To drain directly from the right atrium of the heart, start by injecting approximately 1½ to 1 gal of embalming solution to fill the vascular system. To drain the heart, insert the trocar at approximately the standard point of entry, 2 in. to the left and 2 in. above the umbilicus. Draw an imaginary line across the body connecting the **left** anterior superior iliac spine and the lobe of the **right** ear. Direct the trocar toward a point where this line crosses the right side of the sternum. This point is approximately at the level of the sternum where the fourth rib joins the sternum. Be certain to keep the trocar slightly to the right of the sternum. The trocar point should be kept in the anterior portion of the mediastinum. If there is sufficient pressure in the right atrium, simply placing the trocar in the heart chamber should be sufficient to start drainage. The trocar can be attached to the hydroaspirator.

Do not turn the hydroaspirator on to full suction; half is quite sufficient. Insert the trocar with the hydroaspirator running. As soon as the heart is pierced, the hydroaspirator can be turned off. Most hydroaspirators are lower than the height of the embalming table, so a natural gravity system is established. It is important that a plastic hose be used on the trocar, for the embalmer can then see immediately when the right side of the heart has been punctured.

If the embalmer is unfamiliar with this technique of drainage, it can easily be practiced. Begin cavity aspiration by aspirating the right side of the heart first. The embalmer need not pierce only the right atrium with the trocar; the right ventricle can also be pierced. There should be sufficient pressure in the right side of the heart that the suction of the aspirator on the trocar can open the right atrioventricular valve and, in this manner, drain the right atrium. Should the trocar puncture the ascending aorta or the arch, sufficient embalming solution may be lost to necessitate a six-point injection.

## Drainage Instrumentation

A large variety of drainage devices are available. The most standard drainage instruments are the drain tube and the angular spring forceps. **Drainage instruments are inserted into veins and directed toward the heart.** Some embalmers prefer to lubricate these devices with massage cream to facilitate their entry into the vein. Drain tubes contain a plunger rod, which can also be lubricated with massage cream. After each use, drain tubes should be disassembled, flushed with water, cleaned and disinfected.

The **groove director** is used to assist in the insertion of a drainage tube or forceps into the vein. The groove director is inserted into the vein first. Once it is in place, the drainage instrument is slid along the grooved portion of the instrument. The grooved portion should face the lumen of the vein.

Many times, a drainage tube cannot be fully inserted into the vein; it should not be forced. As long as a portion of the tube can be inserted, it will keep the vein expanded. Changing the position of the tube in the vein often assists with the drainage. Tubes should be tied into a vein, but loosely enough so that their position can be changed.

Drainage tubes come in a variety of lengths and diameters. Those for use in the internal jugular vein (Fig. 12–10) are very large in diameter and short in length. Axillary drain tubes are long and slightly curved for insertion into the axillary vein. Axillary drain tubes are not very large in diameter. A variety of drainage tubes are made for the femoral vein; they come in a wide range of diameters and lengths. One type of iliac drain tube is designed to be inserted into the external iliac vein, and the tip of the tube reaches into the right atrium of the heart; they are approximately 20 in. in length and made of plastic, metal, or rubber. Drainage tubes, with very small diameters, are also available for embalming unautopsied infants.

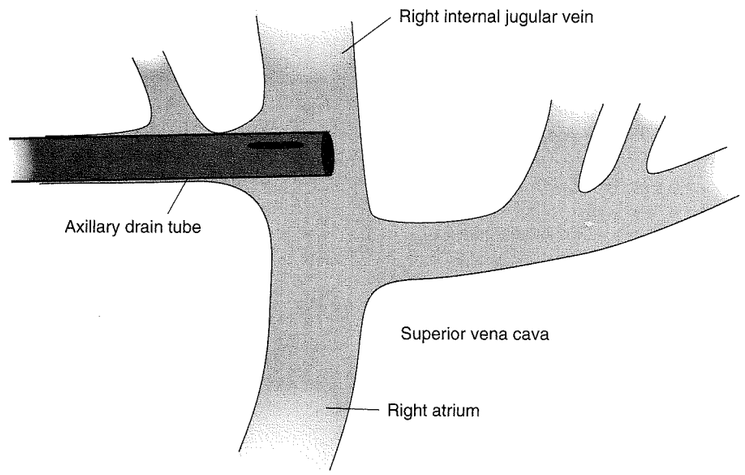


**Figure 12–10.** Drainage tube insert.

| Advantages of the drain tube | Disadvantages of the drain tube |
|---|---|
| The tube keeps the vein expanded | The size of the opening is limited to the diameter of the tube |
| The "stirring" rod helps to fragment coagula | The tube can block the opposite portion of the vein. The tube can block other veins |
| Drainage can be shut off to build intravascular pressure | Coagula cannot be grasped |
| Closed drainage technique can be used | The tube may mark the face or interfere with positioning of the head |
| | The tube can easily be pushed through the vein into a body cavity |

Angular spring forceps can be used to assist drainage from any vein.

| Advantages of the angular spring forceps for jugular drainage | Disadvantages of the angular spring forceps |
|---|---|
| It provides a very large opening for the drainage | It may have to be removed to close the vein for intermittent drainage |
| The head can be positioned to the right | Drainage may splatter |
| The forceps does not mark the face | Embalmer's contact with the drainage is increased |
| Coagula can be grasped | |
| It does not block other venous tributaries | |

The angular spring forceps is convenient to use for drainage from the right internal jugular vein. It **does not block** drainage from the left in nominate vein, right subclavian vein, or upper portion of the right internal jugular vein. These tributaries can be blocked if the jugular drain tube is used. It provides a wide opening for the passage of coagula and it allows the right side of the head to drain. Large masses of coagula can be broken and easily removed from the superior vena cava and the right atrium. The head can easily be positioned without the forceps marking the side of the face.



## Methods of Drainage

Many embalmers use a combination of drainage methods. They begin the injection using continuous drainage and then restrict the drainage (using intermittent drainage) after the blood discolorations clear. **There are three basic types of drainage in relationship to arterial injection.**

### METHODS OF DRAINAGE IN RELATION TO INJECTION

Alternate
Concurrent
Intermittent

*Alternate Drainage.* In alternate drainage, the arterial solution is never injected while drainage is being taken. A quart or two of the arterial solution is injected; then the arterial injection is stopped and venous drainage commences. This is allowed to continue until drainage subsides; then the drainage instrument is closed. The process is then repeated. Injection and drainage are alternated until the embalming is completed. Because 1 or 2 qt of fluid is constantly injected into a confined system, it is believed that a more uniform pressure is developed in all parts of the body. More complete distribution of arterial solution is achieved and more complete drainage results. Fluid diffusion is enhanced, for pressure filtration is increased. This method increases preparation time and care must be taken to avoid distension.

*Concurrent (Continuous).* In concurrent drainage, injection and drainage are allowed to proceed at the same time throughout the embalming.

**Distension is possible with any method of drainage or injection. As soon as distension is evident, stop injection**

Because of the open drainage, it may be difficult to attain a pressure sufficient to saturate tissues throughout the body. Clots (in the venous system) may not be dislodged when the concurrent method is used. Fluid will follow the path of least resistance and more embalming solution may be lost to the drainage. This method of drainage may dehydrate and wrinkle body tissues. It has value in the preparation of bodies with high moisture content to the tissues (edema), for which dehydration is encouraged.

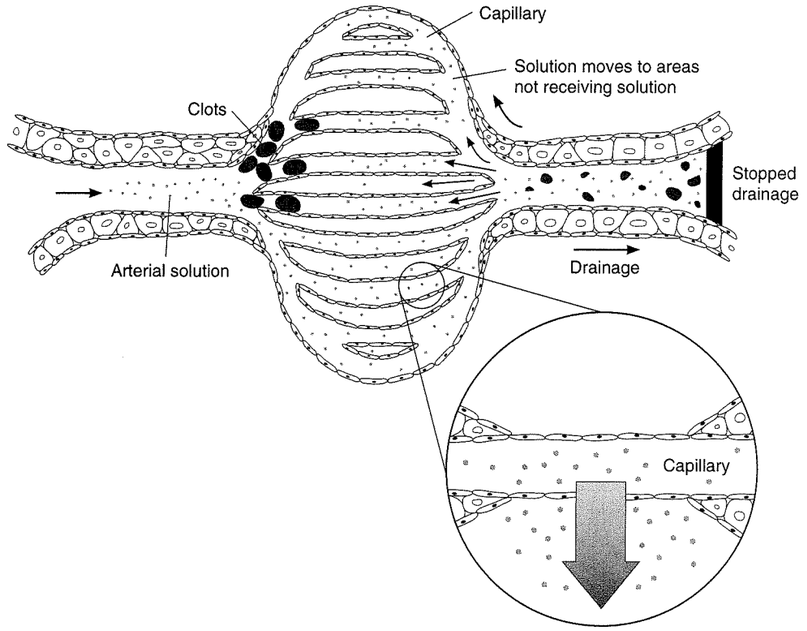


**Figure 12–11.** Intermittent drainage.

*Intermittent Drainage (Fig. 12–11).* In this process, the injection of the embalming solution continues throughout the embalming and the drainage is shut off for selected short periods. Some embalmers stop drainage until a particular amount of solution is injected (1 or 2 qt); others stop drainage until surface veins are raised. It is important that surface intravascular blood discolorations clear before intermittent drainage is begun. This method is less time consuming than the alternate method, encourages fluid distribution and pressure filtration, helps to prevent short-circuiting of the embalming solution and its loss to the drainage, and promotes retention of the embalming solution by the tissues. Intermittent drainage helps the body to retain tissue fluid (which provides a proper moisture balance) and is recommended when colloidal fluids such as humectants or restorative fluids are used to slightly distend emaciated tissues.

## Techniques for Improving Drainage

Drainage (1) makes room for the arterial solution in the vascular system, (2) allows for a thorough distribution of the embalming solution, (3) prevents distension of the body tissues, and (4) prevents adverse discolorations. Creation of good drainage can be done in two periods, prior to injection of the preservative solution and during injection of the preservative solution.

Preembalming techniques include the following:

- *Selection of a large vein.* Preference is generally the internal jugular or the femoral, or external iliac vein.
- *Selection of a large drainage instrument.* An angular spring forceps or drainage tube is used.
- *Injection of a preinjection fluid.* Follow the manufacturer's dilution of the chemical and volume of the chemical injected. If a preinjection chemical is not used, a mild arterial solution can be injected to clear blood discolorations and establish circulation.
- *Removal of extravascular pressure such as gas and fluids in the abdomen.*

The following techniques are included during injection:

- Use of drainage devices to fragment clots.
- Use of massage and pressure applied over the heart and/or liver to move venous clots.
- Increase in the rate of solution injection or increase in the pressure of the solution being injected.
- Intermittent and alternate forms of drainage techniques.
- Selection of another drainage site if necessary.



## Disinfection of the Drainage

The initial or first drainage taken presents the greatest risk to the embalmer when the cause of death was bloodborne infection (acquired immunodeficiency syndrome, hepatitis, or bloodstream sepsis). At present, the Occupational Safety and Health Administration permits bulk blood, suction, and aspirated fluids to be carefully drained into a sanitary sewer system. Drainage consists of blood, interstitial fluids, lymph, and arterial solution. The arterial solution in the drainage will to some degree sanitize the blood and body fluid portions of the drainage. By draining into a sewage system, the drainage also become highly diluted by the addition of running and flushing water.

To minimize contact as blood is being drained, tubing may be attached to the drain tube. This creates a **closed drainage system**. The tubing can be placed directly into a sewage drain. The closed drain system also allows the drainage to be easily collected. In deaths from highly infectious and or contagious diseases—for example, Creutzfeldt–Jacob disease, human immunodeficiency virus, and hepatitis—drained blood can be disinfected by collecting the drainage in a container and adding at least 1½ gal of "fresh" undiluted sodium hypochlorite (household bleach). Cover the container and let the solution stand for a minimum of 1 hour. The waste can then be very carefully poured into the drain being very careful to avoid splashing. Flush the drain with running water for 10 minutes.

*Closed Drainage Technique.* Another technique in preventing blood contamination for the embalming of bodies dead from highly infectious and/or contagious disease is to take very little or no drainage. This technique involves the injection of a very strong arterial solution (e.g., waterless) at a very slow rate of flow. Aspiration should be delayed as long as possible to allow the embalming solution to diffuse to all regions of the body. If the face discolors to avoid graying of the tissues, a very limited drainage can be taken or drainage can be taken directly from the right atrium of the heart by using the trocar.

Some embalmers recommend injecting as much arterial solution as possible prior to draining into bodies dead from contagious disease and, several minutes later, beginning the drainage. This interval allows some mixing of the blood and the embalming solution.

## ▶ CONCEPTS FOR STUDY AND DISCUSSION

1. Select vessels for injection and drainage of a morbidly obese, unautopsied body. Defend the selection you have made by explaining the advantages of using your selection.
2. List the advantages of using restricted cervical injection.
3. List the contents of drainage.
4. List the purposes for drainage.
5. List several techniques for stimulating drainage.
6. Complete the following distribution problems:

### *Embalming Solution Tracing Problems*

ONE-POINT INJECTION AND DRAINAGE

| | |
|---|---|
| Skeletal tissues | Trace arterial solution from the femoral artery (tube directed downward) to the right great toe; drain from the right femoral vein |
| Skeletal tissues | Trace arterial solution from the right femoral artery to the left side of the upper lip; drain from the right femoral vein |
| Visceral tissues | Trace arterial solution from the right femoral artery to the fundus of the stomach; drain from the right femoral vein |

SPLIT INJECTION AND DRAINAGE

| | |
|---|---|
| Skeletal tissues | Trace arterial solution from the right femoral artery to the right great toe; drain from the right internal jugular |
| Skeletal tissues | Trace arterial solution from the right common carotid to the left upper lip; drain from the right femoral vein |
| Visceral tissues | Trace arterial solution from the right common carotid to the appendix; drain from the right femoral vein |

RESTRICTED CERVICAL INJECTION

| | |
|---|---|
| Skeletal tissues | Inject the right common carotid down to reach the left lower lip; drain from the right internal jugular |
| Skeletal tissues | Inject the right common carotid down to reach the right upper lip (with the stopcock directed upward closed); drain from the right internal jugular |
| Visceral tissues | Inject down the right common carotid to the tissues of the left lung; drain from the right internal jugular |

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# CHAPTER 13

# DISTRIBUTION AND DIFFUSION OF ARTERIAL SOLUTION

## CHAPTER OBJECTIVES

- Arterial solution distribution
- Arterial solution diffusion
- Extravascular and intravascular resistances
- Injection pressure and rate of flow
- Signs of arterial solution distribution

Arterial embalming could also be called "capillary embalming." The capillaries, the smallest blood vessels of the body, link the injected embalming solution with the cells of the body. The embalming solution that passes from the capillaries to the tissues comes into contact with the proteins of the cells. The preservatives in the solution stabilize the proteins and create a condition of temporary preservation. This chapter discusses the movement of arterial solution through the blood vascular (intravascular) and interstitial (extravascular) systems of the body. On reaching the capillaries, the embalming solution, by a series of passive physical transport systems, moves to the cells of the body.* The movement of embalming solution from the intravascular to the extravascular location is called **fluid diffusion**. The remainder of the embalming solution, which passes into the venous system of the body, helps to remove the blood and the intravascular blood discolorations. Drainage, which exits a vein during arterial injection, is made up of blood, tissue fluids, lymph, and some of the arterial solution.

The ability of the embalmer to retain as much preservative within the body as possible without visible distension of the tissues is a key factor in thoroughly preserving and sanitizing the body.

While vascular embalming should be thought of as a **unified process**, this process can be divided into **four** divisions: (1) **Delivery of the arterial solution** from the embalming machine through the connecting tubing and arterial tube into the artery. (2) **Distribution of arterial solution** is the movement of arterial solution from the point of injection throughout the arterial system and into the capillaries (perfusion). (3) **Diffusion of arterial solution** is the movement of arterial solution from inside the vascular system (intravascular) through the walls of the capillaries to the tissue spaces (extravascular). (4) **Drainage**, the discharge or withdrawal of blood and blood clots, embalming solution, and interstitial and lymphatic fluids from the body during vascular embalming. The drainage is taken from a body vein.

From this simple diagram, it is seen that the preservative solution delivery, distribution, diffusion, and drainage occur at the same time once the vascular system has been filled with sufficient embalming solution. These processes work similarly to a lawn sprinkler or soaker hose. Arterial solution fills the vascular system, much like water fills the hose to reach the sprinkler. Some of the arterial solution flows through the walls and pores of the capillaries into the tissue spaces, as water passes through the holes in the sprinkler to reach the grass. The major difference is that all the water is sprayed out of the sprinkler. In embalming, a portion of the arterial solution stays inside the capillaries and flows into the veins to be removed as drainage.

The material drained during embalming of the body is a mixture of blood, arterial solution, and interstitial fluid. It has been demonstrated that as much as 50% of the drainage can be arterial solution. Because the

*Passive transport systems require no energy by the cell to operate.