight compression hosiery and avoid—standing for long periods of time. If these measures are insufficient, heavier elastic support hose may be required. Pain, phlebitis (vein inflammation), and disfigurement may justify surgical treatment. Vein stripping is the surgical removal of the saphenous veins, while sclerotherapy is an alternative to surgery in which the varicose vein is injected with a chemical that obliterates it by inducing fibrosis. Both vein stripping and sclerotherapy are avoided unless the saphenous veins are varicosed all the way from groin to ankle. It is desirable to preserve the saphenous veins if possible, because they are the best source of vein in the event that the patient ever needs coronary bypass surgery.

**Cerebrovascular Accident (Stroke)**

Stroke is known clinically as a cerebrovascular accident (CVA). It is the infarction (sudden necrosis) of brain tissue as the result of a loss of blood perfusion stemming from the obstruction or hemorrhage of a cerebral artery. CVA is the third leading cause of death in the United States. CVAs run in families and have a higher incidence in women than in men and in blacks than in whites. Seventy percent of stroke patients are over the age of 65.

Strokes are classified as thrombotic, embolic, or hemorrhagic, depending on the cause. A thrombotic stroke occurs when a thrombus forms and occludes an artery that supplies the brain. The thrombosis itself is usually triggered by arteriosclerosis, but other risk factors include hypertension, smoking, sickle-cell disease, the use of oral contraceptives, arterial inflammation, and dehydration. Embolic stroke is usually caused by a fragment of a thrombus that originates outside the CNS, breaks free (becoming a thromboembolus), and travels in the bloodstream until it lodges in a cerebral artery. In some cases, however, the embolus is a traveling air bubble, a mass of agglutinated bacteria, or a bit of fat. Air embolism sometimes develops after surgery, and fat embolism sometimes results from broken long bones that release yellow bone marrow into the circulation.
Hemorrhagic stroke occurs when brain tissue loses its blood supply because of the rupture of a cerebral artery. Hemorrhagic strokes are further classified according to the size of the brain lesion: petechial (pinhead-sized), small (up to 2 cm in diameter), or massive (several centimeters in diameter). Treatment must begin within 6 hours of occlusion to avoid irreversible brain damage. Drugs are administered to inhibit clotting, restore blood flow, and protect neurons from damage by calcium inflow, free radicals, and excitatory amino acid neurotransmitters. In the case of hemorrhagic stroke, it is important to relieve the increase in intracranial pressure caused by pooled blood (hematoma), sometimes by aspirating the blood. Losses of motor function are treated with physical therapy.

Case Study 20  The Boy Who Didn’t Grow

Five-year-old Kyle is brought to a pediatrician for his annual checkup. By his mother’s account, Kyle is a normal, healthy child. She is just bringing him in for his childhood vaccinations and to meet his new pediatrician.

During the physical examination, the pediatrician notices that Kyle is small for his age. Kyle’s mother tells the pediatrician that although Kyle has always eaten well, he does not seem to grow as quickly as her other children did at that age. When asked about past illnesses, Kyle’s mother answers that he has had no major illnesses, but he frequently gets colds and flu. In fact, she says, Kyle seems to have more colds and flu than his brothers and sisters.

With the mother’s consent, the pediatrician has his nurse draw a sample of Kyle’s blood for analysis. The results of Kyle’s CBC are as follows:

- Hematocrit (Hct) = 50%
- Hemoglobin (Hb) = 14 g/dL
- RBC count = 5.1 x 10⁶/µL
- WBC count = 8,000/µL
- Eosinophil count = 160/µL
- Basophil count = 35/µL
- Monocyte count = 321/µL
- Lymphocyte count = 3,203/µL
- Platelet count = 380,000/µL

After studying these test results, the pediatrician reevaluates Kyle’s heart and lungs. Respiratory function is normal, but he hears a slight heart murmur. The pediatrician then suggests a chest X ray, which reveals left-ventricular hypertrophy and alterations in the pulmonary blood vessels. After an echocardiogram is conducted, Kyle’s condition is diagnosed as patent ductus arteriosus (PDA).

Based on this case study and other information in this chapter, answer the following questions.

1. Does Kyle’s CBC reveal any abnormalities in the number, shape, or size of blood cells?
2. Why is a heart murmur heard in both systole and diastole in Kyle’s condition?
3. Why does PDA reduce a child’s growth rate? Why does it increase the incidence of respiratory infections?
4. Why does the left ventricle sometimes undergo hypertrophy in patients with PDA?
5. If edema were to occur in a PDA patient, would it most likely be localized to the systemic or the pulmonary circulation?
6. Although all aneurysms are serious health concerns, why are dissecting aortic aneurysms more serious than small aortic aneurysms?
7. Nancy has been working on a term paper for the past 3 hours. Upon hearing the doorbell ring, she gets up quickly and faints. Her roommate, Angie, hears Nancy fall and comes running. Assuming that Angie understands the causes of syncope, what could she do to help Nancy?
8. Medical support hose are often used to treat both orthostatic hypotension and varicose veins. How could support hose alleviate the signs and symptoms of either disorder?
9. A patient suffering a hemorrhagic stroke is mistakenly given coumadin. Discuss why you
would expect this patient’s condition to worsen rather than improve.

10. Do you think orthostatic hypotension could be more successfully treated with a diuretic or an antidiuretic drug? Explain your reasoning.

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**Selected Clinical Terms**

**aneurysm**  A weak point in a blood vessel or in the heart where a thin-walled sac forms and may rupture.

**cerebrovascular accident**  A stroke; infarction of brain tissue due to a loss of cerebral blood flow, resulting from the obstruction or hemorrhage of a cerebral artery.

**hemoptysis**  Spitting up blood from the respiratory tract; usually a sign of tracheal, bronchial, or pulmonary hemorrhage.

**orthostatic hypotension**  A rapid drop in blood pressure that occurs when a person stands up, owing to the gravitational drainage of blood into the lower trunk and limbs without adequate compensation by the baroreflex.

**patent ductus arteriosus**  A congenital failure of the ductus arteriosus (a fetal shunt between the pulmonary trunk and aorta) to close after birth, causing circulatory disturbances that can lead to poor weight gain, respiratory infections, and left heart failure.

**Raynaud disease**  An idiopathic spasm of the arteries of the digits, especially the fingers, in response to conditions such as cold and emotional stress, causing pallor, numbness, coldness, throbbing, and paresthesia.

**syncope**  Fainting; a loss of consciousness and muscle tone, often with falling, due to a loss of cerebral blood flow.

**varicose vein**  A vein swollen with pooled blood, often due to failure of the venous valves to close and prevent backflow of the blood.