ported a mean flow of 3.2 ml/hour of cardiac lymph—the major constituent of the non-respiratory portion(5)—in dogs averaging 17.7 kg in body weight. Their figure is 45% of the mean flow rate we measured in the right duct (7.1 ml/hour) in dogs of nearly identical (17 kg) mean body weight, and is thus generally in agreement with the relative distribution of flow we estimated above.

The markedly higher Po_2 in lymph from the lung, compared to lymph from other organs, lends support to a correlation between respiratory gas tensions in "tissues" and in lymph derived from these tissues.

A particularly high oxygen tension in respiratory tissue could help explain its relative vulnerability to the toxic effects of high inspired oxygen tension(8).

Summary. Po_2 in right lymph duct of 15 anesthetized dogs averaged the same as in arterial blood (75 ± 18 mm Hg); Po_2 in thoracic duct lymph was close to that in mixed-venous blood (34 ± 20 mm Hg). Allowing for admixture of systemic lymph in the right duct, Po_2 in lymph from the respiratory portion of the lung must fall between alveolar gas and arterial blood. The marked difference from thoracic duct lymph Po_2 ($p<.001$) supports the concept of lymph as a useful measure of Po_2 in interstitial fluid and tissues. Use of mixing equations shows that during air breathing respiratory (*i.e.*, gas-exchanging) tissues contributed at least 53% of right duct lymph flow.

We are grateful to M. Woolard, W. Ford, L. Norrell and B. Hom for invaluable technical help.

1. Mayerson, H. S., in Blood Vessels and Lymphatics, D. I. Abramson, Ed., Academic Press, New York, 1962, p714.

2. Bergofsky, E. H., Jacobson, J. H., II, Fishman, A. P., J. Clin. Invest., 1962, v41, 1971; Bergofsky, E. H., Wang, M. C. H., Yamaki, T., Jacobson, J. H., II, J. Am. Med. Assn., 1964, v189, 841.

3. Klaus, M., Reiss, O. K., Tooley, W. H., Piel, C., Clements, J. A., Science, 1962, v137, 750; Buckingham, S., McNary, W. F., Sommers, S. C., ibid., 1964, v145, 1192.

4. Popjak, G., Beeckmans, M., Biochem. J., 1950, v47, 233; Harlan, W. R., Jr., Said, S. I., Spiers, C. L., Banerjee, C. M., Avery, M. E., Clin. Res., 1964, v12, 291; Tombropoulos, E. G., Science, 1964, v146, 1180.

5. Warren, W. F., Drinker, C. K., Am. J. Physiol., 1942, v136, 207; Courtice, F. C., Brit. Med. Bull., 1963, v19, 76.

6. Uhley, H., Leeds, S. E., Sampson, J. J., Friedman, M., Proc. Soc. Exp. Biol. and Med., 1963, v112, 684.

7. Miller, A. J., Ellis, A., Katz, L. N., Am. J. Physiol., 1964, v206, 63.

8. Lambertsen, C. J., Fed. Proc., 1963, v22, 1046.

Received February 4, 1965. P.S.E.B.M., 1965, v119.

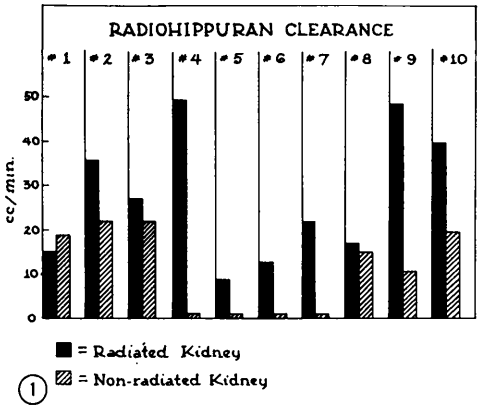
The Effect of X-Irradiation on Renal Damage Secondary to Ischemia. (30085)

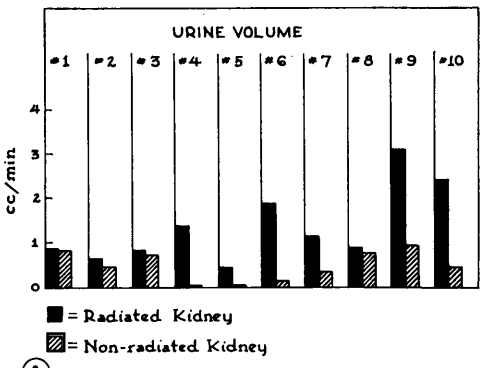
J. U. SCHLEGEL AND A. K. GUP*

Department of Surgery, Section of Urology, School of Medicine, Tulane University, New Orleans, La.

Several groups performing renal transplantation have reported beneficial results from local radiation to the transplanted kidney(1, 2). The actual effects of radiation have been suggested to be either effects on the lymphocytes or the well known but vaguely understood anti-inflammatory effects of X-irradiation. In our own transplantation experience, we have seen what we believe to be an effect of local radiation characterized by onset of diuresis and changing of the renogram tracing from that of an obstructive pattern to a normal tracing(3). We have observed radiohippuran renograms in acute rejection with the typical delay in the secretory peak extending over half an hour. In one patient, whom we had a unique opportunity to study because exploration was deemed necessary, the kid-

* Research Trainee under U.S.P.H.S. Grant CRT-5057. This research was supported in part by Office of Naval Research Grant Nonr 475(07) and U.S. P.H.S. Research Grant 1-P01-HE-09178-01.





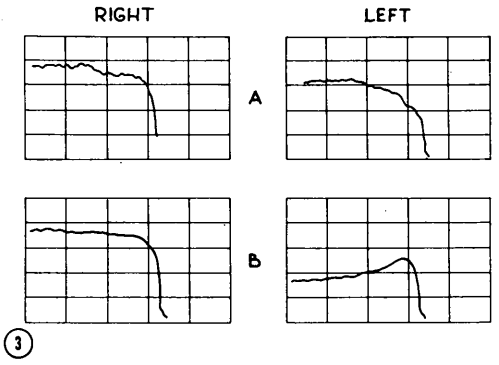


FIG. 1. The 2 columns for each dog represent the mean of 3 radiohippuran clearances obtained on third post-operative day by clamping of both renal arteries for 75 min. In 9 out of 10 dogs, radiohippuran clearances were higher from the kidneys subjected to radiation of 200 R's daily for 3 consecutive days.

FIG. 2. Each column represents mean of 3 volume collections done as part of the clearance determinations depicted in Fig. 1. Radiated kidney had a higher urine volume than non-radiated kidney in all instances.

FIG. 3. Typical renogram pattern from a dog in which the renal artery on both sides had been clamped for 75 min. Following this, renograms in top row were obtained showing an obstructive pattern (A). Radiation was next given in amount of 200 R's daily for 3 consecutive days to left kidney. On third day, renograms in lower part of figure were obtained (B). Radiated kidney (left) showed no obstructive pattern.

neys were found to be tense and edematous, but with no urine in the renal pelves. Thus, it appeared that obstruction was at the tubular level. This pattern is, in essence, comparable to that of early tubular necrosis and the pattern which we have seen following clamping of the renal artery for periods of one to four hours. Following release of the clamp there was evidence of good renal concentration of radiohippuran but little or no urine formation with a secretory peak delay of considerable magnitude on renogram.

Nathan *et al*(4) studied oxygen consumption and para-amino hippurate accumulation in slices of renal cortex from second set kidney transplants in dogs. In spite of advanced rejection, these second set transplants still accumulated PAH *in vitro* at the same high level as other transplant controls and oxygen uptake remained within normal limits. These investigators also showed that the turnover of phosphorus in the acid and lipid soluble fractions remained unaffected by the acute rejection process. The investigators interpreted these observations to suggest that "an interruption of the vascular supply or mechanical interference with a nutritional exchange of the tissue are more likely causes of transplant destruction, and that the cytotoxic reactions are not a major factor in transplant rejection."

Because of the similarity between the apparent preserved ability to concentrate para-amino hippurate and hippuran as seen in acute tubular necrosis and the early rejection phenomenon, we decided to evaluate the possible effect of local X-irradiation to a kidney subjected to prolonged ischemia. It is obvious that the results of such experiments, if positive, will not only provide a tool to explore further the actual effects of local X-irradiation to the kidneys, but will also provide a simple model to study at least part of the rejection phenomenon.

Materials and methods. In 10 dogs, in which blood urea nitrogens had been determined, both renal arteries were exposed and

individually clamped for a period of 75 minutes. The clamps then were removed and both kidneys were exteriorized and placed underneath the skin. Within 30 minutes, the dogs received X-irradiation in the amount of 200 R's to one kidney, the other serving as a control. This irradiation was repeated in the same fashion on the 1st and 2nd post operative day. BUN's and renograms also were followed. On the 3rd post operative day, ureteral catheters were passed to both kidneys through a ureteral incision and renal function studies were performed. Diuresis was induced, if feasible, by administration of 4% urea† in normal saline intravenously. The animals then received an intradermal injection of 60 μc of radiohippuran and 3 radiohippuran clearances were determined for each kidney as previously described(5). The dogs were sacrificed following the clearance determinations.

Results and discussion. Fig. 1 gives the results of the mean of 3 clearances in all the dogs, with the radiated kidney represented by the solid black bars and the non-radiated kidney by the cross hatched bars. It can be clearly seen that the radiated kidney, in almost all instances, has greater clearance than the non-radiated kidney. (The non-radiated kidney not only had a significantly lower clearance of radiohippuran, but also was unable to concentrate the smaller volume of urine it produced during the osmotic diuresis induced.)

† urea—Ureaphil—courtesy of Abbott Laboratories.

Fig. 2 represents the mean differences in volume noted between the 2 sides.

In Fig. 3 is shown a typical renogram from a radiated kidney and the non-radiated control (B). The abnormal renogram found on the non-radiated side is similar to that found on the other side before radiation was given (A).

Summary. On the basis of the results obtained, it appears reasonable to suggest that the effect of radiation in modifying acute rejection is possibly secondary to its effect upon ischemia. Whatever the mechanism may be, it appears that a small amount of radiation has a beneficial effect upon the kidney damaged by anoxia, a finding which may have therapeutic value in a variety of conditions.

‡ Hipputope—courtesy of E. R. Squibb & Sons.

The authors gratefully acknowledge the assistance of the Dept. of Radiology, Tulane Univ. School of Med., in the irradiation of the dogs by Drs. Joseph V. Schlosser and Timothy Caldwell.

1. Martin, D. C., Van DeWater, J., Randel, D., Lee, D. A., Surg. Forum, 1964, v15, 156.
2. Lee, H. M., Kauffman, Cleveland, R. J., Hume, D. M., ibid., 1964, v15, 158.
3. Mobley, J. E., Schlegel, J. U., Surgery, in press.
4. Nathan, P., Foulkes, E. C., Wilchins, L. J., Miller, B. F., Proc. Soc. Exp. Biol. and Med., 1962, v3, 207.
5. Smith, B. G., O'Dell, R. M., Schlegel, J. U., J. Urol., 1962, v87, 106.

Received February 8, 1965. P.S.E.B.M., 1965, v119.

Plasma LH in Cyclic Female Rats.* (30086)

NEENA B. SCHWARTZ AND DAVID CALDARELLI
Department of Physiology, University of Illinois College of Medicine, Chicago

The usual failure to detect LH in the plasma of intact, randomly selected female rats(1,2) is probably the result of a combination of the insensitivity of methods, the 15-minute plasma half-life of LH(3) and the presumably short time span within the estrous cycle during which large quantities of LH are secreted(4-7). In two recent investigations plasma LH was measured during specific times of the estrous cycle in rats: Van der Werff ten Bosch *et al*(8) found highest values during "late diestrus"; whereas Rami-

* This work was supported in part by USPHS Grant HD-00440.