# Intra-abdominal Homologous Heart Transplantation* (34105)

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With the recent introduction of heart transplantation into clinical medicine, there has been a resurgence of interest in various aspects of heart transplantation in animals. Previous work has centered on orthotopic transplantation (1) or implantation of the heart within the neck or groin (2–4). Previous work has also involved intra-abdominal transplantation of the heart and lungs or heart alone (5–9). This study was designed to develop a preparation in the dog which would provide (1) long-term survival of the transplanted organ in optimal physiologic condition; (2) easy accessiblity for study of flow, metabolism, and myocardial mechanics; and (3) feasibility of subsequent transfer to another animal of the same or unrelated species.

*Materials and Methods.* Forty-three mongrel dogs were selected as recipients and an additional 43 as donors with an effort being made to match them so far as body weight was concerned. Recipient animals were divided into six groups: I, control (7 animals); II, steroid-treated (8); III, azathioprine (imuran) (9); IV, steroids plus azathioprine (6); V, steroids plus azathioprine plus 5 days' preoperative treatment with antilymphocyte serum, 0.5 ml/kg (7); and VI, steroids plus azathioprine plus 5 days' pretreatment with ALS, 1.0 ml/kg (6). The antilymphocyte serum was produced by the Microbiological Corporation and was anti-dog horse serum.

With the recipient animal under general anesthesia, laparotomy was performed. The abdominal aorta and vena cava were exposed from the renal vessels to the bifurcation of the aorta or the junction of the iliac veins respectively.

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With the donor animal under general endotracheal anesthesia, a right thoracotomy was done. The animal then received 3 mg of heparin per kilogram body weight intravenously. The right pulmonary veins and pulmonary artery were ligated and transected close to the heart. The left lower lobe veins were then divided between ligatures and the inferior vena cava ligated and divided. The remaining left pulmonary veins were ligated and transected. This was immediately followed by ligation and transection of the superior vena cava and excision of the heart by transecting the aorta and the remaining portion of the left pulmonary artery. Excision of the donor heart required approximately 5 min and all continued in normal sinus rhythm during excision. The donor heart was transferred to saline slush for 2–3 min while the aorta and main pulmonary artery were trimmed to about 2.5 cm in length. The heart was transplanted to the recipient by end-to-side anastomosis of the donor aorta to the abdominal aorta of the recipient. The main pulmonary artery was anastomosed end-to-side to the recipient inferior vena cava about 1.5 cm inferior to the aortic anastomosis. All gas was evacuated from the donor heart and the clamps removed. Once vigorous ventricular fibrillation was present, the heart was electrically defibrillated. The final anatomic arrangement showed the heart lying to the right of the midline with the right ventricle and right atrium uppermost. Blood perfused the coronary vessels through the aorta. Coronary sinus flow was returned by the donor right ventricle to the inferior vena cava and any blood on the left side was ejected through the aorta. The donor heart was subjected to approximately 20 min of total anoxia during the transplantation. The abdomen was then closed in layers with interrupted

suture after the donor heart was restored to a vigorous beat.

Samples for a study of coronary sinus blood were obtained at regular intervals in the postoperative period by percutaneous puncture of the transplanted heart. ECG tracings were made daily over the donor heart to detect signs of rejection. Episodes of rejection were treated in selected groups by the materials as outlined. Blood transfusions were given once anemia was present and treatment of wound infection was carried out by local debridement and antibiotic therapy.

*Result.* Animals survived for varying periods of time depending upon the type of therapy employed. The details are summarized in Table I. Details of coronary sinus blood lactate, gas studies, and other parameters of rejection are the subject of another report.

Deaths due to technical error were corrected in the early series and none has died from this cause in the last 20 animals. Deaths occurring in Groups V and VI were not due to organ rejection although most animals have experienced rejection crises.

*Discussion.* Intra-abdominal storage of the canine heart using the technique described does provide a preparation which is easily accessible for study and long-term evaluation of rejection and other factors of heart transplantation. The length of survival compares closely with results in the orthotopic heart transplant studies in dogs. The utilization of antilymphocyte serum, as described as a treatment prior to the time of implantation, does appear to materially affect the length of survival of the transplanted organ. Although our studies are not complete at this time, further evaluation is needed regarding antilymphocyte serum during the postoperative period. The occurrence of pulmonary infection, as well as wound infection, in a significant number of the animals indicates the need for improvement in the control of rejection phenomena.

*Summary.* A technique of homologous heart transplantation is described which permits study of the multiple aspects of cardiac function and rejection. Some preliminary results are described. Further utilization of this study model is indicated.

1. Shumway, N. E., Lower, R. R., and Stofer, R. C., Advan. Surg. **2**, 265 (1966).

2. Mann, F. C., Priestley, J. T., Markowity, J., and Yates, W. M., Arch. Surg. **26**, 219 (1933).

3. Sayegh, S. F. and Creech, O., Jr., J. Thorac. Surg. **34**, 692 (1957).

4. Reemtsma, K., Williamson, W. E., Igleseas, F., Peva, E., Sayegh, S. F., and Creech, O., Jr., Surgery **52**, 127 (1962).

5. Marcus, E., Wong, S. N. T., and Luisada, A. A., Arch. Surg. **66**, 179 (1953).

6. Bui-Mong-Hung and Vigano, M., Presse Med. **74**, 2047 (1966).

7. Ono, K., Lindsey, E. S., and Creech, O., Surg. Forum **18**, 255 (1967).

8. Abbott, C. P., Lindsey, E. S., Creech, O., Jr., and DeWitt, C. W., Arch. Surg. **89**, 645 (1964).

9. Tomita, F., Sapporo Med. J. **30**, 165 (1966).

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TABLE I. Survival after Homologous Heart Transplantation.

| Group | No. of dogs | Therapy[a] | Mean survival (days) | |
|---|---|---|---|---|
| I | 7 | None | 7.1 | |
| II | 8 | Steroids | 7.4 | (excludes 3 deaths due to technical error) |
| III | 9 | Azathioprine | 19.3 | (excludes 3 deaths due to technical error) |
| IV | 6 | Steroids plus azathioprine | 34 | (2 animals alive at 80 and 75 days) |
| V | 7 | ALS (0.5 ml/kg × 5 days) | 37 | (4 still living, excludes 1 death due to technical error) |
| VI | 6 | ALS (1.0 ml/kg × 5 days) | 22 | (5 still living) |

[a] ALS = antilymphocyte serum.