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INTRARENAL HEMODYNAMIC CHANGES FOLLOWING ACUTE PARTIAL RENAL ARTERIAL OCCLUSION

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FOREWORD

The work described in this report was performed by members of the Environmental Physiology Branch, CARI, and the Department of Physiology, University of Oklahoma School of Medicine, Oklahoma City, Oklahoma. It was supported in part by a grant-in-aid from the American Heart Association and the Tulsa County (Oklahoma) Heart Association.

INTRARENAL HEMODYNAMIC CHANGES FOLLOWING ACTIVE PARTIAL RENAL ARTERIAL OCCLUSION

I. Introduction.

Both an increase and a decrease in total renal vascular resistance, following a period of total renal artery occlusion, have been reported from this laboratory.[1] The duration of the occlusive period and the height of the perfusion pressure were found to prescribe consistently the hemodynamic response. The present study was undertaken to determine if a similar renal vascular response occurred after a period of partial renal artery occlusion. Results indicate that following a period of partial occlusion, in a critical range of renal artery pressure, intrarenal hemodynamic changes mimicked those seen after total obstruction of blood flow. Reactive hyperemia was not observed.

II. Methods.

Experiments were performed on adult mongrel dogs of both sexes, weighing from 15 to 19 kg. Surgical anesthesia was produced and maintained with sodium pentobarbital, the initial dose being 30 mg/kg. The left kidney was exposed through a flank incision. The vessels of the renal pedicle were dissected free of the surrounding tissues, including stripping away of all visible nerve fibers. The renal venous effluent, measured at intervals with an appropriately sized polyethylene tube. with a graduated cylinder and stop watch, was collected in a reservoir, thence through a sigma-motor pump returned to the femoral vein of the dog. Anticoagulation was insured by the administration of 3 mg of Heparin per kilogram of body weight. A screw clamp was positioned on the exposed renal artery. Renal artery pressure was continuously monitored and recorded on a Sanborn direct-writing instrument, a needle being inserted in the vessel distal to the screw clamp. The systemic arterial blood pressure was recorded in the usual fashion from the cannulated femoral artery.

Adjustments of the screw clamp resulted in a step-wise decrease in renal artery pressure. Pressure-flow relationships were observed at each level, and at intervals after removal of the clamp, a "steady-state" condition being prerequisite to each maneuver. A final period of total occlusion was produced in each experiment. In some instances, an adrenergic blocking agent, phentolamine (Regitine, Ciba) was employed in an attempt to characterize any released humoral agents.

III. Results.

Renal blood flows in a total of 10 experiments averaged 2.6 ml/min/gm of kidney (range 1.6 to 3.3), at a mean arterial pressure of 121 mm Hg. Systemic arterial blood pressure was constant. The duration of the times of partial renal artery occlusion was varied from 5 to 30 minutes. Following these spans of time there was a consistent increase in total vascular resistance. The results are depicted in Figures 1 and 2. The total renal resistance, renal blood flow, and renal artery pressure values are arranged by groups based on the percent of change from control values according to the tension produced by the adjusted screw clamp. Beyond a 30% reduction of mean control renal artery pressure, a persistent fall in renal vascular resistance occurred during the period of partial occlusion. Significant alteration in total renal vascular resistance did not occur until renal artery pressure had been reduced to a critical range of from 40% to 50% of the control value. Greater reduction in pressure resulted in an increase in magnitude of the response. Renal blood flows returned to or very near control values within 3 to 11 minutes following release of the constriction. One minute after release of a total occlusion reactive hyperemia was noted, followed by a greater increase in resistance.

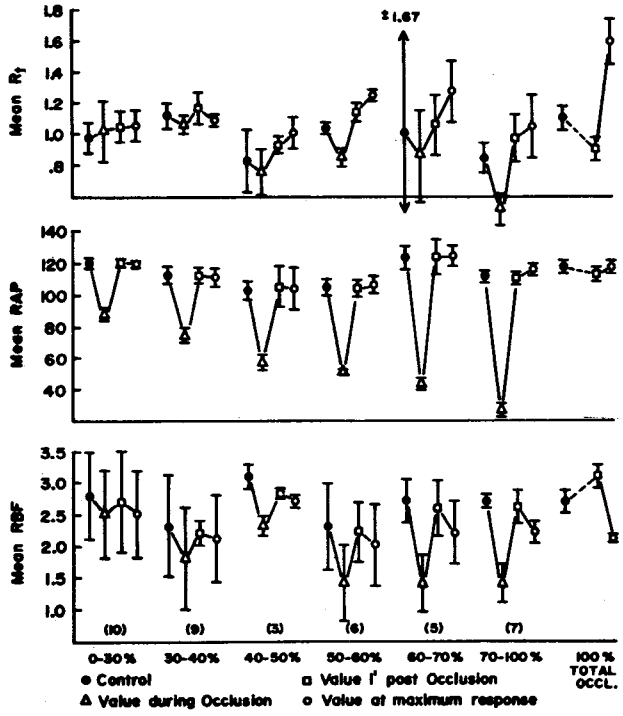

FIGURE 1. Mean data ± standard error showing total renal vascular resistance (R_t), renal artery pressure (RAP), and renal blood flow (RBF) before, during, and after a period of partial and complete renal artery occlusion. Groupings represent percent change from control values. Numbers in parentheses represent number of experiments in each group.

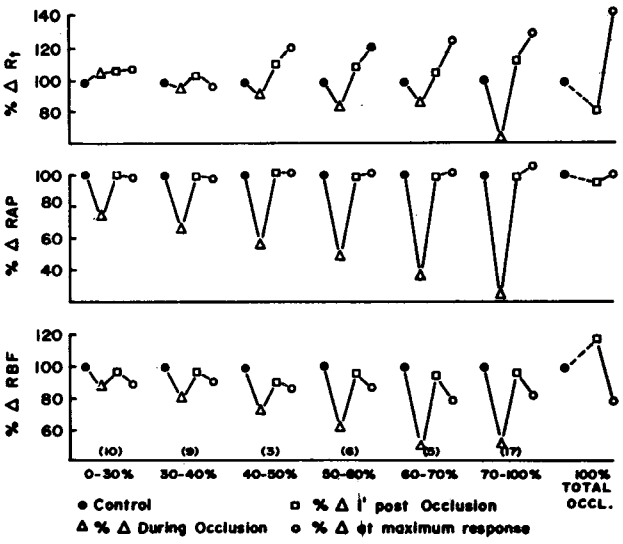

FIGURE 2. Total renal resistance (R_t), renal artery pressure (RAP), and renal blood flow (RBF) as mean values depicted as percent change from control.

IV. Discussion.

Autoregulation of blood flow by the kidney was evident with each step-wise reduction in renal artery pressure, there being a consistent decrease in resistance.[2] At and beyond the apparent critical range (40% to 50% reduction in pressure), after the clamp was removed and control pressures regained, the resistance rise exceeded that expected during autoregulation. This suggested, among other things, the possibility of the release of some vasoconstrictor humoral agent, in these denervated organs. The injection of phentolamine at the peak of the constrictor response had no effect, thus tending to eliminate catecholamines. The renin-angiotensin complex is well-known.[3,4] In two additional experiments utilizing a heart-lung-pump perfused isolated kidney. which has been previously described,[5] antirenin (50 antirenin units*) was introduced into the system. Antirenin, a neutralizing antibody to renin, may be used to block the renin-angiotensin pressor system.[6] Before the introduction of antirenin, both organs demonstrated a typical ischemic response following a period of partial occulsion. The same maneuver after the introduction of antirenin into the blood perfusate resulted in reactive hyperemia, the increase in resistance being totally obliterated. Angiotensin is then possibly playing a major role.

Partial renal occlusion, with a reduction in renal artery blood pressure at or below a critical level (40% to 50% of control) results in a marked increase in renal vascular resistance following release of the obstruction. This is similar to the results observed following periods of total disruption of blood flow to the kidney. It is suggested that the elaboration of renin by the partially ischemic kidney occurs within a very few minutes following insult.

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