A Method For Removing Intravascular Clots from Embalmed Human Specimens[1] (35033)

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The scarcity of unembalmed human specimens, for research utilizing the injection of the vascular system is becoming more acute due to the increased demands for and utilization of such material by the schools teaching the health sciences. Therefore, the following study was undertaken to alleviate this situation by using a method to dissolve and remove embalmed clots from the major branches of the arterial system and subsequently injecting this system. These studies help to determine the course, size, and connections of the arteries, as shown by roentgenograms, by dissections, microscopic and macroscopic sections, plastic casts, and the injections of liquid latex, Microfil, and India ink.

Materials and Methods. Six heads from full term human infants, four adult heads, two hands, and two feet from embalmed specimens were used in this study. After rinsing each specimen in tap water, the major artery of the specimen was cannulated with polyethylene tubing of appropriate size, and the vessels were perfused with the following solution: a commercial proteolytic enzyme,[2] 0.5%; a detergent,[3] 1.0%; and tap water, 98.5%. The perfusate was introduced through the cannula by gravity, or by use of a polystaltic pump; the latter was regulated to deliver 90–100 ml/hr for 6 hr. The perfusion was repeated three times. Following perfusion, Micropaque, 10%, dissolved in water; or India ink, 10%, dissolved in saline; liquid latex; or vinyl acetate; or Microfil were injected into the artery and subsequently the specimen was radiographed, dissected, sectioned, or macerated, depending on the type of study desired.

Results. As shown in the radiograph from the right half of an adult head (Fig. 1), the distal part of the common carotid, the larger branches of the external and internal carotid arteries, and many of their smaller branches, particularly those supplying the brain and the deepest structures of the face were filled with the Micropaque solution—demonstrating that clotted blood had been removed from these vessels.

All of the other specimens were similarly injected to test the effect of the perfusate on clot removal from these areas of the body. For example, as shown in a radiograph (Fig. 2) where the distal part of the radial and ulna arteries were cannulated, perfused, and injected in a manner similar to that used in the specimens of the head, many of the finer branches in the carpal, metacarpal, and phalangal areas were filled with radiopaque injection material. The patency of these vessels was confirmed in the specimens by subsequent dissection, and macroscopic and microscopic sections of the tissues.

Discussion. The injection of an embalming solution into the arterial system usually causes the postmortem blood to be forced distally into the smaller arteries, arterioles, capillaries, and primarily into the veins. This results in part of the lumen in the larger arteries being devoid of clotted blood and containing only the embalming solution. This patency allows the perfusate to traverse part of the artery and come into contact with the clots embedded in the distal part of the circulation. The perfusate, and the dissolved remains of the clot drain from the specimen by way of the transected ends of collateral

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[2] Kazyme, Katzson Brothers, Denver, Colorado.

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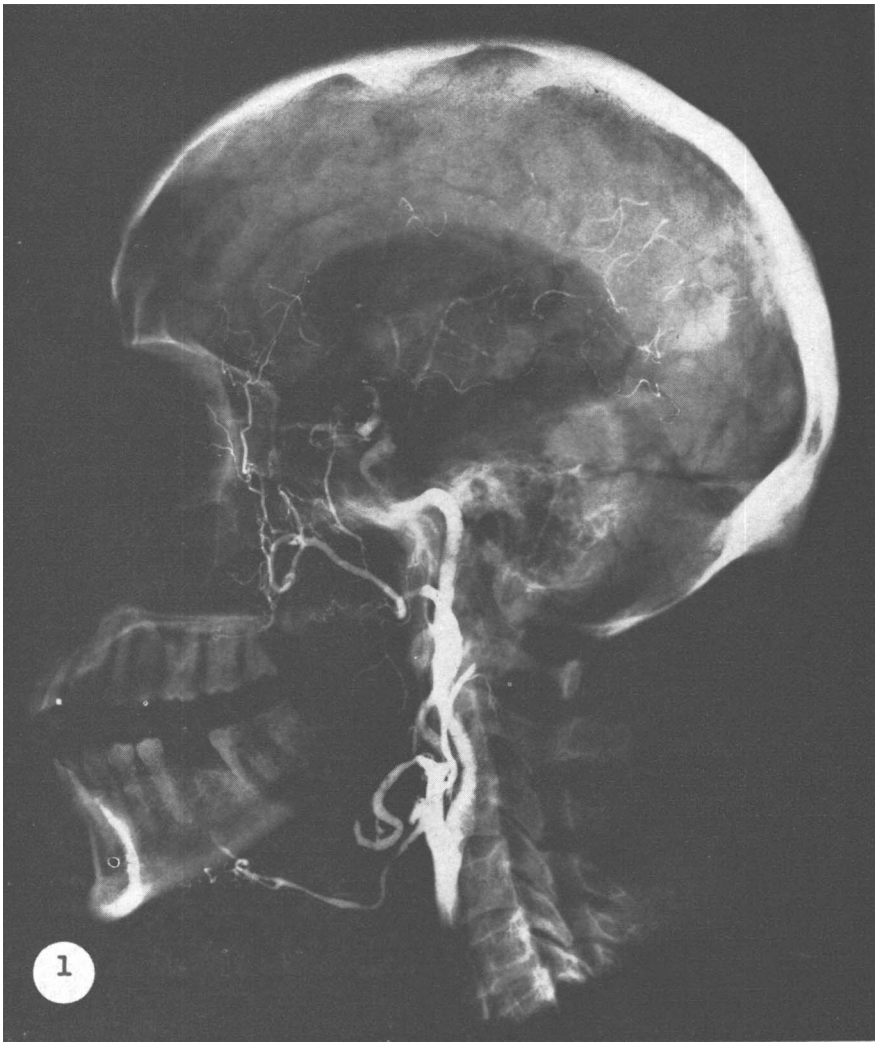

FIG. 1. Roentgenogram of the right half of a human head in which the common carotid artery was perfused with a proteolytic–detergent solution for removal of clotted blood from the branches of this artery. The larger branches of the carotid artery, and many of the smaller vessels to the brain and the deeper parts of the face, when filled with a radiopaque medium (Micropaque), demonstrate the patency of these vessels. ×½.

arteries and/or small veins. With repeated perfusions, the remaining distal part of the clots are dissolved and removed from the lumen of the vessels. In addition to the postmortem clotting of blood, the composition of the embalming solution used may determine the hardness of the clot formed. The embalming solution used for these studies consisted of isopropyl alcohol, 55.5%; propylene glycol, 27.3%; phenol, 13.7%; and formalin, 3.5%.

This embalming solution was injected by a pulsating pump into the right femoral artery of the intact infant or adult cadaver. The cadavers were stored in a horizontal position in a cold room for at least 3 months, (in some instances, 6 months) after embalming. Subsequently the cadavers were used for teaching purposes, usually of one to two semesters in duration. The undissected parts used for this study were removed from the specimen, moistened with embalming solu-

tion, and stored in plastic bags. The relatively small percentage of formalin used in the embalming solution resulted in firm clots which were not as hard as those clots found after using higher percentages (10–20%) formalin for embalming purposes. However, the other ingredients of this embalming solution also helped to denature the proteins resulting in hardening of all the tissues. The commerical preparation of the proteolytic enzymes used in this study consisted of neutral and alkaline proteosis. Therefore, it was im-

FIG. 2. Roentgenogram of a right hand in which the radial and ulnar arteries were perfused and injected by a similar procedure to that used for the specimen shown in Fig. 1. Note particularly the finer branches of the arteries in thc carpal, metacarpal, and phalangeal areas. ×¾.

portant to determine the optimum concentration of enzyme and the best pH range to use for these studies. The pH of the embalming solution was 2.8. The enzymatic–detergent perfusate had pH 5.6, and a sample of the uninjected blood vessel and clot had pH 6.2. Various dilutions of the enzyme in distilled water, from 0.1–20%, were tried on samples of blood vessels containing clots, observed while in glass dishes, and agitated at frequent intervals. The detergent was used primarily to reduce surface tension, and to help soften the embalmed clots, so that the enzymes could work more readily on the protein constituents of the clot. It has been shown that perfusion with a detergent will enhance the subsequent injection of the vascular system in unembalmed material.

In addition to dissolving the embalmed clot, there was little detectable lytic action of this solution on the walls of the blood vessels as shown by sample histologic studies of clot-containing vessels before and after injection. The embalming solution apparently fixes the "interna, media, and externa" so that they were not affected by the enzyme detergent solution. Further studies are underway to determine the extent to which clots may be completely removed from the vascular system.

Summary. Clots were removed from the blood vessels of embalmed human specimens by perfusing them with a proteolytic–detergent–aqueous solution. Large, medium, and small arteries were subsequently injected with one of the following media: radiopaque, latex, plastic, or ink solutions to demonstrate the course, size, and connections of the vessels. Histologic sections indicate that the perfusate for cleansing the vessels had no detectable microscopic effect on the fixed tissue in their walls.

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