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Development of Interarterial Intercoronary Anastomoses by Arteriovenous Fistula Between Pulmonary Artery and Left Atrium.* (24107)

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Observations made on man in open heart surgery have suggested the likelihood of existence of rich intercoronary networks in patients with congenital cyanotic heart disease (Tetralogy of Fallot). The possibility that inter-coronary anastomoses developed in response to cyanosis suggested the following study.

Method. Selected mongrel dogs 15-25 kg in weight were used. Weak or sick animals were rejected. All animals were anaesthetized with 3% sodium nembutal (30 mg/kg body wt.) and placed on a cam type respirator utilizing compressed air. Clean but not sterile technic was employed. A left-sided thoracotomy was performed and the 4th rib was removed. The pericardium was opened parallel to the phrenic nerve so as to display the main trunk of the pulmonary artery and the left auricle. A side to side arteriovenous anastomosis 10-17 mm in length was made in each animal between the pulmonary artery distal to the semilunar valves and the left atrium. The thoracic cavity was closed in layers and

500,000 units crystalline penicillin was given IM for 2 days. Systemic blood for sampling of oxygen content and saturation was obtained by direct cut-down upon the femoral artery. Determinations were by the method of Van Slyke and Neill(1). All animals tolerated the procedure well. Postoperative care consisted of routine kennel rations and a mandatory exercise period of 15 minutes each day for every animal. At varying periods (2 days to 14 weeks) after operation the dogs were sacrificed and the pattern of coronary arteries was studied by corrosion digestion preparations(2). An earlier study of the architecture of coronary arteries in 50 normal dog hearts, using the same injection-corrosion method, served as an adequate control.

Observations. Results are summarized in Tables I and II. With the exception of one animal that died 2 days after operation and in which the shunt was 16 mm in circumference, no dog appeared in acute respiratory distress. Subsequent experiments utilized a fistula no larger than 10-12 mm in circumference. In these animals, including several not reported at this time, there has been no postoperative death. One animal showed signs of dyspnea on exertion. The exercise

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TABLE I. Experimental Study.

Wt, kilos	Circumference of shunt (mm)	Wk post surgery at exam.	Intercoronary anastomoses between branches of left coronary arteries	Anastomoses present between right and left coronary arteries	Location of anastomoses between right and left coronary artery when present
18	16	2 days	Present	None	None demonstrated
16	15	10 "	"	Present	Region of crux, dorsal surface of heart
20	12	2 wk	"	"	Auricular anastomoses
15	12	3 "	"	"	Dorsal surface of heart
16	10	6 "	"	None	None demonstrated
15	10	8 "	"	Present	Dorsal surface of heart
15	12	14 "	"	"	<i>Idem</i>

TABLE II. Control Study, 50 Dogs.

Body wt, kg	Procedure	Intercoronary anastomoses present between branches of left coronary artery	Intercoronary anastomoses present between branches of right and left coronary arteries
5-25	Injection-corrosion study of coronary circulation using vinyl plastic mass at post-mortem	Arterial in size 30% Finer, small vessels 40%	0

tolerance of all other animals remained unimpaired or had adjusted. Systemic arterial oxygen saturation in the reported animals varied between 60 and 88% with an average value of 80%.

At post-mortem the shunt was patent in all cases. The diameter in every specimen was found to be reduced from the dimension recorded at the original operation.

Study of the vinyl plastic injection casts of the coronary artery distribution in the hearts of normal dogs (5-25 kg body weight) demonstrated that intercoronary anastomoses were regularly to be found between the branches of the left coronary artery.

Communications of large size were found in 30% of preparations between left anterior descending artery and branches of left circumflex coronary artery. In a further 40% of specimens fine networks of communicating vessels ramified about the cardiac apex and terminal branches of left anterior descending artery. In not a single injection-corrosion cast was an intercoronary interarterial anastomosis demonstrated between right and left coronary artery in a normal dog heart. In these studies no intercoronary anastomoses

were found in region of the sino-atrial node.

Following surgical production of an arteriovenous fistula the plastic corrosion preparations in 5 of 7 animals clearly demonstrated the presence of an intercoronary communicating channel between branches of right and left coronary artery in animals sacrificed at intervals of 10 days to 14 weeks following surgery. These channels were arterial in size. In every case intercoronary anastomoses were present between branches of the left coronary artery. In all studies these channels were arterial in size.

Data relating to venous and arterial oxygen saturation, hemoglobin and hematocrit adjustments, changes in pH of systemic blood and variations in atrial pressure and in coronary flow are under investigation.

It is noteworthy that in no revascularising procedures examined in this laboratory aimed at creating intercoronary communications, utilizing the same vinyl plastic injection mass, has it been possible to demonstrate objectively intercoronary arterial anastomoses of the size observed in this study, nor with the same celerity. Only following acute total ligations of the circumflex or left anterior descending cor-

onary artery, with survival of the animal, have comparable collateral communications been observed.

Discussion. These observations may have significance in obliterating coronary artery disease in man. The essential role of anoxemia as an underlying stimulus for development of interarterial coronary anastomoses was indicated by Zoll and Schlesinger(3). Eckstein(4) later reported production of intercoronary anastomoses as a result of chronic anemia. Our injection-corrosion study of human hearts at autopsy confirmed those observations. The results presented in Table I suggest that not only do the "new" channels (doubtless always present potentially) provoked by operation function in the role of making available a new source of blood supply to the myocardium by redistribution, but in this respect the collateral vascular bed provoked by operation acts as an anastomotic bridge that may transport blood from the bed of one coronary artery to the bed of another coronary artery, where presumably blood flow may be deficient.

Of equal importance are the magnitude and speed with which these intercoronary communications developed following the procedure. In one instance, arterial sized intercommunicating channels had developed within 10 days.

Summary. 1. No interarterial intercoronary anastomoses between any branch of right and left coronary artery could be demonstrated at autopsy in normal dogs with a vinyl plastic injection mass. 2. Following surgical production of arteriovenous fistula (10-12 mm

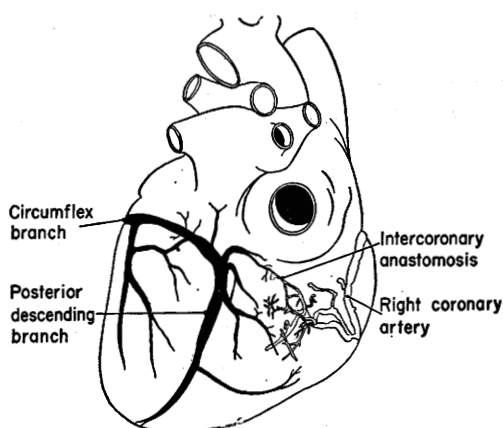


FIG. 1. Tracing of color photo of vinyl injection-corrosion cast to demonstrate intercoronary anastomosis between branch of left circumflex artery and right coronary artery 10 days following surgical production of a fistula between main pulmonary artery and left atrium. Outline of posterior surface of heart has been drawn in.

long) between main pulmonary artery and left atrium, interarterial intercoronary anastomoses between right and left coronary arteries were demonstrated at postmortem examination in 5 of 7 dogs examined at intervals of 2 days to 14 weeks following surgery. These anastomotic communications were arterial in size.

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