immunologically competent cells were not exposed to antigen. Equally significant, detectable specific antibody is made within 24 hours after antigenic stimulation. Similarly, Lennox and Avegno (private communication) has found neutralizing antibody 24 hr after antigenic stimulation of rabbits with coliphage T2. As measurements become more sensitive, it may be possible to demonstrate antibody production immediately after presentation of antigen. It should be emphasized that this possibility does not disprove the inductive hypothesis for genesis of antibody. The enzyme-forming system for synthesis of adaptive (induced or repressed) enzyme is present in the unadapted cell. In systems where the inducer is not a substrate, enzymic activity increases almost instantaneously and linearly after addition of inducer(10). Our results do not support preferentially the clonal selection, natural selection or inductive theory of antibody synthesis. This study does establish that the actinophage-neutralizing antibody system in the mouse is an excellent tool for determination of the minimum time and antigenic dose necessary for antibody synthesis.

Summary. Actinophage injected intraperitoneally into inbred Balb mice appeared almost instantaneously in blood, brain, liver, kidney, spleen, lung and testis. Viable virus was isolated from the blood for 2 days following challenge, from lung, liver and kidney for 6 days, and from testis and spleen for more than 10 days. Mice produced neutralizing antibody within 48 hours after antigenic stimulation. Antibody production was elicited by as few as 10^7 actinophage particles.

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Excision of Infarcts of the Left Ventricle and Replacement by Teflon Prostheses. (26852)

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Murray(1) and Bailey(2) have demonstrated that excision of a myocardial infarct in the dog can be successfully performed. However, the latter showed that the procedure usually resulted in a reduction in left ventricular capacity and cardiac failure. To obviate this, we undertook a series of experiments to determine the practicability of replacement of the excised myocardium with a teflon prosthesis. The results of 10 experiments are reported here.

Procedure. We attempted first to develop a technic which would have an acceptably low morbidity and mortality. In a pilot series of experiments, operations on the left ventricle were performed under cardiopulmonary bypass and aortic occlusion. Later, we added systemic, and then selective (cardiac) hypothermia, but none of these animals survived. It was apparent that a simpler technic, avoiding extracorporeal circulation and hypothermia must be employed. The following pro-

cedure was developed and has been performed successfully in 10 consecutive dogs.

The animal is anesthetized with intravenous sodium pentobarbital, a cuffed endotracheal tube inserted and connected to an automatic respirator (neophore). The pleura is entered through the left fifth interspace, the pericardium is opened widely in front of the phrenic nerve, and the heart delivered. The lowest major trunk of the anterior descending branch of the left coronary artery is ligated, producing an area of cyanosis and flaccidity for 3 or 4 sq cm over the anterior wall and apex of the left ventricle.

A strip of teflon felt one-eighth inch in thickness and one-quarter inch in width is placed on either side of the infarcted area, leaving one or two ml of normal muscle medial to the strips. Four horizontal matress sutures of 2-0 silk are then passed through one strip of teflon, the left ventricular wall, through the opposite teflon strip and then back. To avoid inclusion of important valvular structures, these sutures are placed so as barely to enter the cavity of the heart. When they are tied snugly over the teflon strips, the infarcted segment is excluded from the cavity of the ventricle. The necrotic muscle is then excised and a tailored teflon patch one-eighth inch in thickness secured with continuous and interrupted 2-0 silk sutures to the margins of the defect. Usually, the teflon strips on either side are also incorporated in the suture line. The mattress sutures are now removed, and the heart resumes its previous contour and size. Usually there is some leakage of blood across the graft, but this is controlled by gentle pressure for several minutes. In one animal, (#7), teflon felt of 1/16th inch thickness was used. Bleeding across this patch was excessive, but was controlled after 10 minutes of pressure. Routinely, the estimated amount of blood lost during the operation was replaced by transfusion.

Results. All animals survived the procedure, the first having been operated upon almost 3 months ago. To date, there is no evidence of infection, systemic embolization, congestive heart failure or rupture of the graft. One animal was sacrificed one week postoperatively. The graft, of 1/16th inch teflon felt, was securely attached to the heart muscle, markedly adherent externally to thickened, inflamed pericardium, and covered internally by a layer of fibrin. It had very effectively sealed the defect in the myocardium, and was already firmly incorporated into the left ventricular wall. Soft clot lay in a small intramural chamber which communicated with the main cavity of the left ventricle by the endocardial defect, which was 1.5 cm in diameter.

Discussion. Murray(1) observed that when a major branch proximal to the 2 or 3 large terminal branches of the left coronary artery was ligated, there was cyanosis, dilatation, lack of contraction, and paradoxic systole over the site of distribution of the vessel. Because the contractile force of the left ventricle is partially dissipated by this paradoxically pulsating chamber, there is a reduction in stroke volume, and cardiac output falls. He therefore suggested that excision of acute myocardial infarcts and primary closure of the defect by direct suture might be of benefit. In 25 dogs subjected to this procedure, blood pressure and cardiac output rose after the infarct was excised, and many of these animals were alive one year later. Bailey(2) repeated these experiments. Six of the 25 dogs in his series died of ventricular fibrillation, 2 of bleeding, and one of empyema; 13 others died early because of congestive heart failure, and 3 were sacrificed. Autopsy revealed that there was a significant reduction in capacity of the left ventricle, and he felt that this accounted for the congestive heart failure which caused death in approximately half of the animals.

If irreversible shock or congestive heart failure in patients following myocardial infarction is due to the presence of a non-contracting, paradoxically pulsating expansion chamber made up of necrotic, atonic muscle and scar tissue, consideration should be given to its excision. This, of course, would require operation under cardiopulmonary bypass. It occurred to one of us (A.D.) that to avoid serious reduction in left ventricular capacity following excision of an infarct, with resultant congestive heart failure, it

should be replaced by an inert plastic prosthesis of equivalent size. In other words, no pulsation is probably preferable to paradoxic pulsation, a concept supported by the long and asymptomatic survival of human beings with large, calcified aneurysms of the left ventricle.

Teflon felt of one-eighth inch thickness was selected because this material is soft, non-brittle, inert, durable, non-wettable, resistant to infection and easy to suture. Such prostheses have been demonstrated to act as an inert matrix for deposition of a thin layer of fibrin over the surface in contact with the blood, and for fibrous tissue which grows through the graft itself. Because of low tissue reactivity, the healing time of the implant should be rapid. We may find that woven teflon, similar to that used in synthetic grafts or as an outflow patch in the right ventricle, is preferable. We believe, however, that the felt will be well tolerated, and will eventually be incorporated in the wall of the left ventricle. This will be determined when chronic survivors are sacrificed.

To date, use of a prosthesis has not been attended by complications reported by other investigators after left ventriculotomy. For example, Carter(3) reported that 2 of 25 dogs died of delayed rupture following left ventriculotomy. In another series(4) 3 of 22 dogs with excision of myocardium, and 3 with linear incisions into the left ventricle, died of rupture. In a third group of dogs reported by Dillon(5), portions of the left ventricle were excised in 22; 6 died of rupture, and only 6 were long-time survivors. Wounds of the left ventricle disrupt because of strangulation of the heart muscle by the suture material, almost certainly because of tension on the line of sutures. So far, none of our animals has died of secondary rupture or congestive heart failure. We believe, therefore, that by using the prosthesis, such complications will probably be avoided.

In the one animal we have sacrificed, some clot lay in the chamber formed by excision of the full thickness of the left ventricular wall, including the endocardium. We believe this is caused by the fact that the graft is not sutured to the endocardium, but rather to overlying muscle and epicardium, leaving an intramural diverticulum behind. In the future, attempts will be made to leave the endocardium intact, or if exposed, to suture the felt to this as well.

Summary. Ten mongrel dogs have been subjected to experimental ligation of major branches of the anterior descending trunk of the left coronary artery. The infarcted areas have been removed by a closed technic and replaced by a teflon felt prostheses. All of the animals have survived. Two were sacrificed one week following the operation, while eight others are now being followed for periods of up to four months. They will be sacrificed at the end of a year.

To this time, the implanted material appears to be well tolerated by the myocardium.

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