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# 6

## The Blood Vessels of the Head and Neck

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## LARGE ARTERIES OF THE HEAD AND NECK

### Taking the Carotid Pulse

The bifurcation of the common carotid artery into the internal and external carotid arteries (see text Figs. 6-1 and 6-3) can be easily palpated just beneath the anterior border of the sternocleidomastoid muscle at the level of the supe-

rior border of the thyroid cartilage. This is a convenient site to take the carotid pulse.

### Carotid Sinus Sensitivity

In cases of carotid sinus hypersensitivity, pressure on one or both carotid sinuses can cause excessive slowing of the heart rate, a fall in blood pressure, and cerebral ischemia with fainting.

### Facial Artery Pulse

The facial artery (see text Fig. 6-1), as it winds around the lower margin of the mandible level with the anterior border

of the masseter, is commonly used by the anesthetist to take the patient's pulse.

## Temporal Artery Pulse

The superficial temporal artery, as it crosses the zygomatic arch in front of the ear (see text Fig. 6-1), can also be used by the anesthetist to take the patient's pulse.

## Middle Meningeal Artery and Extradural Hemorrhage

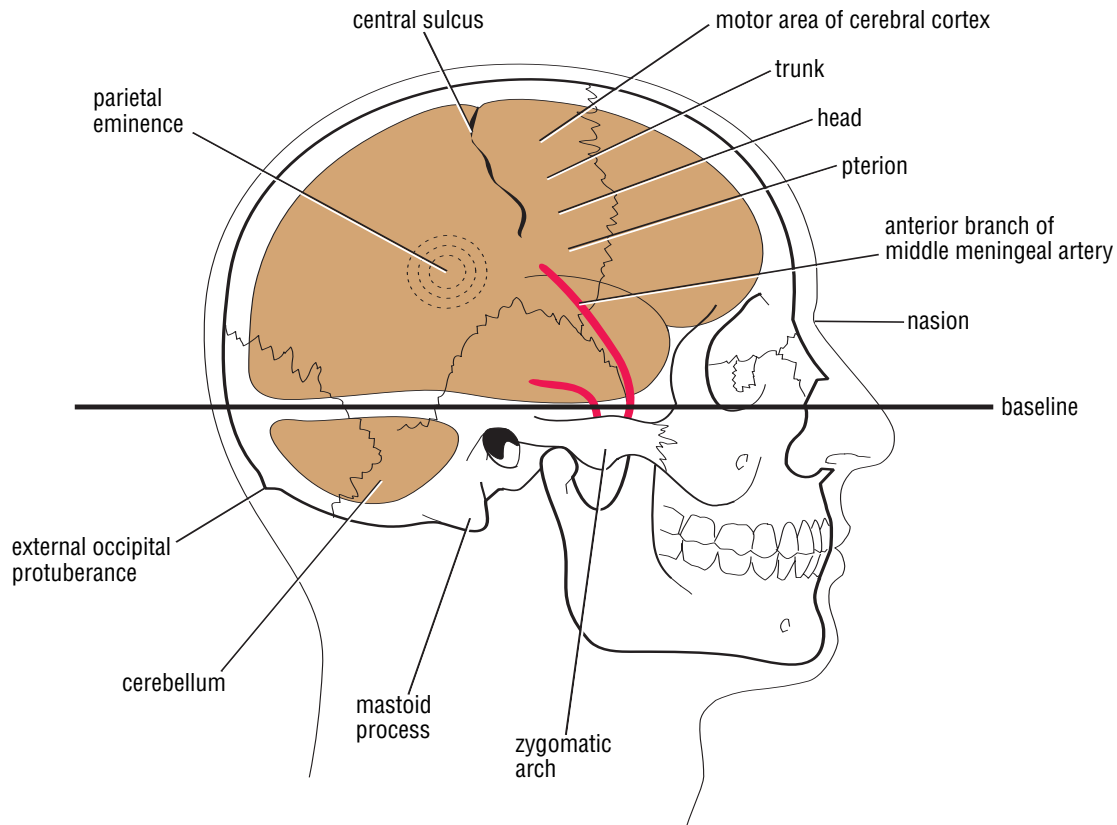
Extradural hemorrhage results from injuries to the meningeal arteries or veins. The most common artery to be damaged is the anterior division of the middle meningeal artery (CD Fig. 6-1). A comparatively minor blow to the side of the head, resulting in fracture of the skull in the region of the anteroinferior portion of the parietal bone, may sever the artery. The arterial or venous injury is especially liable to occur if the artery and vein enter a bony canal in this region. Bleeding occurs and strips up the meningeal layer of dura from the internal surface of the skull. The intracranial pressure rises, and the enlarging blood clot exerts local

pressure on the underlying motor area in the precentral gyrus. Blood may also pass outward through the fracture line to form a soft swelling under the temporalis muscle.

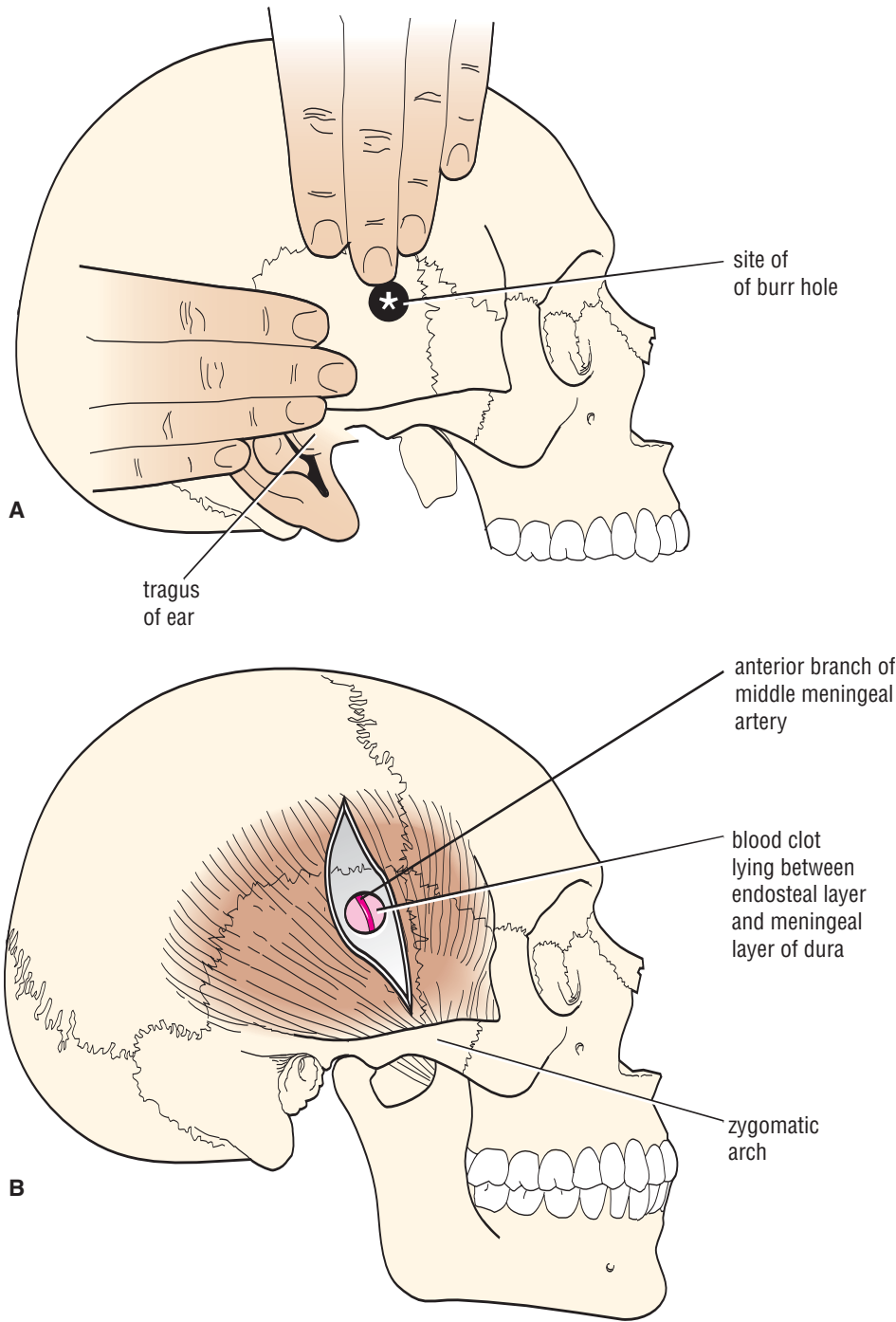
To stop the hemorrhage, the torn artery or vein must be ligated or plugged. The burr hole through the skull wall should be placed about 1 to 1.5 in. (2.5 to 4 cm) above the midpoint of the zygomatic arch (CD Fig. 6-2).

## Atherosclerosis of the Carotid Arteries and Neurologic Injury

Approximately 70% of strokes are caused by extracranial arteriosclerosis of the carotid and/or vertebral arteries. In the carotid arteries the atherosclerotic thromboses usually form slowly in the distal part of the common carotid and the first parts of the external and internal carotid arteries. The result is a diminished blood flow to the central nervous system. Less commonly, emboli, formed of fragments of plaques or blood clots, are carried distally to lodge in the ipsilateral central artery of the retina or in the smaller branches of the middle cerebral artery. Such a situation could produce the classic syndrome of ipsilateral blindness and contralateral hemiplegia, although it is unusual to have both at the same time.



**CD Figure 6-1** Surface landmarks on the right side of the head. The relations of the middle meningeal artery and the brain to the surface of the skull are shown.



**CD Figure 6-2** **A.** Surface landmarks for a temporal burr hole. **B.** The vertical incision passes through the temporalis muscle down to bone. The middle meningeal artery lies between the endosteal and meningeal layers of dura and is embedded in the endosteal layer of dura or lies in a bony tunnel.

## Penetrating Neck Injuries to the Carotid Arteries

Hemorrhage may be severe, with consequent hypotension or shock. An enlarging hematoma may press on the larynx or trachea, compromising the airway. Injuries to the internal carotid artery are usually associated with a central neurologic deficit. Injuries to the common carotid arteries are less

likely to cause neurologic problems, provided there is adequate collateral circulation through the external carotid arteries and their branches.

## Aneurysms of the Carotid Arteries

Aneurysms of the carotid arteries in the neck are rare and are usually caused by arteriosclerosis. They are commonly located at the bifurcation of the common carotid artery. Expansion of

the aneurysm may create pressure on the vagus nerve (causing hoarseness), glossopharyngeal nerve (causing dysphagia), or hypoglossal nerve (causing weakness of the tongue); pressure on the sympathetic trunk as it lies behind the carotid sheath may cause Horner's syndrome. Rupture of the aneurysm resulting in hemorrhage may exert pressure on surrounding structures and compromise the airway (see text Fig. 6-5).

## Cerebral Circulation and the Circle of Willis

The circle of Willis allows blood that enters by either internal carotid or vertebral arteries to be distributed to any part of both cerebral hemispheres. The arterial circle permits the blood to flow across the midline, as shown when the internal carotid or vertebral artery on one side is blocked by disease.

## Compression of the Subclavian Artery and the Brachial Plexus at the Root of the Neck

At the root of the neck, the brachial plexus and the subclavian artery enter the posterior triangle through a narrow muscular-bony triangle (see text Fig. 6-2). The boundaries of the narrow triangle are formed in front by the scalenus anterior, behind by the scalenus medius, and below by the first rib. In the presence of a cervical rib, the first thoracic nerve and the subclavian artery are raised and angulated as they pass over the rib. Partial or complete occlusion of the artery causes ischemic muscle pain in the arm, which is worsened by exercise. Rarely, pressure on the first thoracic nerve causes symptoms of pain in the forearm and hand and wasting of the small muscles of the hand.

## Cerebrovascular Disease

### Cerebral Ischemia

Unconsciousness occurs in 5 to 10 seconds if the blood flow to the brain is completely cut off. Irreversible brain damage with death of nervous tissue rapidly follows complete arrest of cerebral blood flow. It has been estimated that neuronal function ceases after about 1 minute and that irreversible changes start to occur after about 4 minutes, although this time may be longer if the patient's body has been cooled.

## Internal Thoracic Artery and Coronary Bypass Operations

In patients with occlusive coronary disease caused by atherosclerosis, the diseased arterial segment can be bypassed by

inserting a graft. The graft most commonly used is the great saphenous vein of the leg. In some patients, the myocardium can be revascularized by surgically mobilizing one of the internal thoracic arteries (see text Fig. 6-2) and joining its distal cut end to a coronary artery.

## Palpation and Compression of the Subclavian Artery in Patients with Upper Limb Hemorrhage

In severe traumatic accidents to the upper limb involving laceration of the brachial or axillary arteries, it is important to remember that the hemorrhage can be stopped by exerting strong pressure downward and backward on the third part of the subclavian artery (see text Fig. 6-2). The use of a blunt object to exert the pressure is of great help, and the artery is compressed against the upper surface of the first rib.



## VEINS OF THE HEAD AND NECK

## The Sigmoid Sinus and Infection from the Mastoid Antrum

Infection of the mastoid antrum of the ear may spread to the sigmoid venous sinus, causing thrombosis and septicemia.

## Cavernous Sinus Thrombosis and Facial Infection

The area of facial skin bounded by the nose, the eye, and the upper lip is a potentially dangerous zone to have an infection. For example, a boil in this region can cause thrombosis of the facial vein, with spread of organisms through the inferior ophthalmic veins to the cavernous sinus. The resulting cavernous sinus thrombosis may be fatal unless adequately treated with antibiotics.

## Spread of Scalp Infections and the Emissary Veins

Infections of the scalp tend to remain localized and are usually painful because of the fibrous tissue in the subcutaneous layer. Occasionally, an infection of the scalp

spreads by the emissary veins (see text Fig. 6-8), which are valveless, to the skull bones, causing osteomyelitis. Infected blood in the diploic veins may travel by the emissary veins farther into the venous sinuses and produce venous sinus thrombosis.

## Visibility of the External Jugular Vein

The external jugular vein is less obvious in children and women because their subcutaneous tissue tends to be thicker than the tissue of men. In obese individuals, the vein may be difficult to identify even when they are asked to hold their breath, which impedes the venous return to the right side of the heart and distends the vein.

The superficial veins of the neck tend to be enlarged and often tortuous in professional singers because of prolonged periods of raised intrathoracic pressure.

## The External Jugular Vein as a Venous Manometer

The external jugular vein serves as a useful venous manometer. Normally, when the patient is lying at a horizontal angle of 30°, the level of the blood in the external jugular veins reaches about one third of the way up the neck. As the patient sits up, the blood level falls until it is no longer visible behind the clavicle.

## External Jugular Vein Catheterization

The external jugular vein can be used for catheterization, but the presence of valves or tortuosity may make the passage of the catheter difficult. Because the right external jugular vein is in the most direct line with the superior vena cava, it is the one most commonly used (CD Fig. 6-3).

The vein is catheterized about halfway between the level of the cricoid cartilage and the clavicle. The passage of the catheter should be performed during inspiration when the valves are open.

## Penetrating Wounds of the Internal Jugular Vein

The hemorrhage of low-pressure venous blood into the loose connective tissue beneath the investing layer of deep cervical fascia may present as a large, slowly expanding hematoma. Air embolism is a serious complication of a

lacerated wall of the internal jugular vein. Because the wall of this large vein contains little smooth muscle, its injury is not followed by contraction and retraction (as occurs with arterial injuries). Moreover, the adventitia of the vein wall is attached to the deep fascia of the carotid sheath, which hinders the collapse of the vein. Blind clamping of the vein is prohibited because the vagus and hypoglossal nerves are in the vicinity.

## Internal Jugular Vein Catheterization

The internal jugular vein is remarkably constant in position. It descends through the neck from a point halfway between the tip of the mastoid process and the angle of the jaw to the sternoclavicular joint. Above, it is overlapped by the anterior border of the sternocleidomastoid muscle, and below, it is covered laterally by this muscle. Just above the sternoclavicular joint the vein lies beneath a skin depression between the sternal and clavicular heads of the sternocleidomastoid muscle. In the **posterior approach**, the tip of the needle and the catheter are introduced into the vein about two fingerbreadths above the clavicle at the posterior border of the sternocleidomastoid muscle (CD Fig. 6-4). In the **anterior approach**, with the patient's head turned to the opposite side, the triangle formed by the sternal and clavicular heads of the sternocleidomastoid muscle and the medial end of the clavicle are identified. A shallow skin depression usually overlies the triangle. The needle and catheter are inserted into the vein at the apex of the triangle in a caudal direction (see CD Fig. 6-4).

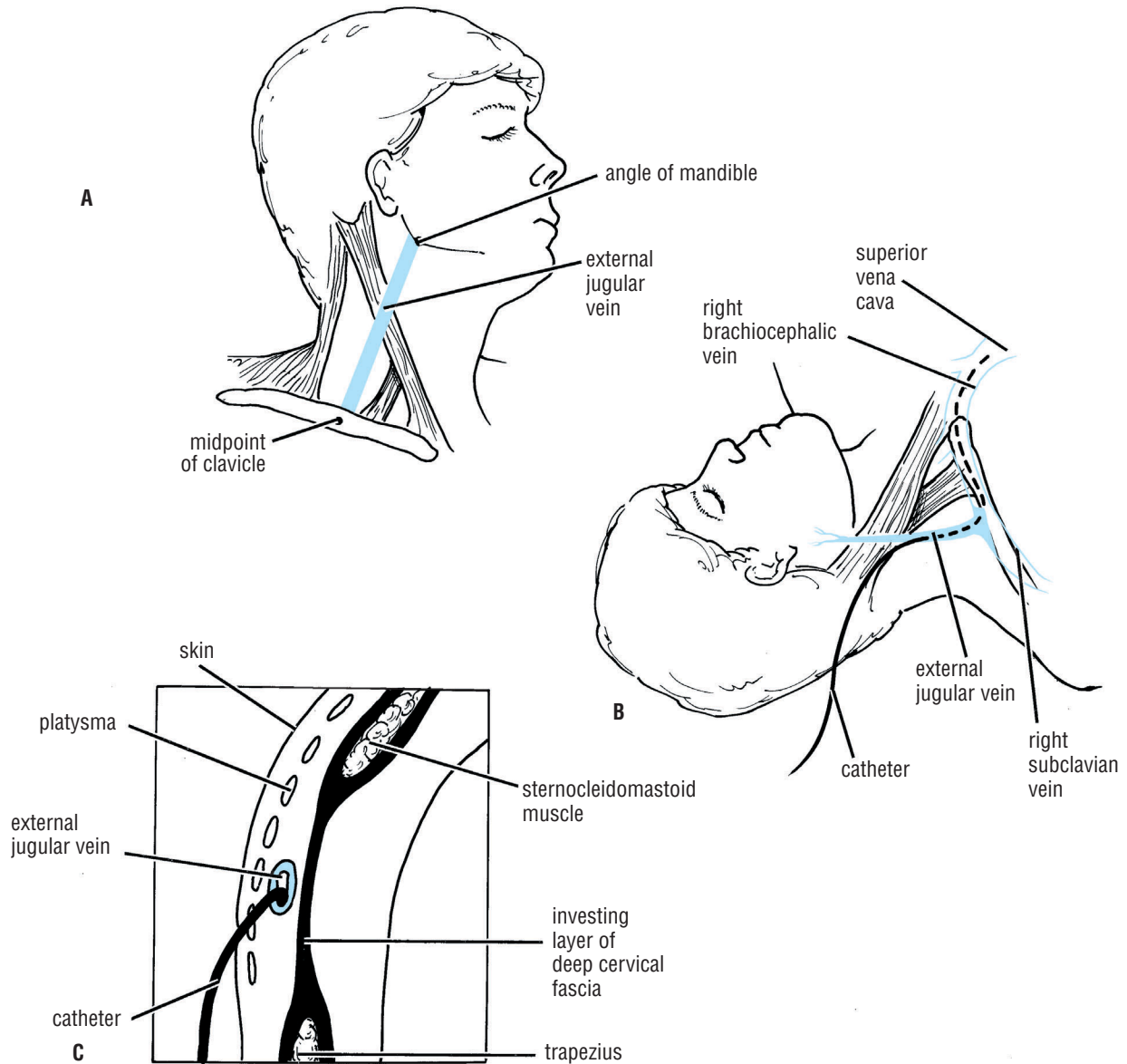
## Subclavian Vein Thrombosis

Spontaneous thrombosis of the subclavian and/or axillary veins occasionally occurs after excessive and unaccustomed use of the arm at the shoulder joint. The close relationship of these veins to the first rib and the clavicle and the possibility of repeated minor trauma from these structures is probably a factor in its development.

Secondary thrombosis of subclavian and/or axillary veins is a common complication of an indwelling venous catheter. Rarely, the condition may follow a radical mastectomy with a block dissection of the lymph nodes of the axilla. Persistent pain, heaviness, or edema of the upper limb, especially after exercise, is a complication of this condition.

## Subclavian Vein Catheterization

The subclavian vein is located in the lower anterior corner of the posterior triangle of the neck (CD Fig. 6-5), where it lies immediately posterior to the medial third of the clavicle.



**CD Figure 6-3** Catheterization of the right external jugular vein. **A.** Surface marking of the vein. **B.** Site of catheterization. Note how the external jugular vein joins the subclavian vein at a right angle. **C.** Cross section of the neck showing the relationships of the external jugular vein as it crosses the posterior triangle of the neck.

### Infraclavicular Approach

Since the subclavian vein lies close to the undersurface of the medial third of the clavicle (see CD Fig. 6-5), this is a relatively safe site for catheterization. The vein is slightly more medially placed on the left side than on the right side.

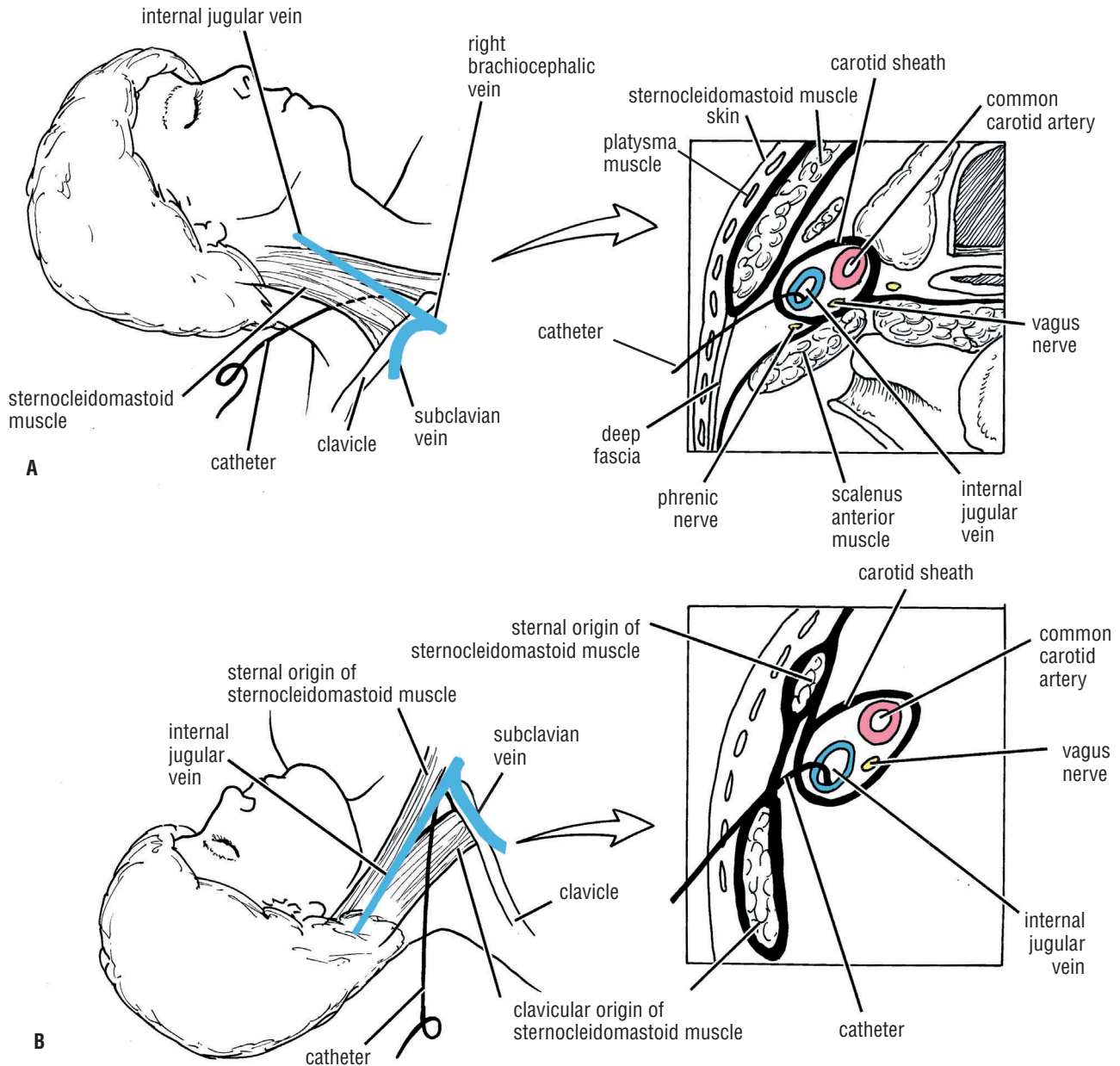
### Anatomy of the Procedure

The needle should be inserted through the skin just below the lower border of the clavicle at the junction of the medial third and outer two thirds, coinciding with the posterior

border of the origin of the clavicular head of the sternocleidomastoid muscle on the upper border of the clavicle (see CD Fig. 6-5). The needle pierces the following structures:

- Skin
- Superficial fascia
- Pectoralis major muscle (clavicular head)
- Clavipectoral fascia and subclavius muscle
- Wall of subclavian vein

The needle is pointed upward and posteriorly toward the middle of the suprasternal notch.



**CD Figure 6-4** Catheterization of the right internal jugular vein. **A.** Posterior approach. Note the position of the catheter relative to the sternocleidomastoid muscle and the common carotid artery. **B.** Anterior approach. Note that the catheter is inserted into the vein close to the apex of the triangle formed by the sternal and clavicular heads of the sternocleidomastoid muscle and the clavicle.

**Anatomy of Problems**

- **Hitting the clavicle:** The needle may be “walked” along the lower surface of the clavicle until its posterior edge is reached.
- **Hitting the first rib:** The needle may hit the first rib if it is pointed downward and not upward.
- **Hitting the subclavian artery:** A pulsatile resistance and bright red blood flow indicates that the needle has passed

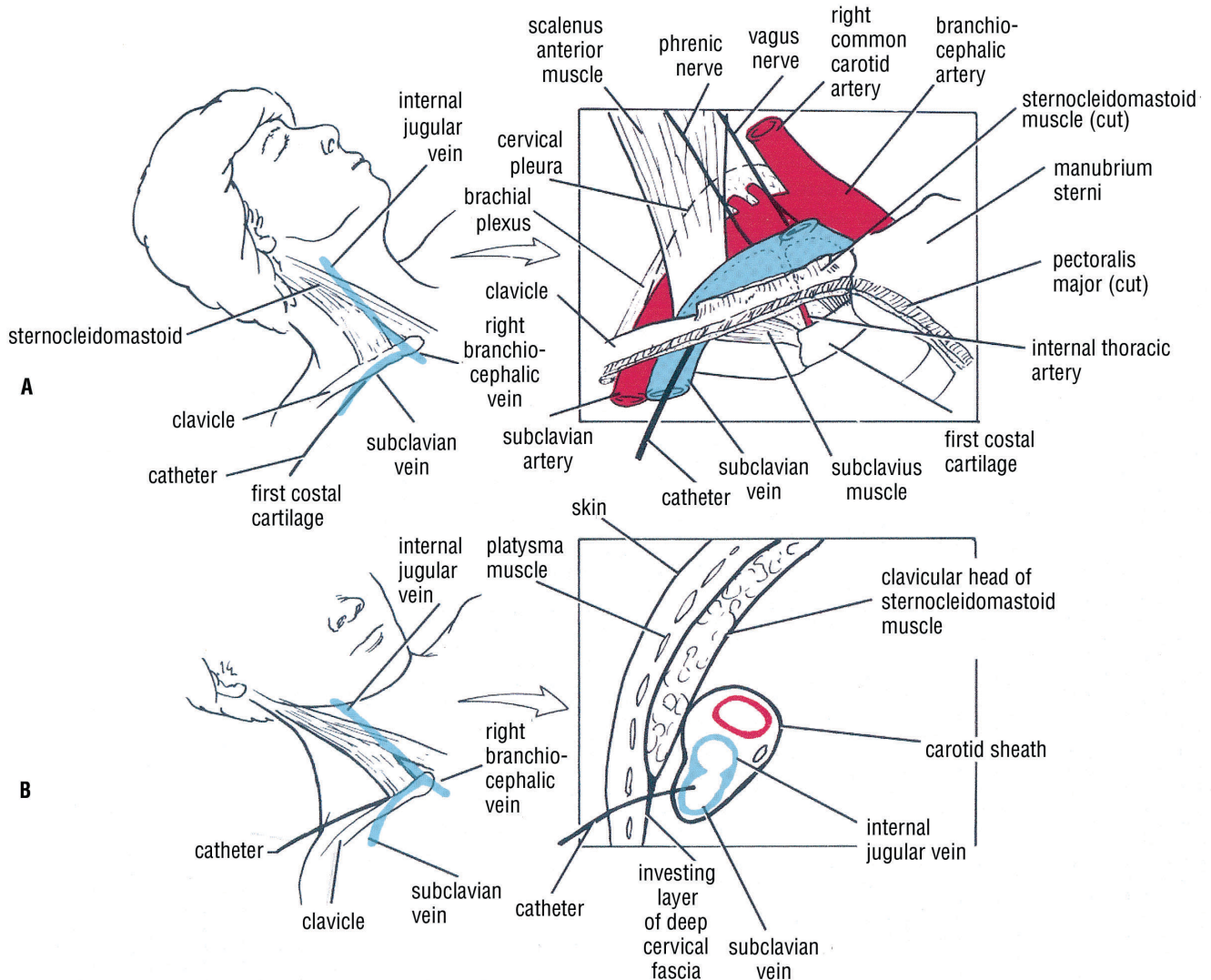
posterior to the scalenus anterior muscle and perforated the subclavian artery.

**Anatomy of Complications**

Refer to CD Fig. 6-5.

- **Pneumothorax:** The needle may pierce the cervical dome of the pleura, permitting air to enter the pleural cavity. This complication is more common in





**CD Figure 6-5** Subclavian vein catheterization. **A.** Infraclavicular approach. Note the many important anatomic structures located in this region. **B.** Supraclavicular approach. The catheter enters the subclavian vein close to its junction with the internal jugular vein to form the brachiocephalic vein.

children, in whom the pleural reflection is higher than in adults.

- **Hemothorax:** The catheter may pierce the posterior wall of the subclavian vein and the pleura.
- **Subclavian artery puncture:** The needle pierces the wall of the artery during its insertion.
- **Internal thoracic artery injury:** Hemorrhage may occur into the superior mediastinum.
- **Diaphragmatic paralysis:** This occurs when the needle damages the phrenic nerve.

## The Procedure in Children

The needle pierces the skin in the deltopectoral groove about 2 cm from the clavicle. The catheter is tunneled

beneath the skin to enter the subclavian vein at the point where the clavicle and the first rib cross.

The more oblique approach in children minimizes the possibility of entering the subclavian artery.

## Supraclavicular Approach

This approach (see CD Fig. 6-5) is preferred by many for the following anatomic reasons:

- The site of penetration of the vein wall is larger, since it lies at the junction of the internal jugular vein and the subclavian vein, which makes the procedure easier.
- The needle is pointed downward and medially toward the mediastinum, away from the pleura, avoiding the complication of pneumothorax.

- The catheter is inserted along a more direct course into the brachiocephalic vein and superior vena cava.

## Anatomy of the Procedure

With the patient in the Trendelenburg position (patient supine with head tilted downward) or simple supine position and the head turned to the opposite side, the posterior border of the clavicular origin of the sternocleidomastoid muscle is palpated (see CD Fig. 6-5). The needle is inserted through the skin at the site where the posterior border of the clavicular origin of sternocleidomastoid is attached to the upper border of the clavicle. At this point, the needle lies lateral to the lateral border of scalenus anterior muscle and above the first rib. The needle pierces the following structures (see CD Fig. 6-5):

- Skin
- Superficial fascia and platysma
- Investing layer of deep cervical fascia
- Wall of the subclavian vein

The needle is directed downward in the direction of the opposite nipple. The needle enters the junction of the internal jugular vein and the subclavian vein. It is important that the operator understands that the pleura is not being penetrated and that it is possible for the needle to lie in a zone between the chest wall and the cervical dome of the parietal pleura but outside the pleural space (cavity).

## Anatomy of Complications

The following complications may occur as the result of damage to neighboring anatomic structures (see CD Fig. 6-5):

- **Paralysis of the diaphragm:** This is caused by injury to the phrenic nerve as it descends posterior to the internal jugular vein on the surface of the scalenus anterior muscle.
- **Pneumothorax or hemothorax:** This is caused by damage to the pleura and/or internal thoracic artery by the needle passing posteriorly and downward.
- **Brachial plexus injury:** This is caused by the needle passing posteriorly into the roots or trunks of the plexus.

# Clinical Problem Solving Questions

**Read the following case histories/questions and give the best answer for each.**

A 40-year-old man mentioned to his physician during a medical checkup that on four occasions during the past 5 months he had fainted at work. On each occasion the fainting attack occurred while he was sitting at his desk. He said that the attack took place when he turned his face to the left and bent down to open a bottom drawer. He also complained that he first felt dizzy before he fainted. The physician noted that the patient was rather formally dressed with a stiff collar and a regimental tie. When the physician commented on his collar, the patient stated that he always wore this type of collar to work. On careful examination of the patient no abnormal physical signs were found. In fact, the man looked very fit.

1. Using your knowledge of anatomy and physiology, make the **most likely** diagnosis.
  - A. Atrial fibrillation
  - B. Cardiac ischemia
  - C. Carotid sinus syndrome
  - D. Anemia
  - E. Petit mal (a form of epilepsy)

Two sisters were playing in their bedroom having a pillow fight, when one of them tripped and fell head first

against a window. The glass was shattered and a knife-like piece became impaled in her neck. Within seconds the wound spurted bright red blood and she ran screaming to her parents. In the emergency department of the local hospital it was immediately apparent that a large artery in the front of the neck had been pierced by the glass.

2. The examining physician made the following observations and comments, all of which were correct **except** which?
  - A. The entry wound was situated along the anterior border of the sternocleidomastoid muscle at about the level of the upper border of the thyroid cartilage.
  - B. The artery involved could be either the terminal part of the common carotid artery or the beginning of the external or internal carotid arteries.
  - C. The arteries were situated beneath the investing layer of deep cervical fascia within the carotid fascial sheath.
  - D. The internal jugular vein, which is also located within the carotid sheath, is not involved because the blood was bright red in color and spurted from the wound on removing the pressure gauze pad.
  - E. Branches of the trigeminal nerve lie in the sheath at this level and are likely to have been damaged.

A 7-year-old boy was playing in his grandparents' garden when he suddenly disappeared from view. His grandfather rushed over to see what had happened to his grandson when he heard muffled crying coming from a hole in the ground. On peering into the hole, the child's head was just visible about five feet from the surface. The local rescue team determined that the child had fallen down a disused well. Fortunately, the opening of the hole was large enough to allow the emergency physician to be lowered to the child. Having reassured the child, it was necessary to check his vital signs. The only arteries that could be palpated were restricted to the head and neck.

3. Name sites in the head and neck where the arterial pulse can be felt.
  - A. On the upper surface of the head in the midline
  - B. Just in front of the auricle of the ear, the lower margin of the mandible, or the anterior border of the sternocleidomastoid muscle at the level of the upper margin of the thyroid cartilage
  - C. Behind the ear over the mastoid process or at the root of the nose
  - D. In the midline of the front of the neck in the suprasternal notch or just below the mandible
  - E. At the apex of the posterior triangle of the neck or halfway down the posterior border of the sternocleidomastoid muscle

A 53-year-old man was admitted to the emergency room unconscious. Apparently he had attempted to cross the road on crutches when he was hit on the side of the head by a car. On examination he was found to have a large swelling over the left side of the head in the temporal region. The neurologic findings included a right-sided hemiplegia. A lateral radiograph of the skull showed a fracture line across the region of the lower anterior end of the right parietal bone.

4. Name the artery that was most likely to have been damaged in the accident.
  - A. The left middle cerebral artery
  - B. The right posterior cerebral artery
  - C. The anterior division of the left middle meningeal artery
  - D. The posterior division of the left middle meningeal artery
  - E. The left superficial temporal artery

A 42-year-old workman was cutting down a tree. During the cleanup of the site, he was feeding the cut branches into a large wood chipping machine and the sleeve of his shirt on his right arm became caught in the machinery. Within seconds his arm was dragged into the cutters. The man attempted to turn off the machine but could not reach the switch. His right upper limb was

cut to pieces and he fell to the ground in agony and quickly lost consciousness. When the emergency personnel arrived on the scene they found the man to be still alive but unconscious and lying in a pool of blood. They had to stop the bleeding immediately.

5. Using your knowledge of anatomy, where would you apply pressure at the root of the limb to stop the bleeding?
  - A. Just above the manubrium sterni in the midline to compress the right brachiocephalic artery
  - B. Above the right sternoclavicular joint to compress the right subclavian artery
  - C. Behind the medial part of the right clavicle, applying pressure downward and backward on the right subclavian artery as it lies on the upper surface of the first rib
  - D. High up in the right armpit to compress the axillary artery
  - E. Behind the lateral part of the right clavicle, applying pressure backward to compress the right subclavian artery as it becomes the axillary artery

A 45-year-old man was rushed to hospital complaining of cardiac pain referred to the root of his neck. After a thorough workup, including a coronary arteriogram, which showed extensive blockage of the coronary arteries, it was decided to do an immediate triple bypass operation. At operation, because of the poor condition of his superficial leg veins, an artery rather than a vein was selected to perform the bypass.

6. From the list of arteries given below, choose an artery in the chest cavity that could be used to perform a coronary bypass.
  - A. Right superior intercostal artery
  - B. Right and left anterior thoracic arteries
  - C. Phrenic arteries
  - D. Musculophrenic artery
  - E. Superior epigastric artery

A patient with a malignant melanoma in the left temporal region was told that because of the seriousness of the condition and the likelihood of metastases, an extensive operation was required including the removal of the deep cervical lymph nodes in the neck.

7. Using your knowledge of anatomy, explain why it is necessary to remove the internal jugular vein in the neck as well as the deep cervical lymph nodes.
  - A. The deep cervical lymph nodes lie deep to the internal jugular vein, and it is necessary to remove the vein to get at the lymph nodes.
  - B. Damage to the internal jugular vein would result in serious air embolism.
  - C. The numerous tributaries of the internal jugular vein would complicate the procedure

- D. The deep cervical lymph nodes are embedded in the carotid sheath and the tunica adventitia of the internal jugular vein.
- E. Metastases of the melanoma commonly invade the internal jugular vein.

A 57-year-old woman was examined by her physician and found to have right-sided heart failure. As the patient lay propped up on pillows in bed, her physician noticed that the blood in a superficial vein on the side of the neck (in the posterior triangle) could be easily seen.

8. From the list of veins in the neck given below, select the **most likely** one that the physician could see.
- Anterior jugular vein
  - Suprascapular vein
  - Superficial cervical vein
  - Internal jugular vein
  - External jugular vein
9. The jugular veins are commonly used to establish a central venous line. Why is it sometimes difficult to pass a catheter from the external jugular vein into the right atrium?
- The catheter tip may catch in the valves.
  - The vein turns at a right angle before it drains into the subclavian vein.

- The catheter tip may enter the mouth of the anterior division of the retromandibular vein.
- The vein may be very small in professional singers.
- The vein is normally constricted as it passes behind the clavicle.

10. In deep penetrating injuries of the neck involving the common carotid artery, the status of the collateral circulation determines the feasibility of ligation versus a reconstructive procedure. Describe the collateral circulation of the common carotid artery. How may injury to the artery produce loss of sight on the same side and contralateral hemiplegia? How may a carotid artery injury produce airway obstruction?
11. Why is air embolism a complication of a lacerated wall of the internal jugular vein?
12. In subclavian vein catheterization using the infraclavicular approach, the following problems may occur, even when great care is exercised: (a) The needle may hit the clavicle; (b) the needle may hit the first rib; (c) the needle may hit the subclavian artery. How would you deal with these problems?

## Answers and Explanations

1. **C** is the correct answer. The carotid sinus syndrome is a condition in which the carotid sinus reflex is hypersensitive. Pressure on one or both carotid sinuses can cause excessive slowing of the heart, a fall in blood pressure, and cerebral ischemia with fainting. In this patient the pressure of the stiff collar on the carotid sinuses, caused by bending over to gain access to the bottom desk drawer, was sufficient to cause the episodes of fainting and loss of consciousness.
2. **E** is the correct answer. The trigeminal nerve is not related to the carotid arteries in the neck. However, the hypoglossal nerve crosses the external carotid artery opposite the level of the tip of the greater cornu of the hyoid bone. The glossopharyngeal nerve is related to the internal and external carotid arteries high up in the neck (see text Fig. 6-4). The vagus nerve lies within the carotid sheath and accompanies the internal jugular vein and common and internal carotid arteries down the neck. The sympathetic trunk lies behind the common and internal carotid arteries (see text Fig. 6-4).
3. **B** is the correct answer. In a difficult situation, when the patient's head and neck are the only accessible parts of

the body for taking the pulse, the following arteries are easily palpable: The pulsating facial artery can be felt as it winds around the lower margin of the mandible in line with the anterior border of the masseter muscle (see text Fig. 6-10). The superficial temporal artery may be palpated in front of the auricle of the ear as it ascends over the zygomatic arch (see text Fig. 6-1). The classical site for feeling the pulse in the neck is along the anterior border of the sternocleidomastoid muscle at the level of the upper border of the thyroid cartilage (see text Fig. 6-3). Here, the common carotid artery divides into the external carotid and internal carotid arteries, and all three are quite superficial at this location.

4. **C** is the correct answer. The anterior division of the middle meningeal artery is the most common artery to be damaged after a blow to the lateral side of the head. The arterial or venous injury is especially liable to occur if the artery and vein enter a bony canal in the region of the anterior inferior angle of the parietal bone (see CD Fig. 6-1).
5. **C** is the correct answer. The arterial supply to the upper limb can be cut off by applying deep pressure to the

third part of the subclavian artery, as it lies on the upper surface of the first rib. Here, the subclavian artery lies behind the medial part of the clavicle and becomes continuous with the axillary artery (see text Fig. 6-10).

6. **B** is the correct answer. The anterior thoracic artery, which is a branch of the first part of the subclavian artery, can be used in coronary bypass operations.
7. **D** is the correct answer. The deep cervical lymph nodes are embedded in the carotid sheath and in the tunica adventitia of the internal jugular vein. The aim of the operation is to remove all the lymph nodes on the affected side of the neck.
8. **E** is the correct answer. The external jugular vein lies superficially beneath the platysma muscle and can be easily seen in a good light (in an obese patient it may be difficult to see). The vein serves as a useful venous manometer. It runs from the angle of the jaw to the midpoint of the clavicle (see text Fig. 6-10). The level of the blood in the vein normally reaches about one third of the way up the neck when the patient is lying at a horizontal angle of 30°. As the patient sits up, the blood level falls until the vein is no longer visible behind the clavicle.
9. **A** is the correct answer. The catheter tip may catch in the valves. The external jugular vein has two sets of valves: One pair lies at its entrance into the subclavian vein and the other pair lies about 4 cm superior to the clavicle. The valves are usually incompetent.
10. The common carotid artery has no branches in the neck except for its terminal branches, the internal and external carotid arteries. The internal carotid artery has no branches in the neck, but at the base of the brain it takes part in the arterial circle of Willis, where it anastomoses with the branches of the vertebral arteries and the internal carotid artery of the opposite side. The

external carotid artery, however, gives off numerous important branches in the neck that anastomose with the fellow branches from the opposite side.

Since the internal carotid artery gives off the ophthalmic artery and the middle cerebral artery, severe damage or blockage of the common carotid artery could cause ipsilateral blindness and contralateral hemiplegia.

The common carotid artery is contained within the carotid sheath beneath the investing and pretracheal layers of deep cervical fascia. Hemorrhage beneath the deep fascia could spread medially and compress the larynx or the trachea, thus compromising the airway.

11. Air embolism is a serious complication of a lacerated wall of the internal jugular vein. Because the wall of this large vein contains very little smooth muscle, its injury is not followed by contraction and retraction (as occurs with arterial injuries). Moreover, the outer coat of the vein is attached to the fascia of the carotid sheath, which hinders the collapse of the vein.
12. When performing a subclavian vein catheterization using the infraclavicular approach, the clavicle may be hit by the advancing needle. The needle may then be “walked” along the lower surface of the clavicle until its posterior edge is reached and then inserted into the subclavian vein. The needle may hit the first rib. This is due to the fact that the needle is pointing downward and not upward. The needle may hit the subclavian artery. This is recognized by feeling the pulsatile resistance to the advancing needle and the presence of bright red blood in the catheter. It indicates that the needle has passed too deeply posterior to the scalenus anterior muscle and perforated the wall of the subclavian artery (see CD Fig. 6-5). The needle should be partially withdrawn and the vein approached again.

