Abstracts of Interest from the
SEVENTH ANNUAL MEETING OF
THE SOCIETY OF THORACIC SURGEONS

A Follow-Up Study of Aortic Valve Homografts to 4½ Years
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Fifty-two patients had homograft replacement of their aortic valves before September, 1968. There were 3 early deaths and 6 further deaths within 2 years (5 had huge hearts from long-standing preoperative regurgitation). No deaths could be attributed to the use of a homograft.

Forty-three patients have been followed from 2 to 4½ years. All but 1 of these are in Functional Class 1 (N.Y.H.A.). Physical and catheterization findings have been very consistent; 23 patients have not had a diastolic murmur; 11 have had diastolic murmurs since operation which have not worsened; and 9 patients with no regurgitation initially developed diastolic murmurs. One of these experienced a sudden cusp rupture at two years, and had a successful homograft. No patient had hemodynamically significant regurgitation but 1 patient’s murmur has been increasing.

There has been no bacterial involvement of the homografts. One fungus superinfection was believed due to injudicious use of antibiotics. Calcification has been found only in the aortic wall portion of the homograft. Betapropiolactone and freeze-drying cannot be criticized nor can irradiation be commended by this study.

We continue to use homografts as the replacement of choice. Homografts remain at least as good as prosthetic valves without the problems of anticoagulants. With small aortic roots, homografts are ideal.

Operative mortality was inversely related to age and weight and directly related to severity of preoperative symptoms; there were no deaths of asymptomatic patients. The overall mortality rate was 22% for the entire interval and 12% for the current 5-year period. At the present time, the mortality rate is 8% for VSD not associated with other severe intracardiac anomalies.

These data compare favorably with published mortality figures for palliative pulmonary artery banding in infancy followed by correction at a later age, and support our current approach of closure of the VSD using extracorporeal circulation in all infants requiring operative aid.

Total correction of Ventricular Septal Defect in Infancy Using Extracorporeal Circulation: Surgical Considerations and Results of Operation
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Between 1955 and 1970, 145 Mayo Clinic patients under the age of 2 years (79 males and 66 females; aged 10 weeks to 24 months—median 14 months) underwent total correction of ventricular septal defect (VSD) using extracorporeal circulation. The frequency of associated lesions was: none 8%, other 4%. Thirteen patients were asymptomatic; symptoms in the remainder included congestive heart failure (76%) failure to thrive (46%), and repeated respiratory infections (32%).

Instantaneous pulmonary capillary blood flow was estimated in 31 anesthetized patients undergoing cardiac bypass by measuring nitrous oxide uptake with a sensitive spremeter or pneumotachograph following a single breath of gas. This method generally showed good agreement with cardiac outputs measured by the dye dilution technique. Advantages of the nitrous oxide technique included rapidity of measurement, no recourse to blood sampling and estimation of instantaneous rather than mean pulmonary blood flow. The indices of pulmonary capillary pulsatility, peak output divided either by cardiac output or stroke volume, were quite comparable to data reported by other investigators using conventional pletysmographic methods in conscious subjects for estimation of pulmonary capillary blood flow. The pulmonary capillary pulsatility diminished postoperatively in the majority of patients, and effect possibly related to increase of pulmonary arterial resistance, compliance or both. Severe pulmonary hypertension before operation was associated with a high operative mortality. A marked fall in cardiac output under anesthesia compared to awake basal measurements associated with near normal pulmonary arterial pressures gave an additional poor prognostic sign. Indeed, preoperative N2O cardiac indices under anesthesia of less than 1.05 liters/min/M2 were associated with the inability to reinstitute cardiac activity on coming off cardiac bypass. It is speculated that the depression in cardiac output seen in certain patients might have been due to inadequate control of the levels of anesthetic agents and arterial carbon dioxide tension, factors known to adversely affect cardiac output in normal subjects.
Left Ventricular Hemorrhagic Necrosis: Experimental Production and Pathogenesis

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At the fifth annual meeting of the Society we presented a lesion termed "left ventricular hemorrhagic necrosis" as a common cause of death in operation for acquired heart disease.

SEASE.

To determine the pathogenesis of this lesion, calves were placed on total bypass and the myocardium was subjected to many situations usually existing in clinical open-heart surgery.

This consisted of total ischemia, total oxygenation (with equal or unequal pressures in the coronary vessels) and perfusion of one or different combinations of two coronary branches. Twelve groups (each consisting of 4 to 6 calves) were studied.

Total myocardial oxygenation with even pressure in coronary arteries and total ischemia for 60 minutes produced minimal pathology and no mortality. Massive left ventricular hemorrhagic necrosis with high mortality occurred when left coronary or one of its branches was not perfused, while the rest of the myocardium received high pressure perfusion.

It is concluded that total and even myocardial oxygenation and total ischemia up to one hour are associated with minimal myocardial injury and no mortality, while imbalance coronary perfusion, especially associated with an area of complete ischemia in the domain of the left coronary artery is associated with massive myocardial damage leading to high mortality.

Discussion:

Editor: It was noted from the slides that the length of the coronary perfusion line was quite critical. A pressure drop of as much as 10 mm. Hg per foot of tubing between the pump head and the cannula tip was measured. This means that a pressure of 150 mm. Hg at the pump may only 70 mm. Hg at the cannula tip only 8 feet away.

Dr. Augustin Arbulu: For aorto-coronary bypass vein grafts, he prefers to use a femoral to coronary arterial shunt to perfuse the coronaries during the procedure. Total bypass and cardiac arrest is not used.

Mechanical Support of the Circulation Using a Modified Pulsatile Roller Pump


A new modified roller pump capable of delivering synchronized pulsatile flow during diastole was developed and tested in 14 calves. Pump performance was evaluated by measurement of pressures in cardiac chambers, cardiac output, coronary blood flow, ventricular function, blood gases, and hematology studies before and after ligation of the anterior descending coronary artery, during the assist period of one hour, and fifteen minutes after assisted circulation.

The pump flow varied from 1.2 to 3.8 l/min representing 38 to 84% of the total circulation. Cardiac output, decreased by ligation of the coronary artery, returned to control values during and after assisted circulation. Cardiac stroke work was decreased to 22% of the preligation value. Coronary flow decreased after ligation of the coronary artery but returned to normal levels during the assist period. Dehydrogenase staining showed an infarct size of 16% in the assisted animals and 22.6% in control animals. Assisted animals had greater Cesium 131 uptake in the infarcted area indicating more blood flow.

These experiments support the thesis that a modified roller pump is capable of effective synchronized diastolic perfusion and that this perfusion decreases stroke work, improves hemodynamics after perfusion, and improves coronary circulation during perfusion.

Discussion:

Dr. John Kennedy: The wave form of any pulsatile pump used in perfusion should be as "heart-like" as possible.

Dr. Lewis Bosher: The chief disadvantages to pulsing roller pumps are the excessive wall contact of the tubing, excessive suction, and non-continuous inflow.

Techniques of Extended Perfusion Using a Membrane Lung


Nine 5-hour and eight 24-hour perfusions were carried out in dogs to evaluate the Peirce-Genera Electric copolymer lung. Trained female dogs (chronically instrumented and sedated) were used for 5-hour vena-arterial partial bypass. Measurements included renal function, left ventricular pressure (LVP), LVP dp/dt, aortic flow, stroke volume, cardiac work, and extensive blood studies. In the 24-hour dogs (minimally instrumented and lightly anesthetized arteriovenous and venovenous perfusion was used. Measurements included blood volume (RISA), weight, venous and arterial pressure, and respiratory studies.

Three of the 5-hour animals had severe bleeding from aortic rupture at the site of the flow probe implantation but were easily supported for 5 hours by recycling the shed blood. All of the 24-hour perfusions resulted in long-term survivors. Animals tolerated induced respiratory insufficiency. Blood volume, weight, and renal function were well maintained. Antacid was not required. Platelets seldom fell below 50%; white cells fell initially but exceeded control at 24 hours. In the majority, plasma hemoglobin reached a peak at 12 hours and then fell, reaching a final level of 50.5±13.5 mg%. There were no coagulation disturbances.

The copolymer membrane lung is versatile and reliable. Blood trauma is acceptably small.

Discussion:

Dr. Thomas Baffes: He raised the question, "Is hemodilution in prolonged bypass dangerous?" The pumping circuitry, he feels, should vary with the problem as each configuration has its own special purposes.

Dr. Marvin Kirsch: He reported total cardiopulmonary bypass on 6 infants under 20 pounds using a membrane lung were done without incident at Ann Arbor.

Dr. Emil Mantini: He mentioned having used prolonged bypass on two patients, one of which was 50 hours in duration.

Dr. Robert Carlson: At the New York Hospital, 6 coronary vein grafts were done using membrane lungs for periods up to 6½ hours.

Dr. John Kennedy: He spoke briefly of one case without incident.

Dr. E. Converse Peirce II: In closing, he felt that hemodilution in a membrane unit should be only used when emergency bypass must be initiated. Better techniques for monitoring heparin levels during prolonged bypass are needed.
Aggressive Surgical Therapy for Thoracic Mycotic Infections in Renal Transplant Patients


The increasing number of patients receiving concurrent steroid and immunosuppressive therapy in preparation for and following renal transplantation provides a vulnerable population for the ubiquitous saprophytic fungi.

Therapy is difficult because (1) the steroid-immunosuppressive regimen often cannot be reduced without endangering the transplanted organ and (2) the anti-fungal drugs useful in these infections cannot always be used in effective dosages because of nephrotoxicity.

Six of 45 renal transplant patients at our institution have developed serious mycotic infections. Two have died with pulmonary and disseminated aspergillosis prior to definitive diagnosis. A third patient died because of pulmonary and disseminated cryptococcosis with CNS involvement following an initial remission with amphotericin B therapy.

Three patients have survived. One (severely ill with hyperpyrexia for 21 days) recovered rapidly after resection of a large aspergilloma of the left upper lung. The second, also hyperpyrexic with seizures, recovered following resection of an active histoplasma of the right lung. The last patient, chronically febrile with an enlarging lesion in the left upper lung, recovered following removal of an abscess containing Corynebacterium equi. Currently reported conservative management of similar patients has not been successful. Diagnostic and therapeutic considerations peculiar to this group of patients are discussed. Early aggressive surgical extirpative therapy in localized pulmonary lesions is emphasized.

Acute Rejection of the Allografted Human Heart: Diagnosis and Treatment

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During the past 2½ years 25 patients have received cardiac transplants at Stanford. Overall survival is 42% at 6 months and 33% at 12 and 18 months.

Fifty-nine episodes of acute allograft rejection were diagnosed in 20 patients. No correlation between histocompatibility match and rejection history was apparent. Useful indices of graft rejection included electrocardiographic changes (decreasing QRS voltage, appearance of atrial arrhythmias, rightward shift of the electrical axis); clinical examination (decreased precordial activity, appearance of gallop rhythm, hypotension); and a decrease in ventricular wall velocity as measured by echocardiography. No useful serological correlates of rejection were noted.

Fifty-six rejection episodes were reversed with increased immunosuppressive therapy, and 3 episodes progressed to graft failure and patient death. In the cardiac transplant recipient utilization of multiple indices of allograft function allows early diagnosis and successful treatment of acute rejection episodes in most instances.

Blood Flow Through Aorto-Coronary Venous Bypass Grafts and Early Postoperative Patency: A Study of 100 Patients

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Blood flow was measured at operation in venous bypass grafts of 100 patients who underwent a total of 162 grafts to the right (RCA), and left anterior descending (LAD), and the circumflex (CIRC) coronary arteries, or to a combination of these. Response to direct injection of papaverine into the graft was also studied. Selective angiography of the grafts was performed two weeks after operation in all patients.

Patency rate was 90.1% (146 of 162). Blood flow in grafts to the RCA averaged 61 ml per minute, 64 ml per minute in grafts to the LAD and 71 ml per minute in grafts to the CIRC. Following injection of 20 mg of papaverine into the grafts, blood flow averaged 130, 134 and 131 ml per minute respectively.

Blood flow through the 16 grafts which eventually became occluded averaged 24 ml per minute.

All grafts without response in flow following papaverine injection or all grafts with basal flow inferior to 25 ml per minute (except in two instances) became occluded. All grafts with flow greater than 45 ml per minute remained patent.

Further Evaluation of the Composite-Seat, Cloth-Covered Aortic Prosthesis

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Between August, 1968 and August, 1970 the Model 2310 cloth-covered composite-seat aortic prosthesis was implanted in 162 patients, 35 of whom had replacement of multiple valves. The composite-seat prosthesis was used 24 times as a replacement for a Model 1000 prosthesis which had developed ball variance and used 8 times as a replacement for the earlier style cloth-covered Model 2300 prosthesis.

The operative mortality has been 12% for isolated aortic valve replacement and 14% for multiple valve replacement. The late mortality is 5.3% for isolated aortic valve replacement and 4.6% for multiple valve replacement.

In 1,070 patient-months of follow-up there have been no early emboli so far and there have been only 2 late embolic episodes which were in patients using multiple artificial valves. Four patients have not been taking coumadin for various reasons and 6 patients have been in a double blind anticoagulant study. These patients have had no emboli.

As previously reported, hemodynamic function of the Model 2310 valves continues to be excellent. Hemolysis has been minimal in the absence of parabasilar leak with RBC survival time similar to previous style noncloth-covered valves.

We believe the Model 2310 cloth-covered aortic prosthesis with its enlarged orifice, studded composite-seat, and stellite poppet is an encouraging step toward the goal of an artificial heart valve with the low thrombogenicity of autogenous tissue and the durability and ease of inserting prosthetic material.