CHAPTER **12**

INJECTION AND DRAINAGE TECHNIQUES

CHAPTER OBJECTIVES

- Safe work practices
- Arterial solution distribution
- Injection techniques
- Drainage
- Drainage techniques

During arterial embalming of the body, four processes take place **at the same time:** (1) **injection** of the arterial solution at a set rate of flow and pressure from the machine; (2) **distribution** of the embalming solution through the blood vascular system; (3) **diffusion** of the embalming solution from the blood vascular system (capillaries) to the cells and tissues; and (4) **drainage** of the contents of the blood vascular system, including some of the fluids of the tissues, and a portion of the embalming solution.

When all four of these processes are successful, a sufficient amount of embalming solution is delivered to the tissues to achieve a uniform preservation and sanitation of the body tissues without distension. In addition, these processes remove intravascular discolorations, color the tissues, and establish the proper moisture balance in the tissues, so that dehydration or overly moist tissue is not a problem.

Injection involves not only the pressurized injecting apparatus but also the equally important artery (or arteries) used for the delivery of the arterial solution and the vein (or veins) used for drainage. In the unautopsied body, the ideal artery for injection is the largest artery, the aorta. Its location, however, makes the aorta an impractical choice. The best location for drainage is the right atrium of the heart, but again, its location within the thoracic cavity makes it an impractical choice. Therefore, the vessels used for injection and drainage should be as close as possible to both the aorta and the right atrium.

▶ WORK AND ENGINEERING CONTROLS

Work practice and engineering controls are those work procedures and building mechanisms that reduce the exposure levels to formaldehyde and other hazardous chemical vapors during the embalming of the body. Some examples include the following items:

1. Adequate and properly operating air exchange system.
   a. The exhaust ventilation should draw fumes **away** from the embalmer.
   b. There needs to be a good supply of incoming clean, fresh air.
2. Prevent spillage of chemicals.
   a. Gently mix embalming solutions and avoid splashing.
   b. Keep the rate-of-flow valve on the embalming machine closed or stopcocks on arterial tubes closed to prevent leakage, before and after injection, or when the delivery hose is being moved between injection sites.
3. Keep embalming machines in good repair.
   a. No leakage from within the machine apparatus.
   b. No leakage where hose attachments are made to machine or arterial tube.
4. Rinse fluid bottles and empty into the arterial solution.
5. Cap all chemical bottles.

6. Keep a lid on the embalming machine reservoir.
7. Use continuous aspiration of body cavities during the injection of the autopsied body.
8. Clamp all accessible leaking arteries during the injection of the autopsied body.
9. Restrict drainage as much as possible after blood discolorations have cleared
   a. Helps to retain embalming solution within the body.
   b. Lowers the volume of chemicals placed into the waste system.
10. Use closed drainage.
    a. Attach tubing to the drain tube.
    b. Direct heart drainage with trocar.
11. Cover the waste sink to avoid splashing and aerosolization.
12. Use moving water to immediately remove drainage from the embalming table.
13. Avoid high water pressure to avoid splashing.

These controls combined with personal protective attire and equipment will greatly reduce exposure to chemicals or their vapors. Refer Chapter 3 for a discussion of personal protective equipment.

► ARTERIES FOR INJECTION/VEINS FOR DRAINAGE

Arteries are used for injection of the arterial solution, because, unlike some of the long veins of the body, they **do not** have valves. When arterial solution is injected "down" the leg, the drainage is returned "up" the leg through the veins. In life, blood flows back to the heart. In embalming, drainage flows in a similar direction, toward the heart. This direction of drainage flow makes the **right atrium** of the heart the center of drainage.

The embalming solution, injected into an artery, does not enter the chambers of the heart. The **aortic-semilunar valve closes** as the arterial solution fills the ascending aorta and the arch of the aorta. The central point of arterial solution distribution is said to be the **arch of the aorta**.

► INJECTION TECHNIQUES

Embalming of the unautopsied body begins when the embalmer selects a suitable artery or combination of arteries (as in restricted cervical injection) from which the arterial solution can be distributed throughout the **entire body**. Should injection of the embalming solution from this injection site fail to distribute the fluid to all areas of the body, other arteries must be raised and injected.

Embalming analysis continues throughout the embalming process. In the preembalming period, an artery and a vein are selected for the primary injection and drainage sites. During arterial injection the embalmer will note which regions of the body are **not** receiving arterial solution. A decision must then be made to select another injection point to embalm the region of the body lacking arterial solution. The following are vascular injection procedures:

One-point injection	Injection and drainage from one site
Split injection/ drainage	Injection from one site and drainage from another site
Multi-point injection	Injection at two or more sites
Restricted cervical	Injection of both common carotid arteries
Six-point injection	Injection of the right and left common carotid, axillary (subclavian/brachial) and femoral (common/external iliac) arteries

One-point Injection

In single-point injection, one location is used for **both** injection and drainage, requiring only one incision to be made. The most frequently used one-point injection sites are the right common carotid artery and accompanying internal jugular vein, and the right femoral artery and accompanying vein.* The axillary (or brachial) artery and vein is least used. **Years ago, when most embalming was performed at the residence of the deceased and a minimum amount of very concentrated fluid was injected, the axillary, no doubt, was the most frequently used artery because the head could easily be cleared of discoloration, and drainage could easily be collected from this site or by drainage from the right atrium of the heart. Also, the incision would not be seen by the family after the preparation.**

CRITERIA FOR SELECTION OF AN ARTERY AS AN INJECTION SITE

1. Size (diameter) of the artery
2. Practicality of drainage from the accompanying vein
3. Depth of the location of the artery
4. Flexibility of the artery because of its branches
5. Effect on posing the body
6. Incision location if leakage is a possibility (if edema is in the area of the artery)
7. Proximity of the vessel to the arch of the aorta

*Reference is made to Chapters 8 and 9 concerning the advantages and disadvantages of each artery and vein as a point for injection or drainage. The left vessels could also be used.

CRITERIA FOR SELECTION OF A VEIN FOR DRAINAGE

1. Size (diameter) of the vein
2. Proximity to the right atrium of the heart
3. Discolorations of the face and neck (blood)
4. Ease with which vein can be brought to the surface because of tributaries
5. Depth of vein

Often embalming necessitates the use of large volumes of embalming solution. The internal jugular or femoral vein allows for better drainage than the small axillary or basilic veins. Good drainage is essential when a large amount of solution is being injected. Some embalmers prefer to drain from each injection site when sectional embalming is performed in the unautopsied body; others prefer a central site such as those just mentioned.

There are three major injection sites: the common carotid, femoral (external iliac), and axillary (brachial) arteries. These arteries are large in size (especially the femoral and common carotid) and they are located as close to the aorta as is possible in the unautopsied body. An arterial tube comparable to the size of the artery is recommended (when arteriosclerosis is not a concern) for maximum rate of flow of the embalming solution. The diameter of the arterial tube determines to a great degree the volume and velocity of embalming solution injected in any given time period and under any given pressure. Procedures for such an injection from the three major sites are as follows:

RIGHT COMMON CAROTID INTERNAL JUGULAR VEIN

1. Insert an arterial tube into the right common carotid artery directed downward toward the trunk of the body
2. Insert an arterial tube into the right common carotid artery directed upward toward the right side of the face, leaving the stopcock **open**
3. Insert a drainage instrument into the right internal jugular vein **directed toward the heart**
4. **Inject** the trunk of the body; several gallons of solution are required for the adult body
5. Inject sufficient solution up the right side of the head

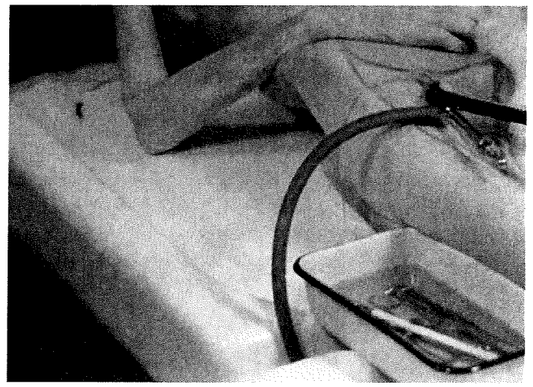


Figure 12–1. Single-point injection and drainage from the right femoral artery and vein. Note the concurrent disinfection of the instruments. A hose is attached to collect drainage from the drain tube, closed system of drainage.

RIGHT FEMORAL ARTERY AND VEIN

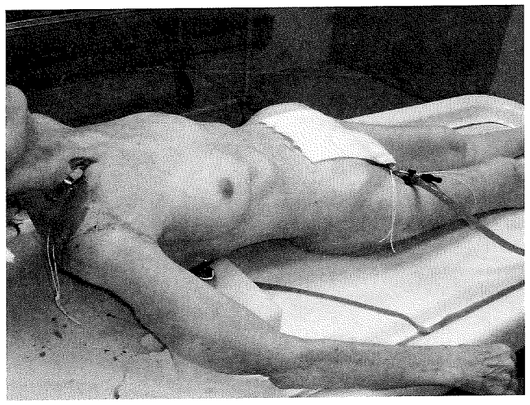
1. Insert a drainage tube **directed toward the heart** into the femoral vein
2. Insert an arterial tube directed toward the right foot into the femoral artery
3. Insert an arterial tube directed toward the trunk (head) of the body
4. Inject the right leg first
5. Inject the trunk, arms, and head

Note: See Figure 12–1

RIGHT AXILLARY ARTERY AND VEIN

1. Insert an arterial tube into the axillary artery directed toward the right hand
2. Insert an arterial tube into the right axillary artery directed toward the trunk and the head of the body
3. Insert a drainage instrument in the axillary vein directed toward the heart
4. Inject the head and the trunk first
5. Inject the right arm

Note: See Figure 12–2A.



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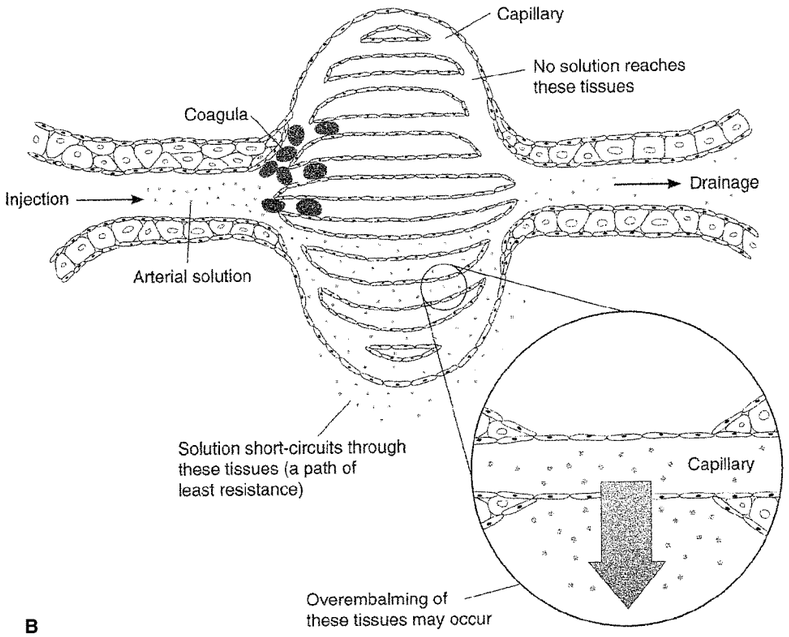

B

Figure 12–2. A. Split-injection. Femoral artery injected, drainage from right internal jugular vein. **B.** The greatest disadvantage of the one-point method of injection and drainage is the short-circuiting of arterial solution. Solution has a tendency to find direct routes from the arterioles to the venules in the region around the injection site. This can account for overembalming of the area near the injection site and loss of a large amount of arterial solution through the drainage.

Short-circuiting of Arterial Solution. A disadvantage of any injection and drainage from the same point is the short-circuiting and loss of the arterial solution. The solution has a tendency to find direct routes from the arterioles to the venules or through only portions of the capillaries in the region around the injection site and thus spills into the drainage. This can account for overembalming of the area near the injection site and loss of a great amount of arterial solution through the drainage.

Fluids Follow the Path of Least Resistance. Quite often the skin area is the path of least resistance, for the skin has a greater amount of capillaries than deeper body tissues. The skin areas surrounding the injection and drainage points frequently receive a greater volume of solution (Fig. 12–2B). Embalming in which only the skin and the superficial portions of the body and not the deeper tissues receive solution has been referred to as **shell embalming**. Massage, manipulation, and restriction of drainage all help to reduce shell embalming and encourage movement of arterial solution into the muscles and deep tissues.

Coagula in the Arterial System Can Easily be Pushed into Minute Arterial Tributaries. The solution then seeks out paths of least resistance and quickly finds its way into the venous system. Once there, it can easily be removed at the drainage site. Unrestricted drainage also contributes to the short-circuiting problem (Fig. 12–2B).

Split Injection/Drainage

Split injection is the injection of solution from one site and the drainage taken from another location. This method reduces short-circuiting of the solution and attempts to establish a more even distribution of the arterial solution. The most frequently used combination of vessels in the split injection method is the right internal jugular vein (drainage) and the right femoral artery (injection). **What starts out as a one-point injection can lead to split injection if drainage is difficult to establish. An example would be if the embalmer begins with a one-point injection using the femoral vessels, but soon finds difficulties with the drainage. Raising the internal jugular vein generally solves the drainage problem.** Examples of split injection include the following:

RIGHT FEMORAL ARTERY, RIGHT INTERNAL JUGULAR VEIN

1. Insert a drainage instrument into the right internal jugular vein directed toward the heart
2. Insert an arterial tube into the right femoral artery directed toward the right foot
3. Insert an arterial tube into the right femoral artery directed toward the trunk and head of the body
4. Inject the right leg and foot first; drainage is taken from the jugular
5. Inject the trunk and head of the body, drainage is taken from the jugular

RIGHT COMMON CAROTID ARTERY, RIGHT FEMORAL VEIN

1. Insert a drainage instrument into the right femoral vein directed toward the heart
2. Insert an arterial tube into the right common carotid artery directed toward the right side of the head
3. Insert an arterial tube into the right common carotid artery directed toward the trunk of the body
4. Inject down the right common carotid artery first to embalm the trunk of the body and left side of the face; drainage is taken from the femoral vein
5. Inject the right side of the head; drainage is taken from the femoral vein

Multi-point Injection

Multi-point injection is the injection from two or more arteries. Multi-point injection is used when the arterial solution does not evenly distribute to the entire body. An example would be injection of the body from a one-point site using the femoral artery and vein. If the solution did not enter the left arm, the left axillary (brachial) artery can be used to inject the arm. If the fluid still does not reach the hand, the radial or ulnar arteries can be raised to inject the hand.

Six-point Injection

This method of injection can be used as the primary injection technique. If the embalmer is preparing a body dead for a long period and anticipates poor solution distribution and possibly tissue distension, he or she can **begin** the embalming using sectional injection. The embalmer would raise several arteries for injection; drainage is taken from each injection location **or** from one drainage point.

A **six-point injection** is a sectional injection. It involves the injection of six arteries, the right and left common carotids, right and left subclavian (axillary or brachial) arteries, and the right and left femoral (common, external iliac) arteries. The six-point injection is used in the preparation of most autopsied bodies. It can also be used in the preparation of the unautopsied body. Preparation of bodies of members of the armed services and bodies being shipped to some foreign countries may require a six-point injection with multi-point drainage.

The sectional procedure ensures thorough distribution throughout a body region. This type of injection allows different solution strengths to be used in different body regions. A suggested procedure for the **six-point injection** follows:

1. Raise the right internal jugular vein and insert a drainage instrument directed toward the heart.

2. Raise the right common carotid artery and insert an arterial tube directed toward the trunk of the body. Also insert a tube directed toward the right side of the head.
3. Raise the left common carotid and insert a tube directed toward the left side of the head. Tie off the lower portion of the artery.
4. Raise the right axillary (or brachial) artery and insert an arterial tube directed toward the right hand. Tie off the upper part of the artery.
5. Raise the left axillary (or brachial) artery and insert a tube directed toward the left hand. Tie off the upper part of the artery.
6. Raise the right femoral artery and insert an arterial tube directed toward the right foot. Tie off the upper portion of the artery.
7. Raise the left femoral artery and insert an arterial tube directed toward the left foot. Tie off the upper portion of the artery.
8. Inject in the following order: right leg, left leg, right arm, left arm, trunk of the body (inject down the right common carotid), left side of the head, and right side of the head.
9. Drainage can be taken from the right internal jugular vein for all body areas injected, or drainage may be taken from each accompanying vein.
10. The body may be aspirated before injecting the head, if purge has been a problem.

Some embalmers refer to a 12-point injection. This is a six-point injection but arterial solution is injected both toward the head and the limbs as well as toward the trunk of the body.

CONDITIONS THAT MAY REQUIRE MULTIPOINT INJECTION

1. When a body area does not receive arterial solution
2. Bodies dead for long time periods
3. Bodies that show evidence of decomposition
4. Death caused by a ruptured aortic aneurysm
5. Bodies dead of highly contagious diseases involving the blood vascular system (this method of injection maximizes tissue saturation with embalming chemicals)
6. When disposition of the body is to be delayed
7. When required by military or shipping regulations
8. When a one-point injection has been used but embalming solution purge develops and drainage stops (distribution cannot be observed)
9. Bodies with generalized edema
10. Bodies that are difficult to firm
11. Bodies that exhibit poor peripheral circulation
12. Bodies that exhibit poor distribution after a one-point injection is completed
13. Bodies with true tissue gas
14. Body or area of the body needing to be reembalmed **after** cavity embalming has been done
15. Autopsied bodies
16. Organ and/or tissue donors

Restricted Cervical Injection*

In restricted cervical injection, both common carotid arteries are raised so that the head can be separately injected (Fig. 12–3). This injection method is the standard practice in many funeral establishments.

1. Raise the right common carotid artery and insert an arterial tube directed toward the trunk of the body. Insert an arterial tube directed toward the right side of the head and **leave the stopcock open.**
2. Insert a drainage instrument into the right internal jugular vein directed toward the heart.
3. Raise the left common carotid artery and insert an arterial tube directed toward the left side of the head; **tie off the lower portion of the left common carotid artery and leave the stopcock open**.
4. Inject the trunk of the body **first**; drainage is taken from the right internal jugular vein. (Solution entering the head by collateral circulation exits through the two open stopcocks. Only the trunk of the body is embalmed.)
5. Inject the left side of the head.
6. Inject the right side of the head.

Restricted cervical injection can be a routine embalming technique, with the difficulties encountered in embalming today (time delays, poor distribution as a result of vascular clotting, edema, and difficulty in firming as a result of drug therapy). Hence, more embalmers are using restricted cervical injection as their primary injection method.

The restricted cervical method of injection affords the **greatest control** over entry of arterial solution into the head. Because the tubes that are directed upward are left open while the trunk is injected, any solution that does reach the face and head via the collateral circulation **exits** the carotid arteries through the open arterial tubes.

*Much of this information was supplied by David G. Williams, Pittsburgh, Pennsylvania.

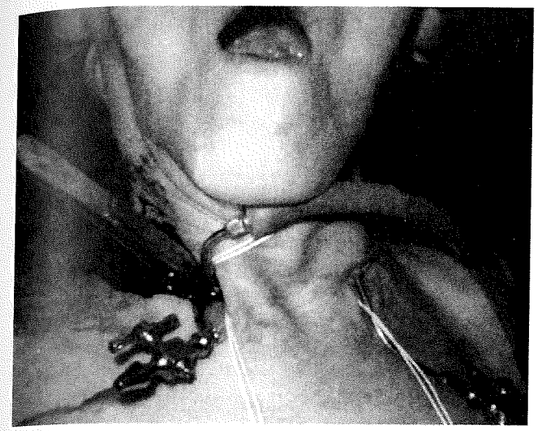

Figure 12–3. Restricted cervical injection.

The restricted cervical injection is recommended in several situations.

"Normal" Unautopsied Body. This technique allows the embalmer to control the amount of arterial solution entering the head. It allows large volumes of fluid, increased pressures, and faster rates of flow to be used for embalming the body trunk and the limbs without over injection of the head and the face. A separate solution can be prepared for injection of the head and the face.

Bodies with Facial Trauma. With restricted cervical injection a minimum volume of a very strong solution can be injected into the head to preserve and firm tissues with a minimum amount of tissue distension.

Bodies in Which Facial Distension Is Anticipated. Delayed embalming, refrigerated, frozen, and bodies exhibiting early signs of decomposition are all examples where the face can easily swell during arterial injection. Restricted cervical injection allows the trunk to be saturated with large amounts of strong solution, while the head and facial tissues are injected separately to control distension.

Bodies in Which Eye Enucleation Has Been Performed. Restricted cervical injection allows complete control over the strength, amount of solution, pressure, and rate of flow of arterial solution entering the facial tissues and thus helps to control distension of the eyelids.

Bodies with Generalized Edema. A large volume of solution can be injected into the trunk areas. Frequently, if facial tissues are not edematous, a milder solution can be used for injection of the head to prevent distension and/or dehydration of the tissues.

Difficult-to-Firm Bodies. With many of the drugs used today protein levels in the body can be low. Restricted cervical injection allows the embalmer to inject large quantities of preservative solutions without overembalming the facial tissues.

Bodies with Distribution Problems. Restricted cervical injection allows the use of high pressures and high rates of flow without distending the facial tissues.

Bodies with a High Formaldehyde Demand. Burned bodies and bodies dead from renal failure require large amounts of preservative. Restricted cervical injection allows the embalmer to inject strong solutions of special-purpose high-index fluids without overembalming the facial tissues.

Bodies in Which Purge Is Expected. In a body that purges prior to arterial injection, the purge often continues during the embalming process. Examples include bodies with esophageal varices (as in alcoholism); bodies that suffered pneumonia, tuberculosis of the lungs, and ulcerations of the upper digestive organs; and bodies that show decomposition changes. Restricted cervical injection allows the embalmer to embalm the limbs and the trunk areas, then **aspirate the body,** set the features, and embalm the head. This eliminates the necessity to reset the features if purge occurs.

Jaundiced Bodies. The head can be embalmed with a jaundice fluid preparation or other jaundice treatment. Restricted cervical injection allows thorough distribution of the solution to the facial tissues. The remainder of the body can be injected using arterial solutions suitable to the body conditions. First inject the body, then inject the head and the face.

ADVANTAGES TO THE USE OF RESTRICTED CERVICAL INJECTION

1. Amount of arterial solution entering the facial tissues can be controlled
2. Large volumes of arterial solution can be injected into the trunk without overinjecting the head and the face
3. Two solution strengths can be used: one for the trunk and the limbs and another for the head and the face
4. Arterial coagula, if present in the aorta, are pushed toward the lower extremities
5. Different pressures can be used to inject the head and the trunk
6. Different rates of flow can be used to inject the trunk and the head
7. The trunk can be injected first and the body can be aspirated to stop purging; the features can be set **after aspirating,** and then the head can be injected last
8. The **instant tissue fixation** technique can be employed for trauma and decomposition cases
9. For jaundiced bodies, only the head is treated with jaundice fluids

ADVANTAGES TO USE OF THESE VESSELS FOR RESTRICTED CERVICAL INJECTION

1. Arteriosclerosis is rarely seen in the carotid arteries; they are very large vessels and very elastic
2. The common carotid arteries have no branches (except their terminal branches) and thus are easily raised to the surface
3. Clots present in the right or left carotid artery can be identified and removed
4. The carotid arteries allow direct injection of the head and facial tissues
5. The carotid arteries are accompanied by the large internal jugular veins, which directly drain the head and the face

▶ INSTANT TISSUE FIXATION

Instant tissue fixation is an embalming technique that makes use of restricted cervical injection. This embalming technique is used for the injection of the head (although other body areas can be similarly treated) with a limited amount of very strong arterial solution. Some examples of when it is used would include:

- Early decomposition when facial swelling is anticipated.
- When facial trauma is present.
- When facial tissues must be dried and firm for restorative treatments.
- When facial excisions are necessary, cancers, etc.
- Reembalming of the face.

Vessels

Both right and left common carotid arteries are raised and usually drainage is taken from the right internal jugular vein. In this method of injection, very little drainage is taken as only a minimal amount of arterial solution is injected.

Solution Strength

A very strong arterial solution is prepared, and in some cases, a waterless solution can be used. One solution suggested contains 16 oz of a high-index arterial fluid (25-index or above), 16 oz of a coinjection chemical, 16 oz of water, and 1 to 1½ oz of arterial fluid dye. This solution is designed to immediately preserve, dry, and firm the tissues.

Pressure

The solution is mixed in the machine. When a centrifugal injection machine is used, the pressure with the rate of flow valve **off** should be set at 20 lb or above.

Method of Injection

Connect the injection hose to the arterial tube in the left common carotid artery. Be certain that the arterial tubes used are as large as the arteries allow. Turn the machine **on** with the rate-of-flow valve **closed**. Set the pressure at 20 lb. Once the hose is connected, open the rate-of-flow valve a full turn and immediately turn it **off**. This creates a "pulse" type of fluid flow. The solution is injected in a strong spurt, under high pressure, for only a moment. Repeatedly turn the rate-of-flow valve on and off until sufficient solution has been injected. Only a minimum amount of solution is needed because of its strength. The dye will indicate the presence of the solution in the tissues. In addition, the dye helps to prevent graying of the tissues. Next, the right side of the head is injected in the same manner. High pressure is used, but the rate-of-flow valve is turned on and off for only a moment each time. The purpose of this method of embalming is to inject a very strong but minimal amount of preservative solution. Thus, maximum preservation is achieved with a minimum of tissue distension (Fig. 12–4).

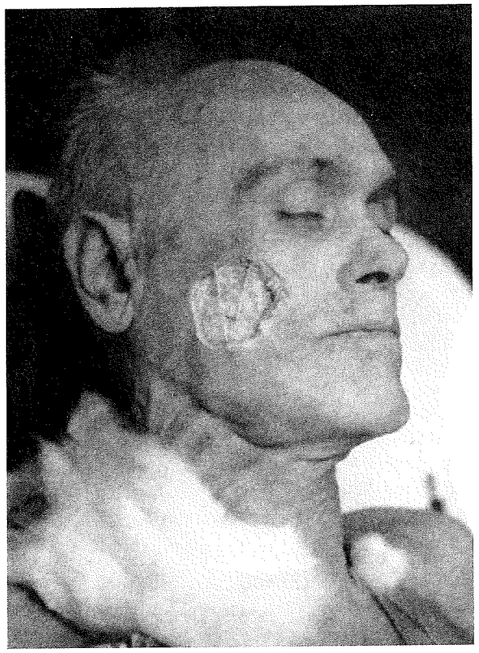

Figure 12–4. Facial tissues embalmed using the instant tissue fixation technique prior to the removal of a cancerous tumor of the right cheek.

▶ VARIATIONS OF INJECTION TECHNIQUES

The autopsied body presents its own injection problems. When the body has undergone a complete autopsy, generally a six-point (sectional) injection is used; each body extremity is embalmed separately.

After surgeries, partial autopsies, or when organs have been removed for donation, direct access and use of the abdominal or thoracic aorta as an injection site becomes a possibility.

Traumatic injuries may result in the severance of vessels. It may become necessary to inject severed arteries to preserve a body extremity. Arteries when cut or severed will remain open—the lumen of the vessel can be seen—this can be helpful in locating a vessel for injection.

▶ DRAINAGE

As stated at the beginning of this chapter, four processes occur at the same time in the embalming of the body: (1) injection of the solution, (2) distribution of the solution, (3) diffusion of the solution, and (4) drainage. Distribution and diffusion of arterial solution are discussed in Chapter 13.

LYMPHATIC CIRCULATION

The lymphatic vessels originate as blind-end tubes called lymph capillaries (Fig. 12–5). These tubes are located in the spaces between the cells. The lymph capillaries are larger and more permeable than the blood capillaries. They converge to form lymph channels called the lymphatics. These lymphatics have valves similar to those of veins and contain lymph nodes along their routes. Their fluid eventually enters the blood vascular system by flowing into the thoracic and the right lymphatic ducts. The thoracic duct empties lymph into the junction of the left subclavian vein and the left internal jugular vein. The lymph from the right lymphatic channel empties into the junction of the right subclavian vein and the right internal jugular vein

In life, the lymph is composed of the fluids that pass from the blood through the walls of the capillaries. Here it is called tissue or interstitial fluid. More fluid enters the interstitial spaces from the blood than is directly reabsorbed back into the bloodstream by the capillaries. This excess fluid is drained by the lymph system. Once the interstitial fluid enters the lymph capillaries it is called lymph. At the time of death these lymph channels can be the site of large numbers of microbes. The lymph system is part of the defense system for protecting the body from pathological microbes. Embalming solution will diffuse from the interstitial spaces into the lymph channels. Massage and manipulation of the body during injection combined with the use of restricted drainage help to move embalming fluid throughout the lymph system

Embalming solution can be diffused through the lymphatics in the following order: lymphatic capillary → lymphatic vessel → lymph nodes → lymph vessels → lymphatic trunk → subclavian veins

Drainage is brought about by displacement. As the arterial solution fills the vascular system the contents of the vascular system are displaced. There are 5 to 6 qt of blood in the vascular system of the average body. This accounts for approximately 8% of the body weight. At death, there is generally a wave contraction of the arterial system. This contraction forces the greatest volume

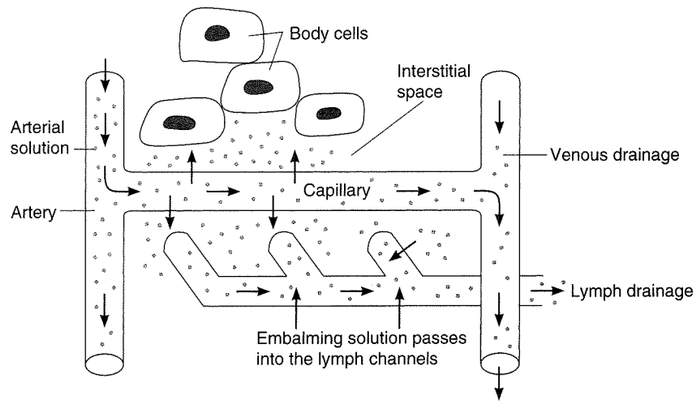

Figure 12–5. Drainage consists of blood, interstitial fluid, embalming solution, and lymphatic fluid.

of blood into the capillary and the venous portions of the blood vascular system.

It has been estimated that after death, 85% of the blood is found in the capillaries, 10% in the veins, and 5% in the arteries. Amounts of blood in the vascular system vary depending on the cause and the manner of death. In addition, the blood will gravitate (postmortem hypostasis) into the dependent body regions over time. This engorges the dependent capillaries with blood (livor mortis) and leaves the less-dependent tissues free of most of the blood.

Contents of Drainage

Drainage is composed of blood and blood clots, interstitial fluid, lymphatic fluid, and embalming solution. As arterial solution flows into the capillary, a portion of the solution passes through the walls of the capillary and is retained by the body. This retained preservative is the portion of the embalming solution that preserves, sanitizes, moisturizes, and colors the body tissues. Some of the embalming solution moves through the capillaries, into the venules and veins, and exits as part of the drainage. It has been estimated that 50% or more of the drainage taken during embalming is actually embalming solution.

The color and consistency of the drainage change during the injection in the body. During injection of the first gallon of embalming solution, drainage contains more blood than for subsequent injections. As the blood in the vascular system is gradually displaced and replaced with embalming solution, the drainage lightens in color and becomes thinner. The initial drainage is the most dangerous; however, all drainage should be carefully controlled and splashing should be avoided. Embalming the body raised on "body bridges" allows the drainage to fall onto the preparation table where it can be washed into the sanitary sewer system. Closed drainage (a clear plastic hose attached to a drain tube and the open end placed in the sanitary drain) will not expose the embalmer to the contents of the drainage.

As the embalming solution passes through the capillaries, some of the interstitial fluid in the tissue spaces is drawn into the capillaries by osmosis because of the high concentration of the embalming solution, especially when strong arterial solutions are used. Some interstitial fluid will also enter the drainage through the lymphatic system. Dehydration can result when too much interstitial fluid is removed. In bodies with skeletal edema, this is how the edema is removed from the tissue spaces.

Drainage can then be said to consist of blood, venous blood coagula, interstitial fluid, and arterial solution (Fig. 12–6). Bacteria and microbial agents and their products that have entered the blood vascular system before or after death are also removed in the drainage. In bodies with skeletal edema, the edematous fluid may

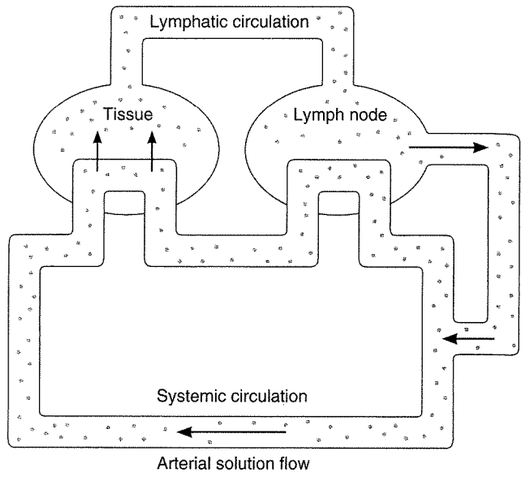

Figure 12–6. Lymphatic and systemic circulation.

be part of the drainage. Venous coagula are included in the contents of the drainage. Several types of clotted materials present in the drainage; however, all clotted materials come from the **veins** or from a heart chamber. It is impossible for any arterial coagula to pass through the capillary beds and enter the venous side of the circulatory system. The following coagula can be identified:

- **Postmortem coagula**—These coagula are not actual clots, but simply blood inclusions that have congealed and stuck together; they can be large and dark.
- **Postmortem clots**—These clots are multicolored. The bottom portion of the clot is dark, for it was formed by red blood cells that gravitated to the dependent part of a vessel. The clear layer on the top of the clot is a jelly-like layer of fibrin.
- **Antemortem clots**—Clots such as thrombosis form in layers—a layer of platelets, followed by a layer of fibrin, followed by another layer of platelets, and so on.

The viscosity of the blood can vary depending on the cause of death and the time between death and embalming. As the body gradually dehydrates after death, the viscosity of the blood increases. Bodies that have been refrigerated for very short periods after death, have been administered anticoagulant drugs such as heparin or dicumarol, or have died from carbon monoxide poisoning, exhibit low blood viscosity.

The volume of drainage is not equal to the volume of embalming solution injected. A large portion of the blood vascular system, particularly the arteries, is empty at death. This entire area must be filled, which accounts for the delay often noted between the start of the injection and the start of the drainage. At the conclusion

of the embalming, the arterial system is filled; some of the injected solution is found in the capillaries and the veins, and some has passed through the capillaries to be retained by the tissues and the cells.

In some bodies, there will be little or no drainage.

As long as the solution is distributing and there is no swelling or discolorations in the tissues, drainage need not be a concern

Sometimes there is little to drain, as illustrated in these examples:

1. In cases of esophageal varices and ruptured ulcerations of the digestive tract (blood has been lost to the lumen of the esophagus, stomach, or intestines), drainage actually occurs within the intestinal tract.
2. Accidental death could cause the spleen or other internal organ to rupture; blood is lost from these sites and drainage also occurs at these ruptures.
3. Traumatic death may result in a large loss of blood outside the body. This hemorrhage decreases the volume of blood available for drainage.
4. Insertion of the drainage tube into the femoral or external iliac vein may tear the vein, allowing drainage to flow into the abdominal cavity.
5. When a preinjection embalming solution is used, a portion of the blood is removed. At the time of arterial solution injection, there is less blood to drain.
6. Pathological lesions such as with tuberculosis may account for a blood loss in life and will create an internal site of drainage at the time of arterial solution injection.
7. Bloodstream infections frequently cause extensive clotting, and anemic diseases reduce blood volume; these factors contribute to poor distribution and low drainage volume.

Often in bodies in which hemorrhage into the digestive tract or abdominal cavity occurred prior to death, there may be a gradual swelling of the abdomen as the arterial solution is injected because some of the drainage (and arterial solution) will fill the digestive tract or abdominal cavity. This drainage can later be removed with a trocar. Likewise, hemorrhage into the stomach, esophagus, or lung tissues can result in a purge during injection. The purge will take the form of drainage. It is actually possible to drain from the mouth if a stomach ulcer has ruptured large veins! Aspiration can later remove these fluids. Some medications cause gastrointestinal bleeding. If this bleeding was intense, a major portion of the drainage may flow into the intestinal tract during arterial injection.

The bodies just described may demonstrate two forms of drainage: internal, into a cavity or hollow organ, and external, through the drainage tube or exit as purge.

Good drainage may be expected under the following conditions:

1. The interval between death and preparation is short; the body retains some heat.
2. The body shows early evidence of livor mortis, indicating that the blood has a low viscosity and can easily be moved.
3. Death was not the result of a febrile disease or a bloodstream infection.
4. Skeletal edema is present.
5. The body is jaundiced.
6. The person had been treated with blood thinners or anticoagulants (e.g., heparin, dicumarol, aspirin), resulting in low blood viscosity.
7. The body was refrigerated shortly after death but not for a long period.
8. Death was due to carbon monoxide poisoning.

Purpose of Drainage

The bodies used for dissection are often embalmed but not drained and most are swollen to the point where they could not be viewed for funeral purposes. Bodies dead for long periods of time can be slowly embalmed without draining and are often suitable for viewing. Drainage is taken for a number of reasons:

1. *To make room for the arterial solution.* Distension would result without removal of some of the blood (especially today, when 3 to 5 gal of preservative solution is injected into the average body).
2. *To reduce a secondary dilution of the arterial fluid.* The blood in the capillaries along with the interstitial fluids can dilute the embalming solution.
3. *To remove intravascular blood discolorations.* Livor mortis is a postmortem intravascular blood discoloration. Discolorations such as carbon monoxide and capillary congestion are antemortem blood discolorations. Injection of arterial solution accompanied by blood drainage should greatly reduce or remove these discolorations.
4. *To remove a tissue that rapidly decomposes.* Blood is a liquid tissue that rapidly decomposes after death, and decomposition of the blood can result in discolorations, odors, and formation of gas.
5. *To remove an element that speeds decomposition.* Blood, a portion of which is liquid, can hasten hydrolysis and the decomposition of the body tissues. Moisture is needed for decomposition and blood can provide that medium.
6. *To remove bacteria present in the blood.* With some diseases, the microbes normally found in the

intestine can translocate to the bloodstream. After death, this translocation greatly increases. Removal of blood as drainage helps to reduce microbial agents in the body.

7. *To prevent discolorations.* When the blood in the body (hemoglobin) mixes with the formaldehyde of the arterial solution methyl-hemoglobin can form, which produces a gray color in the tissues (formaldehyde gray).
8. *To reduce swollen tissues.* When pitting edema is present in the skeletal tissues, it is possible to remove some of the edematous fluid via the blood drainage from the body.

Drainage, from some bodies, is most important in clearing very pronounced discolorations, especially when the face, the neck, and the hands are affected. **If a primary purpose for drainage must be stated, it would be that the drainage makes room for the arterial solution so it can be evenly distributed to all tissues of the body with a minimum distension.**

Center of Drainage

The center of drainage in the dead human body is the right atrium of the heart (Fig. 12–7). The superior vena cava returns blood to this chamber from the head and the upper extremities. The inferior vena cava returns blood from the visceral organs, trunk, and legs. If the internal jugular vein is used as a drainage point, all blood from the lower extremities and visceral organs must pass through the right atrium to be drained. Likewise, if drainage is to be taken from the femoral vein, blood from the arms and the head must pass through the right atrium. After death, the blood in the right atrium frequently congeals. This condition warrants drainage from the right internal jugular vein where an instrument, such as angular spring forceps, can be placed directly into the right atrium to fragment this coagulum.

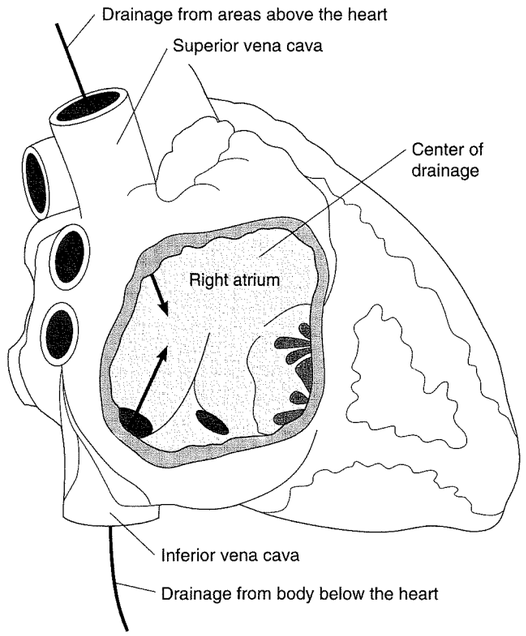

Figure 12–7. The center of drainage in the dead human body is the right atrium of the heart. The superior vena cava returns blood to this chamber from the head and the upper extremities. The inferior vena cava returns blood from the visceral organs, trunk, and legs.

Above and Below Heart Drainage

Some embalmers also use two locations for drainage. A second drainage point is often used when the femoral vein is used as the beginning injection and drainage point. If there is a blockage in the inferior vena cava, right atrium or the jugular veins, the neck and the face can begin to discolor. The veins of the neck and possibly the tissues of the neck can distend. The right internal jugular vein should be raised and opened as a second drainage site.

Drainage instruments are inserted into the vein and directed toward the heart

Drainage Sites

The primary drainage site is the location from which drainage is first taken. In the unautopsied body, the veins most commonly used for drainage are the right internal jugular vein, the femoral vein, or the external iliac vein.

Axillary and basilic veins can be used, but their small size and the need to extend the arm make these veins an impractical choice. **Any vein can be used for drainage whether it is large or small or on the right or left side of the body.** In unusual circumstances, even the external jugular vein can be used if the internal jugular vein is obstructed by a cancerous growth or a large attached thrombosis.

A broken vein can still be used as a drainage site; if an instrument such as angular forceps cannot be inserted, a groove director may be used. Following injection the area can be dried and the ends of the broken vein are ligated

Should a vein tear while it is being raised, the following steps can be taken to attempt to place an instrument in the portion of the vein leading to the heart:

1. Force as much blood from the vein as possible.
2. Clean the area using an absorbent material.

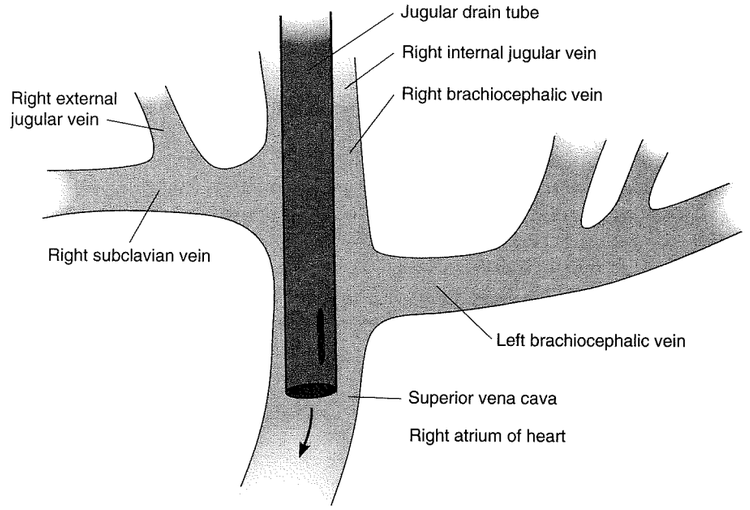

Figure 12–8. Drainage tube placed in the right internal jugular vein.

3. Observe where blood is seeping from the broken portion of the vein.
4. Clamp an edge of the wall of the broken vein with a small serrated or rat-toothed hemostat, or place the hemostat across the entire broken portion of the vein.
5. Gently insert a drainage device toward the heart; if the vein has been torn into two pieces, do not remove the hemostat.
6. After embalming, pass ligatures and tie off the severed ends of the vein (holding them with hemostats).

In Chapter 9, the advantages and the disadvantages of the various veins for drainage are discussed, as are the incision locations and the relationships of veins to arteries. The internal jugular vein is the most valuable drainage point. It is the largest systemic vein that can be raised in the unautopsied body. The right internal jugular vein leads directly into the right atrium of the heart. Figure 12–8 illustrates why the **right** and not the left internal jugular vein is most frequently used for drainage. Should there be a complication with the right internal jugular vein, the left can be used, but note that the vein turns to the right, often making insertion of a drainage instrument difficult.

Direct Heart Drainage*

The right atrium of the heart can be directly drained using a trocar (Fig. 12–9). This very old method of drainage was often used when embalming was performed at the residence of the deceased. The drainage could be conveniently collected in bottles, which could be taken back to the funeral parlor to be emptied.

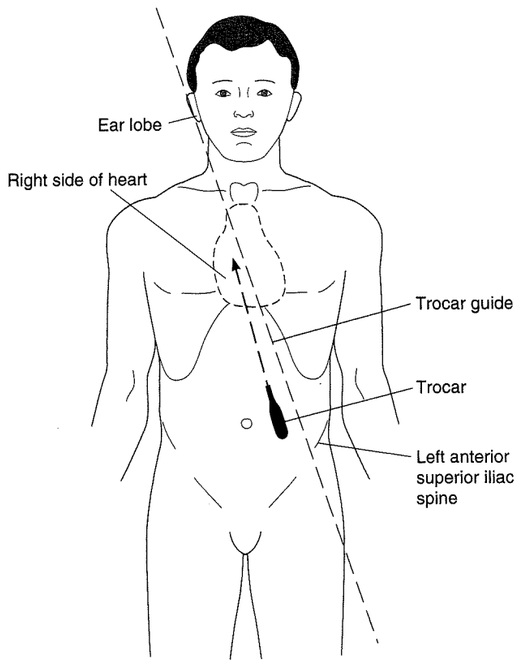

Figure 12–9. Direct heart drainage.

*This method is not intended for use as a primary drainage technique but only in special situations where a vein cannot be used for drainage.