Ch. 5: Death – Agonal and postmortem changes

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Rapid cooling of the body by refrigeration or natural means helps to slow the onset of rigor mortis, slow the onset of decomposition, and keep the blood in a liquid state. These are all advantageous for embalming.

115:

Increase in Blood Viscosity. Viscosity refers to the thickness of a liquid. The blood is composed of two portions: (1) a "solid" portion made up of the various groups

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of blood cells and (2) a "liquid" portion in which the cells are suspended. After death, blood has a tendency to increase in viscosity and thicken. This thickening is brought about by the dehydration of the body. As the tissues lose moisture to the surrounding air, the liquid portion of the blood begins to move through the capillary walls into the tissue spaces. Given enough time and the proper conditions, this liquid could leave the body by surface evaporation. The remaining blood begins to thicken as a result of a gradual loss of the liquid or serum portion of the blood.

As a result of this thickening, the blood cells begin to stick together, and if this occurs in the arterial system, the agglutinated blood will eventually clog small arteries during arterial injection. On the venous side, blood drainage will be difficult. Not only is dehydration responsible for the thickening of blood, but gravity alone tends to "drain off" the liquid portion of the blood, leaving behind a more viscous blood.

Ch. 6 Embalming chemicals

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Six general chemical groups provide the basic components of the various embalming formulations (Fig. 6–1):

1. Preservatives
2. Disinfectants (germicides)
3. Modifying agents
   a. Buffers
   b. Anticoagulants (water conditioning agents)

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Anticoagulants (Water Conditioners or Softeners). Anticoagulants are an important component of embalming fluids, especially arterial fluids, because they are used to maintain blood in a liquid state and thereby make it easy to remove from the circulatory system.

When blood collects in the capillary bed in the dependent parts of the body after death, it has a tendency to thicken and clot very easily. In some cases, as in death from pneumonia, the blood tends to clot more readily. The volume of circulating blood tends to decrease when high fever precedes death, and the blood becomes more viscous and clots more readily after circulation stops.

It is therefore necessary to include, in an embalming fluid, chemicals that maintain blood in a liquid state so that it is easily displaced from the body. Such chemicals inhibit or stop the clotting of blood. Claims are often made that such materials also "liquefy" clotted blood, but it is not likely that this happens.

The compounds that are used for this purpose must be chemically compatible with, or inert toward, other intimately blended components of the formulation. The materials that are employed as anticoagulants also function as "water softeners" or "water conditioners"; however, products specially designed for that purpose are commercially available and are sold for use as additives or supplemental chemicals with the arterial solution. The products known as water "softeners" or water "conditioners" are used for one or all of four reasons.

First, such products are intended to be used as aids to improve drainage by keeping blood in a liquid state during the embalming operation and softening the framework of clotted material so that it readily breaks up into smaller pieces.

Ch. 9 Embalming vessel sites and selections

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5. Clotting

If an embalmer feels that clots may be present in the arterial system, particularly in the aorta, the femoral artery should **not** be used as the starting point for injection. The best choice in this situation is to begin the injection of the arterial solution from the common carotid, because if any coagula do break loose, it is better that this material be directed toward the legs. If the femoral artery is used, the coagula could be pushed up into the common carotid arteries or the axillary vessels. These arteries supply body areas that will

be viewed. Clotting may be suspected in bodies that have been dead for long periods, in deaths from systemic infections and febrile disease, and in bodies of persons who were bedfast for long periods.

When the embalmer suspects that the blood vascular system is heavily clotted or that distribution of arterial solution will be difficult, the best vessel to use in beginning the arterial injection is the common carotid artery, and drainage should be taken from the right internal jugular vein. An even better method is to raise both common carotid arteries at the beginning of the embalming (restricted cervical injection). As the head is thus separately embalmed, the embalmer maintains control over solution distribution into the facial tissues.

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1. Considerations
   a. The vein is very large.
   b. There is direct drainage from the face and the head.
   c. It is accompanied by the common carotid artery, which can be used for injection.
   d. The right internal jugular vein leads directly through the right brachiocephalic and superior vena cava into the right atrium, allowing easy removal of clotted material that may be present.

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The following are some advantages to use of the restricted cervical injection:

- The arteries are large.
- Carotids are very elastic and have no branches, so they are easy to elevate.
- The arteries are accompanied by the largest veins.
- The arteries are rarely sclerotic.
- Clots or coagula present in the arterial system will be pushed away from the head area.

189, femoral artery:

3. Precautions
   a. The most frequent reason for inability to use the femoral artery as an injection point is the presence of arteriosclerosis in the artery.
   b. In obese bodies, the vessels may be very deep.
   c. There is no control over the solution entering the head, especially when large volumes of solution must be injected or when strong solutions are used.
   d. Coagula in the arterial system can be pushed into the vessels that supply the arms or the head, areas that will be viewed.

191: femoral vein

   e. Clots in the right atrium and the upper areas of the vascular system may be difficult to remove.

Ch. 10 Embalming analysis

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Blood Thinners. Drugs that thin the blood in life will often reduce postmortem blood clotting in the vascular system. Reduced postmortem clotting will improve distribution and subsequent diffusion of the arterial solution.

Bodies that exhibit a mid-line scar over the sternum no doubt in life had open heart surgery, valve repair or vascular by-pass, most of these persons take some form of anti-coagulant or blood thinning medication. Keeping the blood thin will increase postmortem hypostasis of the blood and intense livor mortis in the dependent tissues. Expansion of the veins in the distal arm will be noted when the arms are lowered to the sides of the body.

These indicators inform the embalmer that good distribution of the embalming solution can be expected.

Surgery. In making a pre-embalming analysis, choice of embalming technique may be greatly influenced by whether death occurred during or immediately after surgery. Surgery could be the primary factor in an analysis, as illustrated in the following examples.

HEART SURGERY OR AORTIC REPAIR. During these procedures, the heart may be stopped for a period during which an artificial means of life support is used. Frequently, if death occurs during or shortly after this type

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As a general rule, best results are obtained when embalming is done as soon as possible following the death. Three postmortem conditions that interfere most with good distribution of the arterial solution are blood coagulation, rigor mortis, and decomposition. Embalming the body before these changes are established helps to produce better results.

If there is to be a delay between death and preparation, refrigeration will help to slow the onset of some postmortem changes. Cooling of the body helps to slow postmortem blood coagulation, the onset of rigor mortis and decomposition. Refrigeration, however, can create its own problems depending on how long it is used. In time refrigeration can create dehydration, increase blood viscosity and postmortem edema, intense livor mortis and postmortem stain. Refrigeration can also cre-

During arterial injection:

1. What areas of the body are receiving arterial solution? This can be noted by the presence of fluid dyes in the tissues and the clearing of intravascular discolorations such as livor mortis.
2. What areas are not receiving arterial solution? Dyes will not be present and livor mortis, if present, will not be cleared; no firmness will be present.
3. What can be done to stimulate the flow of arterial solution into areas not receiving solution?
   a. Massage along the arterial route that supplies fluid to the area.
   b. Increase the pressure of the solution being injected.
   c. Increase the rate of flow of the solution being injected.
   d. Lower, raise, or manipulate the body area.
   e. Close off the drainage to increase the intravascular pressure.
4. What areas must receive sectional arterial injection? Areas that did not receive solution even after massage and changes in injection protocol must be injected separately.

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TABLE 10–2. POSTMORTEM PHYSICAL AND CHEMICAL CHANGES

Change	Embalming Significance
Physical	
Algor mortis	Slows onset of rigor and decomposition
	Keeps blood in a liquid state; aids drainage
Dehydration	Increases the viscosity of the blood; sludge forms
	Partly responsible for postmortem edema; increasing preservative demands
	Darkens surface areas; cannot be bleached
	Eyelids and lids will separate; lips wrinkle; fingers wrinkle
	Could retard decomposition if severe enough
Hypostasis	Responsible for livor mortis and eventual postmortem stain
	Increases tissue moisture in dependent tissue areas
Livor mortis	Varies in intensity from slight redness to black depending on volume and viscosity of the blood
	Intravascular discoloration; can be cleared
	Can be set as a stain if too strong an uncoordinated arterial solution is used
	Keeps capillaries expanded; can work as an aid to distribution
Increase in blood viscosity	If it clears **by itself** it could serve as a sign of arterial solution distribution
	Sludge is created; intravascular resistance
	Postmortem edema can accompany problem
	Blood removal becomes difficult; distribution can be poor

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Bodies refrigerated more than 12 h; some rigor; livor	Solution stronger than average; avoid pre-injection; dye tracer; circulation problems expected; restricted cervical injection

Ch. 12 Injection and drainage techniques

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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).

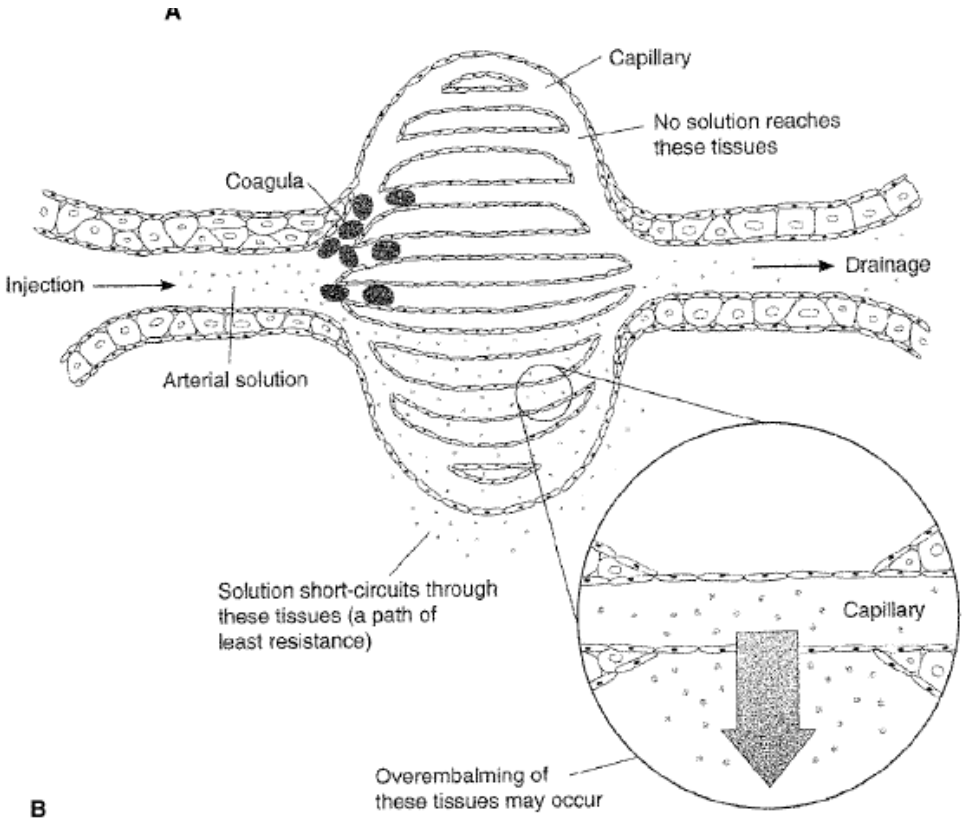

Figure 12–2. A. Split-injection. Femoral artery injected, drainage from right internal jugular vein. **B.** The greatest disadvantage of the one-point method of injection and drainage is the short-circuiting of arterial solution. Solution has a tendency to find direct routes from the arterioles to the 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.

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

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

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Contents of Drainage

Drainage is composed of blood and blood clots, interstitial fluid, lymphatic fluid, and embalming solution. As

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

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.

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7. Bloodstream infections frequently cause extensive clotting, and anemic diseases reduce blood volume; these factors contribute to poor distribution and low drainage volume.

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.

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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.

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.

Ch. 22 Vascular considerations

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Table 22–1 lists intravascular arterial conditions that can limit the distribution of arterial solution to various body areas. Arteriosclerosis and arterial coagula are the problems most frequently encountered by the embalmer.

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Cerebrovascular accident	"Stroke" caused by a clot or the rupture of a small artery in the brain.	Vasoconstriction may occur on one side of the body, reducing the distribution of arterial solution.
Clots or coagula	Antemortem or postmortem clumping of blood elements	Arterial clots can block or reduce fluid flow to a body region, and may not be removed through drainage. Venous clots may often be removed; if clots are unmovable, swelling and discoloration can result.
Emboli	Detached blood clot	Blockage of a small artery interrupts solution distribution. Venous emboli can block drainage.
Extracerebral clot (stroke)	A clot, usually in the carotid artery, that stops blood supply to the brain	The clot can occlude the artery, making it impossible for arterial solution to flow to one side of the face. Blockage may occlude the carotid so it cannot be used as an injection site. Resulting stroke may cause vasoconstriction on one side of the body, reducing arterial solution distribution.
Thrombosis	Blood clots attached to the inner wall of a blood vessel	Arterial solution distribution may be difficult. If occurring in a vein, drainage may be hard to establish from the affected tissues.

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When vascular problems are anticipated, the use of the common carotid artery is advised for injection. This vessel rarely exhibits arteriosclerosis. In those instances, when sclerosis is present, the size of the lumen of the carotid generally allows for easy insertion of arterial tubes. The accompanying internal jugular vein is large; the superior portion directly drains the head. The inferior portion of this vein leads directly into the right atrium of the heart. This chamber serves as the center of blood drainage during embalming. The use of angular spring forceps as an aid to drainage will help to remove venous coagula.

▶ CONGESTIVE HEART FAILURE

Frequently, death certificates cite congestive heart failure as the primary cause of death. Some complications of the end stage of congestive heart failure are of particular interest to the embalmer:

1. Blood is congested in the right side of the heart.
2. The neck veins are engorged with blood; the facial tissues are dark because of the congestion of blood in the right side of the heart and the veins of the neck.
3. Lips, ears, and fingers are cyanotic.
4. Generalized pitting edema may be present. Edema of the legs and feet is pronounced in most bodies. Ascites may be present.
5. Blood may be more viscous because of an increase in red blood cells (polycythemia).
6. Salt is retained in the body fluids.

The carotid artery is used for injection and the right internal jugular vein for drainage, or restricted cervical injection is employed. This helps to ensure good drainage from the head and the right atrium of the heart. The first gallon of arterial solution is made mild to clear the blood congestion and discolorations. If edema

The liver may be enlarged and its functions decreased. This should improve drainage, as the level of clotting factor in the blood will be low.

▶ ARTERIAL COAGULA

At death, some blood remains in the arteries, especially in the large aorta. During the postmortem period, this blood can congeal (Fig. 22–3). Injection of the arterial solution may loosen and push coagula into the smaller arteries. By injecting the common carotid arteries, these coagula would be moved toward the legs.

If the femoral artery is used as the primary injection point, coagula can be moved into the common carotid arteries and stop the flow of arterial solution into the facial tissues. When the femoral artery is injected upward arterial coagula, most frequently, flow into the left subclavian artery, and it becomes necessary to raise and

inject the axillary or brachial artery of the left arm. When the common carotid is used as the primary injection site, arterial coagula are moved into the iliac and femoral arteries. The femoral arteries can be raised to embalm the legs; should this prove unsuccessful, the legs can be treated by hypodermic or surface embalming, or both.

If embalming is begun at a slower rate of flow and the use of preinjection fluids (which may loosen arterial coagula) is avoided, the arterial solution can pass **over** but not loosen coagula.

▶ VENOUS COAGULA

As veins enlarge toward the drainage site, venous coagula do not pose as serious a problem as arterial coagula. Failure to move the coagula, however, can block a vein, and this blockage can lead to tissue distension and discoloration. Massage from distal points toward the heart. Use the right internal jugular vein for drainage, as coagula in the right atrium can be easily reached with angular spring forceps and removed. Intermittent drainage helps to increase venous pressure and loosen coagula from the veins. Multisite injection and drainage may be warranted. When this condition is encountered in a localized area, use a stronger arterial solution to ensure that a minimum amount of arterial fluid delivers the maximum preservative.