Peripheral serum assays of long term surviving animals also showed less evidence of renal ischemia as judged by the low levels of erythropoietin in PCO-treated animals. PCO thus appears to be a beneficial agent for use in hypothermic renal preservation systems.

57. Perfusate and Microwave Radiation Effects on Nonfrozen Canine Kidneys.[1] HAZEL I. HOLST, FREDERICK KETTERER,* AND HERNDON B. LEHR (Harrison Department of Surgical Research, School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania 19104).

Storage by freezing has been successful in cellular suspension and tissues with a large surface to volume ratio. The problem with organ storage is 2-fold: 1) the cryoprotective perfusion media must protect and not damage the cells and 2) the thaw must be rapid, and cannot be accomplished by thermal conduction. This experiment was designed to test various perfusates, pulsative pressure vs. hydrostatic pressure, supercooling, and microwave radiation on the nonfrozen kidney.

Thirty mongrel dogs were used. Each dog was anesthetized; one kidney was removed, perfused at 10°C, and reimplanted into the neck. Three weeks later a contralateral nephrectomy was performed if the experimental kidney was functioning. Of the 17 animals treated by perfusion alone, 11 animals survived contralateral nephrectomy with slightly elevated blood urea nitrogen (BUN's). Modalities not affecting survival and BUN were 1) base of dimethyl sulfoxide (DMSO) whether Normasol, dextran, or dog plasma, 2) hydrostatic or pulsatile pressure and 3) mild hypo- or normotonicity of electrolytes in the perfusate. All four animals with concentrations of DMSO over 40% in the perfusate had nonfunctioning kidneys. There were two technical failures. Of the three kidneys perfused and supercooled to −5° or −10°C none functioned. Of the 10 kidneys treated by microwaves without and with perfusates only three functioned. These kidneys had no more than five 1-sec bursts of high power or 15 sec or low power without DMSO perfusate. In conclusion, cooled DMSO up to a concentration of 30% (3.9 M) in varying perfusates is only mildly toxic to renal tissue. DMSO interaction with microwave radiation allows a very narrow margin of safety in renal thawing.

58. Conduction Thawing of Frozen Kidneys: An Experimental Technique.[1] RALPH HAMILTON, BARBARA S. LUNDY,* AND HERNDON B. LEHR (Harrison Department of Surgical Research, School of Medicine, University of Pennsylvania, and the Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania).

In an effort to isolate the problems involved in the frozen storage of kidneys, a method of permitting rapid uniform freezing and thawing of functional units of a kidney by thermal conduction has been developed. Dissection has shown that the renal arteries hand veins divide into several branches which wrap around the renal pelvis before sending radially directed vessels to medulla and cortex. By selective resection of approximately 50% of the kidney, it is possible to obtain thin slices of kidney tissue, adequately vascularized by branches of renal artery and vein, and still connected to the renal pelvis so that urine can be collected. The high surface to volume ratio permits rapid heat exchange by thermal conduction.

The technique was evaluated in kidneys which were perfused with a 10% glycerol solution prior to autotransplantation in the neck. At the completion of the perfusion the kidney was bisected into the renal pelvis. Right and left halves were partially resected along a parasaggital plane as far as the vascular network around the renal pelvis. At this point the kidney resembled the shape of a butterfly, with the pelvis corresponding to body and renal parenchyma corresponding to the wings. The kidney was frozen by conduction in a Dry Ice refrigerator at 2°C per min. Thawing from −60°C was carried out at a rate of 50°C per min. After vascular anastomosis, but, prior to release of the vascular clamps, the cut surfaces of the kidney were coated with a thin layer of isobutyl 2-cyanoacrylate monomer (Ethicon IBC-2) to control hemorrhage. The two halves of the kidney were glued together in the midline to close the renal pelvis. In control animals urine production was noted within the first 24 hrs and continued indefinitely. Frozen-preserved animals did not produce urine but arteriograms indicated preservation of a normal circulatory system and renal pelvis.

The significance of this study is that rapid uniform heat exchange by thermal conduction was accomplished for complete functional units of a kidney. The preparation is a versatile experimental model for studies in frozen kidney preservation.

59. Progress in Microwave Thawing of Canine Kidneys.[2] FREDERICK KETTERER,* HAZEL I. HOLST, AND HERNDON B. LEHR (Harrison Department of Surgical Research, School of Medicine, and the Department of Engineering, University of Pennsylvania, Philadelphia, Pennsylvania 19104).

Previous investigation on the use of high intensity microwave energy for thawing frozen organs showed that rapid thaw was possible but that thermal runaway was still a serious problem. In the present study a combination of thawing schedules was used in thawing a series of 30 canine kid-

[1] Supported by a grant from the John A. Hartford Foundation, Inc.

[2] Supported by a grant from the John A. Hartford Foundation, Inc.