

CHAPTER III

RESULTS

GROUP I

GENERAL CIRCULATION

Effects of hypertonic saline infusion on general circulation of six dogs in group I are shown in Table I. During clamp the left renal artery for 45 minutes, mean arterial pressure (MAP) and total peripheral resistance (TPR) increased significantly ($p < 0.01$) from the control level. Packed cell volume (PCV) and cardiac output (CO) decreased significantly whereas heart rate (HR), stroke volume (SV), plasma volume (PV) and blood volume (BV) changed insignificantly. It was found that CO, MAP, PV and BV increased significantly in 10 minutes after hypertonic saline infusion. Hypertonic saline infusion also caused a significant decrease in TPR, PCV and blood hemoglobin concentration whereas no significant changes in SV and HR were observed in comparison with clamped period.

RENAL FUNCTIONS

Effects of hypertonic saline infusion on renal hemodynamics are shown in Table II. When the left renal artery was clamped for 45 minutes and after released clamp there were no significant decrease in GFR, ERPF and RBF of the contralateral control kidney. Renal fraction and FF were not significantly increased, but RVR increased significantly ($p < 0.01$) in the right control kidney. However, these changes were not statistically significant at 10 minutes after hypertonic saline infusion. With regard to experimental kidney, it was found that



Table I Effects of hypertonic saline infusion on general circulation of six dogs in group I.

	Control	During clamp Lt renal artery (A)	Release clamp and 10 min. after hypertonic NaCl infusion (B)	A VS B
CO (L/min)	1.48±0.19	1.19±0.23*	1.65±0.41*	p<0.05
SV (ml/beat)	9.8±1.1	8.4±1.6 ^{NS}	10.9±2.7 ^{NS}	NS
MAP(mmHg)	112±25.31	131±29.76**	138±24.20**	NS
HR (beat/min)	151±13	145±23 ^{NS}	151±19 ^{NS}	NS
TPR(dyne-sec/cm ⁵)	6139.9±1592.6	8854.5±1882.3**	6978.5±1730.9 ^{NS}	p<0.01
PCV(%)	35±6.9	33±6.4**	30±5.7**	p<0.01
Hb (gm %)	10.9±2.3	10.6±1.8 ^{NS}	9.9±2.2*	p<0.05
PV (liter)	0.548±0.08	0.722±0.18 ^{NS}	1.02±0.33*	p<0.05
BV (liter)	0.840±0.14	1.07±0.23 ^{NS}	1.45±0.45*	p<0.05

Values were statistically significantly different with respect to the control: *p<0.05, **p<0.01, NS = not significant. (MEAN±S.D)

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Table II Effects of hypertonic saline infusion on renal hemodynamics of six dogs compared with control, during clamp the left(Lt) renal artery and after released clamp.(MEAN±S.D)

	Control	During clamp Lt renal artery	30 min. after release clamp (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
Urine flow(ml/min)	Rt 0.51±0.33 Lt 0.55±0.36	0.65±0.59 ^{NS} -	0.54±0.46 ^{NS} -	1.02±0.97 ^{NS} 0.38±0.33*	NS
GFR (ml/min)	Rt 19.04±5.7 Lt 17.68±7.8	15.59±4.1 ^{NS} -	15.10±4.6 ^{NS} -	19.47±7.9 ^{NS} 7.66±6.2*	NS
ERPF (ml/min)	Rt 73.6 ± 22.6 Lt 76.3 ± 30.8	59.8 ± 35.5 ^{NS} -	48.9 ± 25.9 ^{NS} -	73.7±51.8 ^{NS} 40.4 ± 33.4*	NS
RBF (ml/min)	Rt 115.2±46.1 Lt 119.9±56.3	93.3 ± 66.6 ^{NS} -	75.0 ± 48.0 ^{NS} -	109.7±89.7 ^{NS} 58.9 ± 50.9*	NS
FF (%)	Rt 27±20 Lt 24±4	31±10 ^{NS} -	35±10 ^{NS} -	33±14 ^{NS} 26±12 ^{NS}	NS
Renal fraction (%)	Rt 7.7 ± 2.7 Lt 8.0 ± 3.3	8.6 ± 7.4 ^{NS} -	were not measured	8.7 ± 7.8 ^{NS} 3.8 ± 3.7**	-
RVR(dyne-sec/cm ⁵)	Rt 132601.27 ± 47455.4 Lt 145292.61 ± 89997.3	232562.57** ± 133045.6	278860.32** ± 143264.7	213335.68** ± 121268.6 625282.36 ^{NS} ± 638893.5	NS

Values were statistically significantly different with respect to the control: *p < 0.05, **p < 0.01, NS = not significant. Rt = right kidney, Lt = left kidney.

GFR, ERPF, RBF, FF and renal fraction rose to 43 %, 53 %, 49 %, 108 % and 48 % of mean control values, respectively.

In experimental kidney, persistent anuria occurred in a period of clamp and after released clamp. After hypertonic saline infusion the rate of urine flow increased to 69 % of control value in the ipsilateral experimental kidney. But in the contralateral control kidney, hypertonic saline infusion induced urine flow increased to 100 % and 89 % from a mean values before clamp and after released clamp respectively.

The urinary excretion of sodium ($U_{Na}V$), potassium (U_KV) and chloride ($U_{Cl}V$) from control kidney were not significantly decreased during clamp and after released clamp of left renal artery. However, the significant increase in $U_{Na}V$ and $U_{Cl}V$ were found in the right control kidney after hypertonic saline infusion, but no significant change in U_KV . The fractional excretions of Na, Cl and K were not significant change in during clamp, after released clamp and hypertonic saline infusion. (Table III)

In control kidney, hypertonic saline infusion did not have any significantly effects on U/P osmolarity ratio and urine osmolarity compared between the period of clamp and after released clamp, but plasma osmolarity increased significantly ($p < 0.01$). The osmolar clearance in the control kidney was decreased insignificantly during clamp and after released clamp. After hypertonic saline infusion, it was shown that osmolar clearance increased significantly ($p < 0.05$) in normal control kidney. The excretion of free water clearance increased by approximately 187 % in control kidney, but this change was not statistically significant. In the experimental kidney, However, the tubular reabsorption of free water was occurred after hypertonic saline infusion when compared with the control value. (Table IV)

Table III Effects of hypertonic saline infusion on plasma concentration of electrolytes (P_E), urinary excretion of electrolytes ($U_E V$) and fractional excretion of electrolytes of six dogs in group I. (MEAN \pm S.D)

	Control	During clamp Lt renal artery	30 min. after release clamp (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
P_{Na} (mEq/L)	142 \pm 5.5	141.2 \pm 3.1 ^{NS}	142.3 \pm 3.1 ^{NS}	147.7 \pm 2.4 [*]	p < 0.05
P_K (mEq/L)	3.4 \pm 0.72	3.5 \pm 0.44 ^{NS}	3.5 \pm 0.55 ^{NS}	3.3 \pm 0.66 ^{NS}	NS
P_{Cl} (mEq/L)	115.3 \pm 7.9	128.0 \pm 9.1 [*]	123.8 \pm 6.1 ^{NS}	128.7 \pm 6.8 [*]	NS
$U_{Na} V$ (uEq/min)	Rt 45.12 \pm 32.7 Lt 47.89 \pm 26.3	44.82 \pm 38.7 ^{NS} -	32.34 \pm 23.5 ^{NS} -	76.92 \pm 50.3 [*] 51.68 \pm 54.3 ^{NS}	p < 0.05
$U_K V$ (uEq/min)	Rt 13.33 \pm 11.3 Lt 16.38 \pm 15.4	10.19 \pm 4.3 ^{NS} -	11.07 \pm 3.9 ^{NS} -	11.17 \pm 6.8 ^{NS} 11.31 \pm 9.0 ^{NS}	NS
$U_{Cl} V$ (uEq/min)	Rt 72.3 \pm 44.4 Lt 72.6 \pm 35.7	45.2 \pm 46.03 ^{NS} -	34.5 \pm 31.4 ^{**} -	86.5 \pm 60.4 ^{NS} 62.6 \pm 64.6 ^{NS}	p < 0.01
Fractional excretion of Na (%)	Rt 1.5 \pm 0.94 Lt 1.8 \pm 0.42	1.9 \pm 1.64 ^{NS} -	1.6 \pm 1.25 ^{NS} -	3.2 \pm 2.61 ^{NS} 9.5 \pm 15.5 ^{NS}	NS
Fractional excretion of K (%)	Rt 24.13 \pm 28.1 Lt 38.30 \pm 58.39	18.34 \pm 5.6 ^{NS} -	23.83 \pm 13.5 ^{NS} -	22.12 \pm 17.6 ^{NS} 64.14 \pm 75.3 ^{NS}	NS
Fractional excretion of Cl (%)	Rt 2.98 \pm 1.7 Lt 3.34 \pm 1.8	2.15 \pm 2.3 ^{NS} -	1.83 \pm 1.5 ^{NS} -	3.74 \pm 2.4 ^{NS} 13.44 \pm 22.3 ^{NS}	NS

Values were statistically significantly different with respect to the control: * p < 0.05, ** p < 0.01, NS = not significant. Rt = right kidney, Lt = left kidney.

Table IV Effects of hypertonic saline infusion on plasma osmolarity, urine osmolarity, U/P osmolarity ratio, osmolar clearance and free water clearance of six dogs in group I. (MEAN±S.D)

	Control	During clamp Lt renal artery	30 min. after release clamp (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
Plasma osmolarity (mOsm/L)	302±4.6	304±9.2 ^{NS}	302±8.1 ^{NS}	312±6.2 ^{**}	p < 0.01
Urine osmolarity (mOsm/L)	Rt 394.8±229.8 Lt 401.7±187.9	348.0±324.4 ^{NS} -	360.8±314.7 ^{NS} -	342.4±301.7 ^{NS} 387.2±113.6 ^{NS}	NS
U/P osmolarity ratio	Rt 1.31±0.8 Lt 1.20±0.6	1.14±1.0 ^{NS} -	1.19±1.0 ^{NS} -	1.09±0.9 ^{NS} 1.22±0.4 ^{NS}	NS
Osmolar clearance (ml/min)	Rt 0.579±0.3 Lt 0.604±0.3	0.565±0.3 ^{NS} -	0.516±0.2 ^{NS} -	0.771±0.4 [*] 0.512±0.5 ^{NS}	p < 0.05
Free water clearance (ml/min)	Rt -0.023±0.4 Lt 0.0004±0.3	0.181±0.5 ^{NS} -	0.120±0.4 ^{NS} -	0.344±0.8 ^{NS} -0.002±0.3 ^{NS}	NS

Values were statistically significantly different with respect to the control: *p < 0.05, **p < 0.01,

NS = not significant. Rt= right kidney, Lt= left kidney.

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GROUP II

GENERAL CIRCULATION (Table V)

HgCl₂ injection caused a significant decrease in CO from 1.23 to 0.97 L/min. However, SV, HR, PV and BV were not significantly change as compared with control values. There were significant ($p < 0.05$) increase in MAP, TPR and PCV, but Hb was not affected after HgCl₂ injection. In HgCl₂ treated animals, CO, SV, PV and BV were not significantly increased by a period of 10 minutes after hypertonic saline infusion. There was no significant changes in HR, TPR, MAP, PCV and Hb after hypertonic saline infusion.

RENAL FUNCTIONS

After HgCl₂ injection at 45 minutes, it was found that GFR, ERPF and RBF decreased significantly. The significant ($p < 0.05$) increment of RVR may be associated with a reduction of RBF. Renal fraction was not significantly decreased whereas no significant increase in FF was occurred. There was no significant alteration in renal hemodynamics at 10 minutes after hypertonic saline infusion when compared with mean values of HgCl₂ injection period. (Table VI)

The rate of urine flow was increased after HgCl₂ injection and at 10 minutes after hypertonic saline infusion insignificantly in HgCl₂ treated dogs. (Table VI)

The urinary excretions of sodium, chloride and potassium were increased in either after HgCl₂ injection or hypertonic saline infusion. The fractional excretions of sodium, potassium and chloride were not significantly increased in either after HgCl₂ injection or hypertonic saline infusion. (Table VII)

After HgCl₂ injection, it was found that U/P osmolarity ratio and urine osmolarity were decreased but not statistically sig-



Table V Effects of hypertonic saline infusion on general circulation of six dogs in group II compared with control and 45 min. after $HgCl_2$ injection. (MEAN \pm S.D)

	Control	45 min. after $HgCl_2$ injection (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
CO (L/min)	1.23 \pm 0.36	0.97 \pm 0.31***	1.01 \pm 0.40 ^{NS}	NS
SV (ml/beat)	7.4 \pm 1.9	6.0 \pm 2.4 ^{NS}	6.4 \pm 3.4 ^{NS}	NS
MAP (mmHg)	105 \pm 28.8	118 \pm 31.9*	116 \pm 28.0*	NS
HR (beat/min)	165 \pm 26	158 \pm 40 ^{NS}	154 \pm 44 ^{NS}	NS
TPR (dyne-sec/cm ⁵)	7479.29 \pm 2478.1	11259.74 \pm 4428.5*	11186.08 \pm 5050.0*	NS
PCV (%)	35 \pm 4.9	40 \pm 6.1*	39 \pm 6.4*	NS
Hb (gm %)	8.41 \pm 1.0	9.10 \pm 1.5 ^{NS}	8.9 \pm 1.3 ^{NS}	NS
PV (liter)	0.609 \pm 0.16	0.548 \pm 0.22 ^{NS}	0.633 \pm 0.13 ^{NS}	NS
BV (liter)	0.958 \pm 0.31	0.918 \pm 0.34 ^{NS}	1.07 \pm 0.26 ^{NS}	NS

Values were statistically significantly different with respect to the control: * $p < 0.05$, *** $p < 0.005$

NS = not significant. Values obtained calculated from both kidneys.

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Table VI Effects of 10 min. after hypertonic saline infusion on renal hemodynamics of six dogs in group II compared with control and 45 min. after HgCl₂ injection. (MEAN ± S.D)

	Control	45 min. after HgCl ₂ injection (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
Urine flow (ml/min)	0.71 ± 0.35	1.89 ± 2.48 ^{NS}	3.56 ± 4.05 ^{NS}	NS
GFR (ml/min)	44.9 ± 14.1	23.8 ± 17.3 [*]	24.0 ± 7.0 [*]	NS
ERPF (ml/min)	133.7 ± 36.0	52.5 ± 28.7 ^{**}	62.7 ± 30.2 ^{**}	NS
RBF (ml/min)	208.6 ± 65.5	90.6 ± 53.3 ^{**}	104.6 ± 54.7 ^{**}	NS
PF (%)	35 ± 8	47 ± 27 ^{NS}	42 ± 11 ^{NS}	NS
Renal fraction (%)	19.5 ± 7.3	12.2 ± 7.4 ^{NS}	13.7 ± 11.3 ^{NS}	NS
RVR (dyne-sec/cm ⁵)	26339.01 ± 75280.6	937421.85 [*] ± 479228.0	722010.19 [*] ± 365624.0	NS

Values were statistically significantly different with respect to the control: * p < 0.05, ** p < 0.01,

NS = not significant. Values obtained calculated from both kidneys.

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Table VII Effects of 10 min. after hypertonic saline infusion on plasma concentration of electrolytes (P_E), urinary excretion of electrolytes ($U_{E,V}$) and fractional excretion of electrolytes of six dogs in group II compared with control and 45 min. after $HgCl_2$ injection.

	Control	45 min. after $HgCl_2$ injection (A)	10 min. after hypertonic NaCl infusion (B)	A VS B
P_{Na} (mEq/L)	140.8 ± 3.9	140.0 ± 4.8 ^{NS}	146.7 ± 4.6 ^{**}	p < 0.01
P_K (mEq/L)	3.6 ± 0.2	3.8 ± 0.5 ^{NS}	3.1 ± 0.6 ^{**}	p < 0.01
P_{Cl} (mEq/L)	119.2 ± 6.2	124.5 ± 10.8 ^{NS}	133.3 ± 5.5 ^{**}	p < 0.01
$U_{Na,V}$ (uEq/min)	97.4 ± 76.6	270.5 ± 362.2 ^{NS}	448 ± 411.4 ^{NS}	NS
$U_{K,V}$ (uEq/min)	54.8 ± 5.6	38.4 ± 23.6 ^{NS}	40.2 ± 17.7 ^{NS}	NS
$U_{Cl,V}$ (uEq/min)	117.9 ± 96.6	373.0 ± 531.4 ^{NS}	708.7 ± 761.4 ^{NS}	NS
Fractional excretion of Na (%)	1.39 ± 1.05	9.02 ± 11.8 ^{NS}	12.72 ± 11.5 ^{NS}	NS
Fractional excretion of K (%)	34.7 ± 11.2	50.3 ± 28.9 ^{NS}	54.5 ± 35.3 ^{NS}	NS
Fractional excretion of Cl (%)	1.9 ± 1.6	12.3 ± 15.8 ^{NS}	21.4 ± 21.3 ^{NS}	NS

Values were statistically significantly different with respect to the control: **p < 0.01, NS = not significant. Values obtained calculated from both kidneys. (MEAN ± S.D)

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nificant, and also was not significantly increased in plasma osmolarity from control values. The significant reduction in U/P osmolarity ratio and urine osmolarity were found after hypertonic saline infusion while the plasma osmolarity significantly ($p < 0.05$) increased in $HgCl_2$ treated animals. There was no significant change in osmolar clearance in either after $HgCl_2$ injection or hypertonic saline infusion. The free water reabsorption diminished after $HgCl_2$ injection, but free water excretion increased in 10 minutes after hypertonic saline infusion. However, there was no significant change in this result. (Table VIII)



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Table VIII Effects of 10 min. after hypertonic saline infusion on plasma osmolarity, urine osmolarity, U/P osmolarity ratio, osmolar clearance and free water clearance of six dogs in group II compared with control and 45 min. after HgCl_2 injection. (MEAN \pm S.D)

	Control	45 min. after HgCl_2 injection (A)	10 min. after hypertonic NaCl infusion (B)	A vs B
Plasma osmolarity(mOsm/L)	296 \pm 7.1	300 \pm 9.5 ^{NS}	312 \pm 4.3 [*]	p < 0.05
Urine osmolarity(mOsm/L)	544 \pm 132.4	392 \pm 162.5 ^{NS}	304 \pm 104.8 [*]	NS
U/P osmolarity ratio	1.83 \pm 0.4	1.30 \pm 0.5 ^{NS}	0.97 \pm 0.3 [*]	NS
Osmolar clearance(ml/min)	1.38 \pm 0.71	2.34 \pm 2.56 ^{NS}	3.31 \pm 2.78 ^{NS}	NS
Free water clearance(ml/min)	- 0.63 \pm 0.4	-0.088 \pm 0.4 ^{NS}	0.928 \pm 1.4 ^{NS}	NS

Values were statistically significantly different with respect to the control: *p < 0.05, NS = not significant. Values obtained calculated from both kidneys.

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Summary effects of hypertonic saline infusion between ischemic dogs and HgCl₂ treated dogs on cardiac output and renal fraction, GFR and RHF, THR and RVR, urinary and fractional excretions of sodium, potassium and chloride were shown in Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6, respectively.



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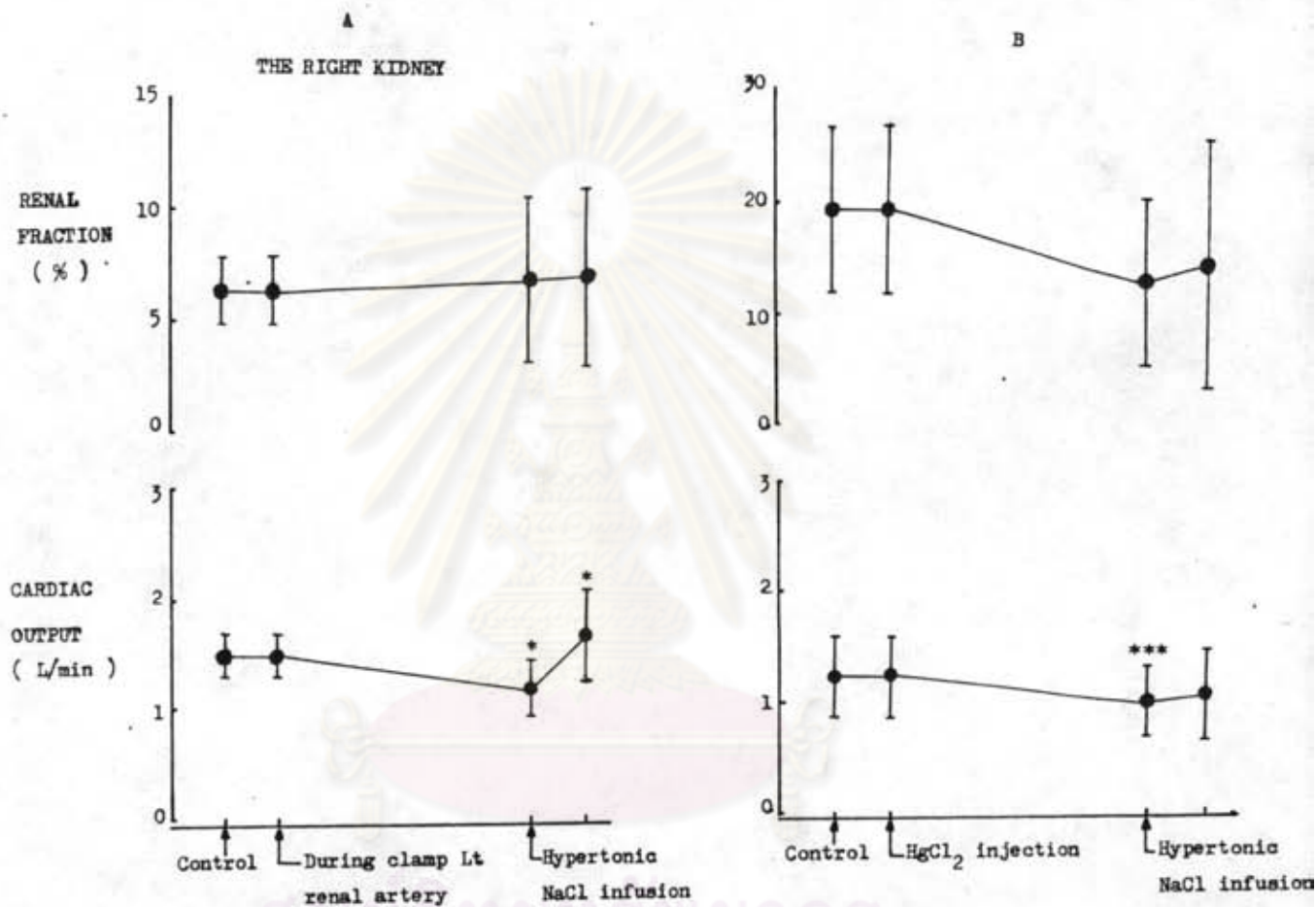


FIGURE 2 Effects of hypertonic saline infusion on renal fraction and cardiac output of ischemic dogs compared with HgCl₂ treated dogs. A, ischemic dogs. B, HgCl₂ treated dogs. * $p < 0.05$, *** $p < 0.005$

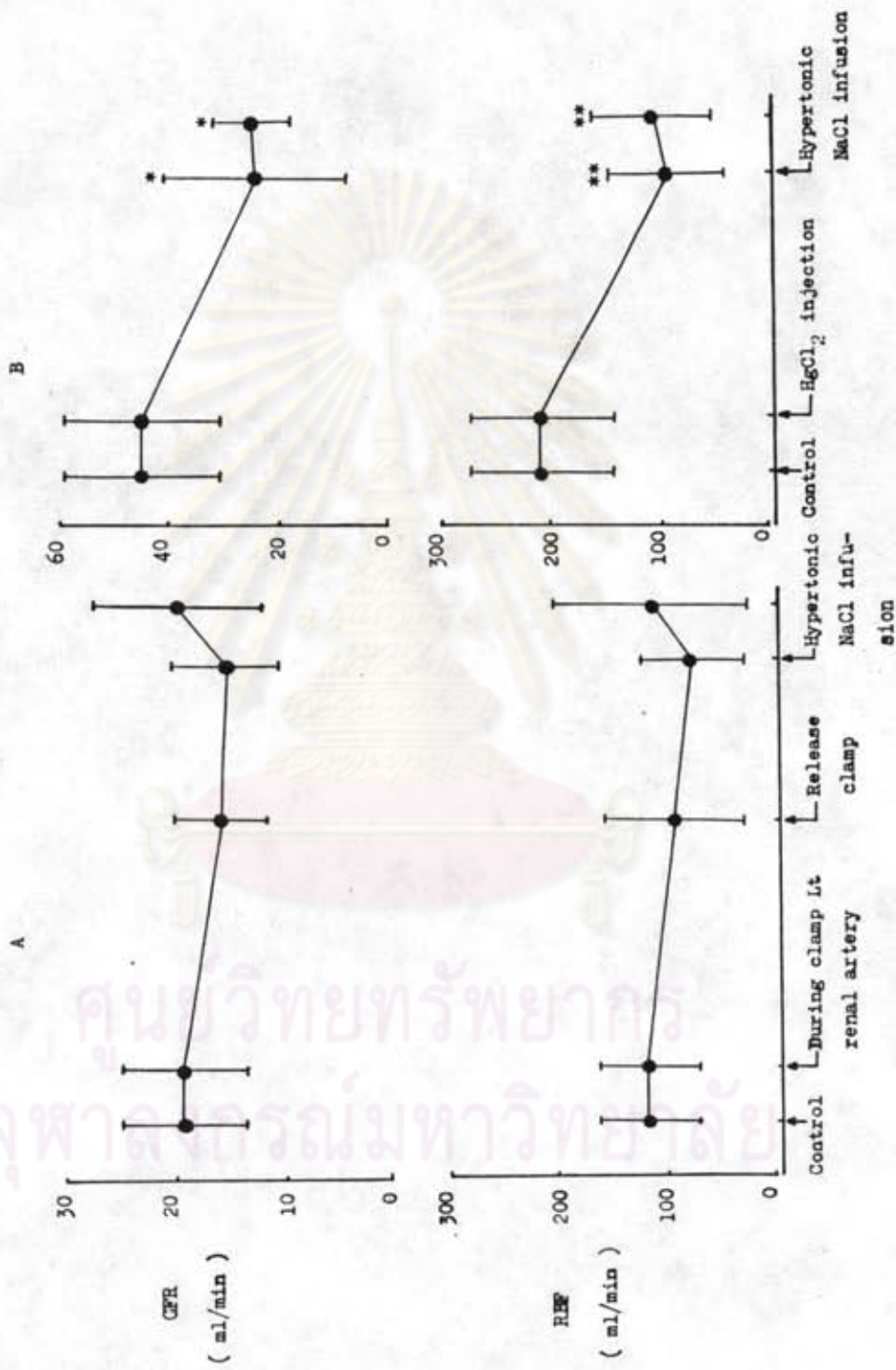


FIGURE 3 Effects of hypertonic saline infusion on RBF and CFR in right control kidney of ischemic dogs compared with HgCl₂ treated dogs. A, ischemic dogs. B, HgCl₂ treated dogs. * p < 0.05 , ** p < 0.01

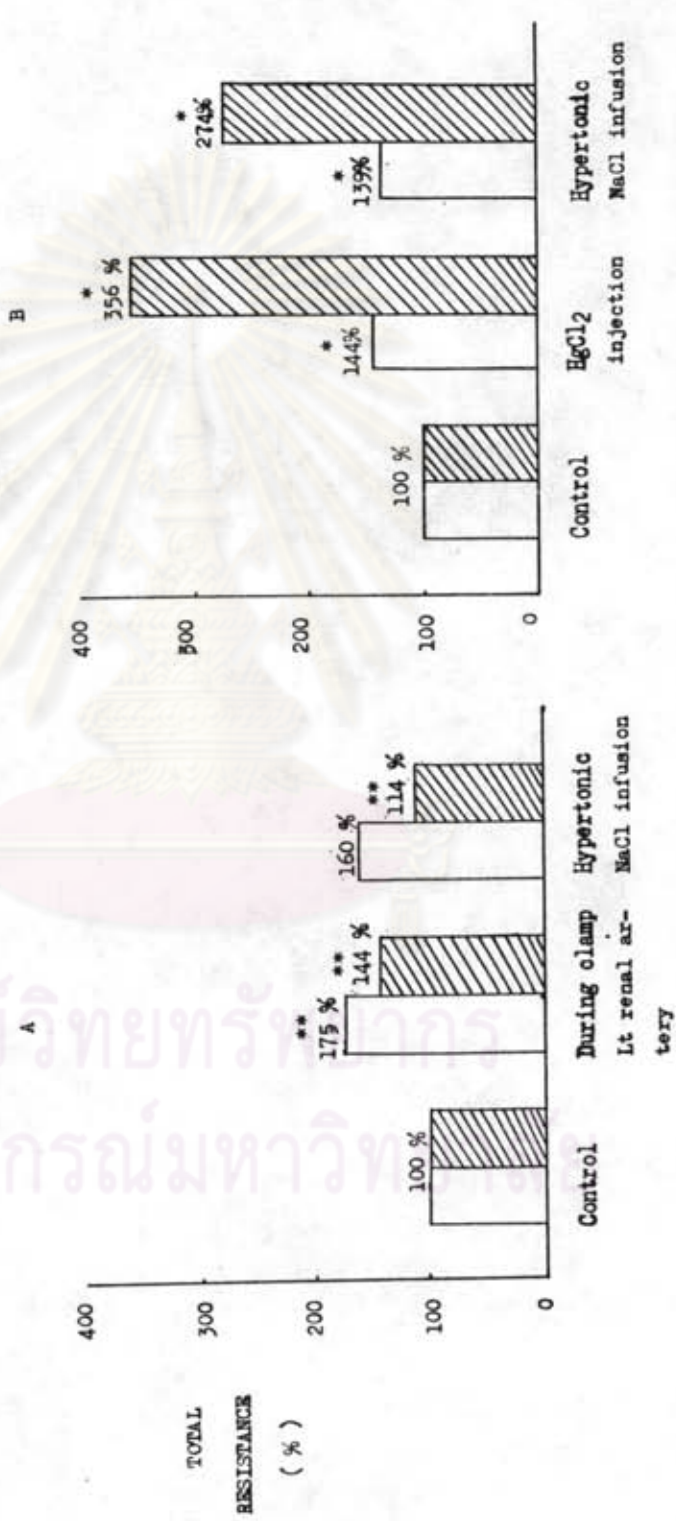


FIGURE 4 Effects of hypertonic saline infusion on total peripheral resistance (TPR, □) and renal vascular resistance (RVR, ▨) of ischemic dogs compared with HgCl₂ treated dogs. A, TPR and HR of ischemic dogs. B, TPR and HR of HgCl₂ treated dogs. * p < 0.05, ** p < 0.01

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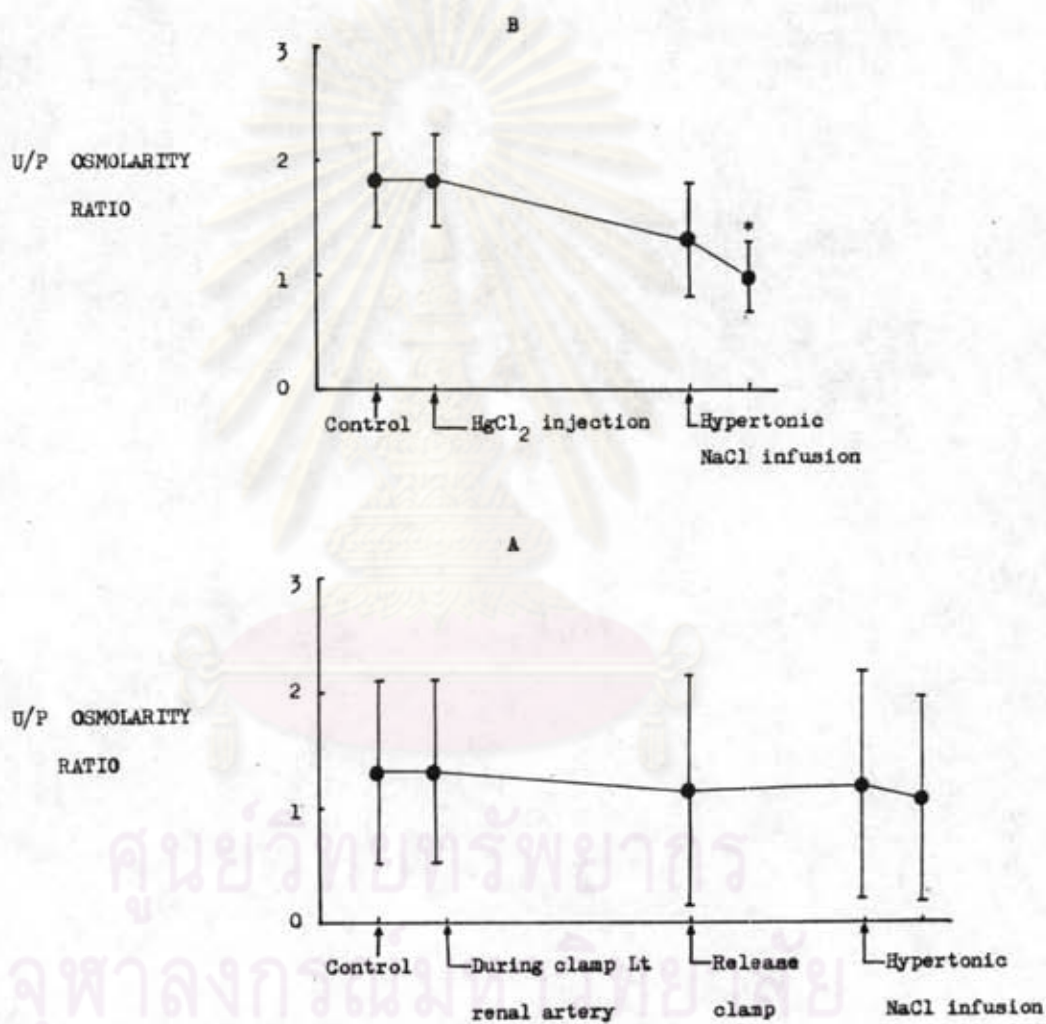


FIGURE 5 Effects of hypertonic saline infusion on U/P osmolarity ratio of ischemic dogs compared with HgCl₂ treated dogs. A, right kidney of ischemic dogs. B, HgCl₂ treated dogs. * $p < 0.05$

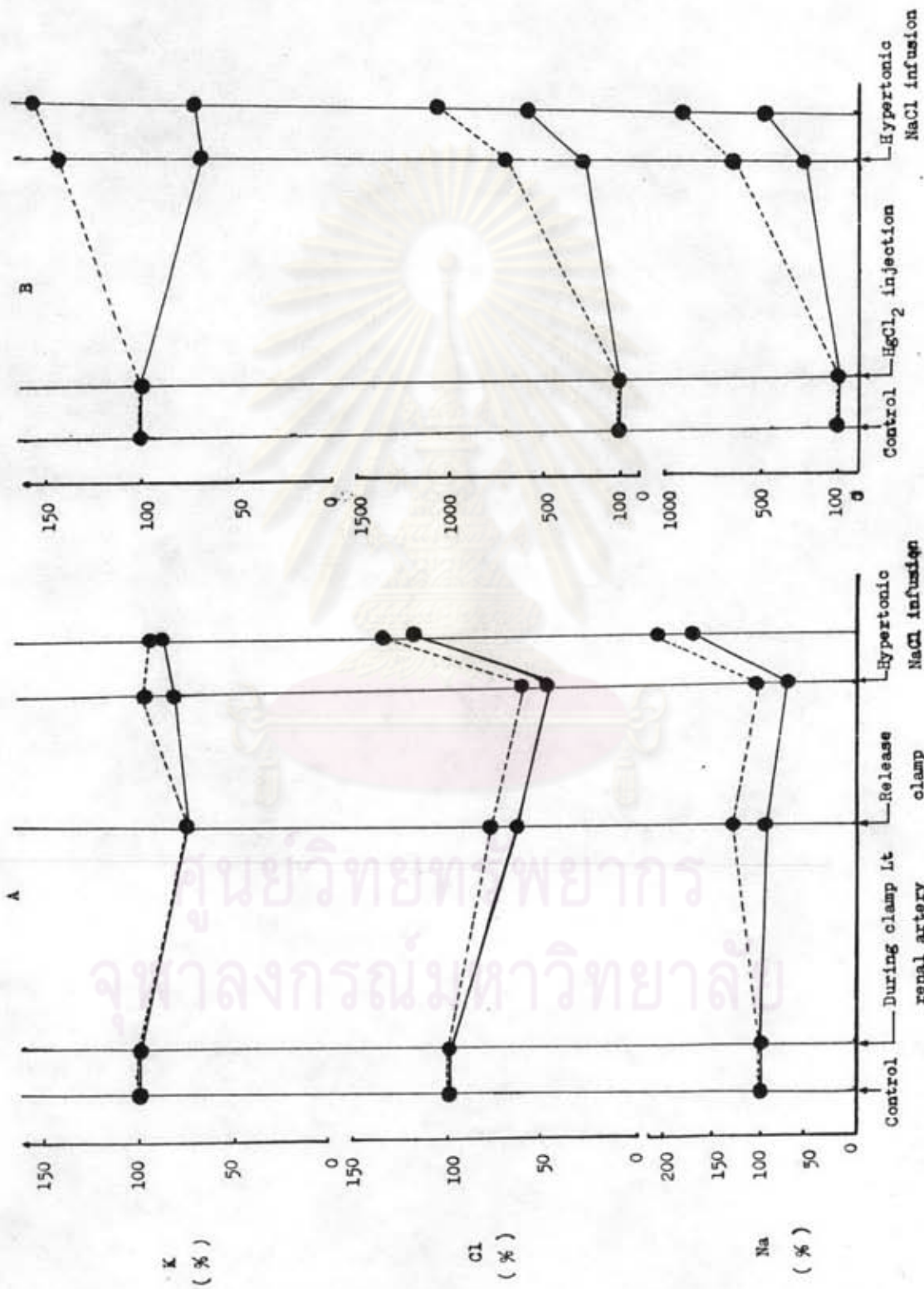


FIGURE 6 Effects of hypertonic saline infusion on urinary excretion of electrolytes (—) and fractional excretion of electrolytes (----) of ischemic dogs compared with HgCl₂ treated dogs. A, right kidney of ischemic dogs. B, HgCl₂ treated dogs.