A METHOD OF COOLING THE HEART

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A method of cooling the heart by perfusing the pericardial cavity with ice-cold physiological saline through a special plastic fistula tube is suggested. Two channels at right angles to each other are drilled in the rim of the tube so that during perfusion the surface of the heart can be uniformly irrigated and a rapid fall in the temperature of the myocardium (from 1.2 to 4°C/min) can be obtained without disturbing the cardiac rhythm. In the author's opinion, the suggested method differs advantageously from other methods used to cool the heart; it provides better opportunities for studying the physiological properties of the heart and can be recommended for use in the practice of cardiac surgery.

In experimental research involving hypothermia, besides general cooling of animals a technique of cooling isolated organs such as the brain, heart, etc., is used. This is usually done by passing blood or isotonic salt solutions through the blood vessels of the organ to be cooled or by applying ice to the organ [3, 5].

These methods, when used on the heart, suffer from certain disadvantages. To create optimal conditions for cooling the heart its outer surface must be irrigated simultaneously and uniformly with the cooling fluid.

The suggested method of cooling the heart is based on the method of perfusion of the pericardium used for a long time in physiology to study the mechanism of cardiac tamponade [1, 2, 4]. To supply the perfusion fluid to the pericardial cavity and to remove it a special plastic fistula tube is proposed (Fig. 1). At one end of the tube (length 18 mm, diameter 4.5 mm) it has a rim (diameter 11 mm, thickness 2.2 mm) for holding the tube in the pericardial cavity and on the other end fits a sliding portion of the same diameter, with a rim 4 mm thick, freely movable along the tube. As the sliding part moves along the tube toward the pericardium, the membrane is firmly fixed between the rim inserted into the pericardial cavity and the sliding part.

TABLE 1. Changes in Temperatures of the Left Ventricle of the Cat during Local Cooling of the Heart

Expt. No.	Duration of perfusion (in min)	Minute volume of perfusion (in ml)	Temperature of myocardium (in °C)		Decrease in temperature per min (in °C)	Time taken to restore temperature (in min)
			initial	final		
3	15	33	33	15	1,2	—
4	5	100	28	12,6	3,1	15
4*	5	100	25	5	4	10

*Repeated cooling

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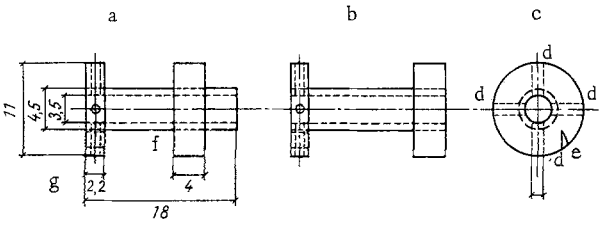

Fig. 1. Fistula tube for perfusion of the pericardium: a, b) longitudinal sections; c) transverse section through tube; a) sliding portion (f) close to rim of tube (g); b) sliding portion moved along channel toward end of tube; c) front view of rim with channels (d); e) notch cut in rim. Dimensions of tube given in millimeters.

A notch is cut out of one sector of the rim like the notch on a gastric fistula tube to enable the rim of the tube to be inserted through an incision of smaller diameter in the pericardium. The surface of the rim facing the epicardium is in firm contact with it. Four radial canals equidistant from each other are drilled in the rim of the tube at right angles to its lumen to secure uniform irrigation of the heart (Fig. 1c). One such tube is introduced through an incision into the pericardial cavity on the ventral surface of the heart and another on the dorsolateral surface. The heart is cooled with ice-cold physiological saline which escapes from the orifices of the holes drilled in the first tube, spreads out fanwise over the pericardium and myocardium, and drains away through the corresponding holes in the rim of the second tube.

During experiments with cooling of the heart the flow of ice-cold solution is regulated by screw clips and a dropper mounted in the rubber tube connecting it to the reservoir. The level of the solution in the cylinder is 70 cm above the heart. The temperature of the solution in the cylinder, as it enters the pericardial cavity, and in the vessel in which perfusion fluid draining from the pericardial cavity collects, is measured by mercury thermometers. A thermocouple is introduced through an incision in the chest wall into various parts of the myocardium of the left ventricle. Before perfusion the chest wall is closed with artery forceps. The rectal temperature was measured with a thermometer inserted to a depth of 6-7 cm. Complete agreement was found between the volumes of ice-cold solution entering the pericardial cavity and leaving it in equal time intervals. The difference between the temperature of these volumes did not exceed 2°C.

Heart-cooling experiments were carried out on six cats under thiopental anesthesia. Artificial respiration was applied through the trachea by a push-pull apparatus. Perfusion of the pericardial cavity with the ice-cold solution lowered the myocardial temperature. The results given in Table 1 show that the degree of lowering of the myocardial temperature increases with an increase in the minute volume of perfusion.

The results obtained suggest that this method can be used to cool the heart. A definite advantage of the method is that the cardiac rhythm is not disturbed and the temperature of the organ returns quickly and spontaneously to normal after the cooling has been discontinued.

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