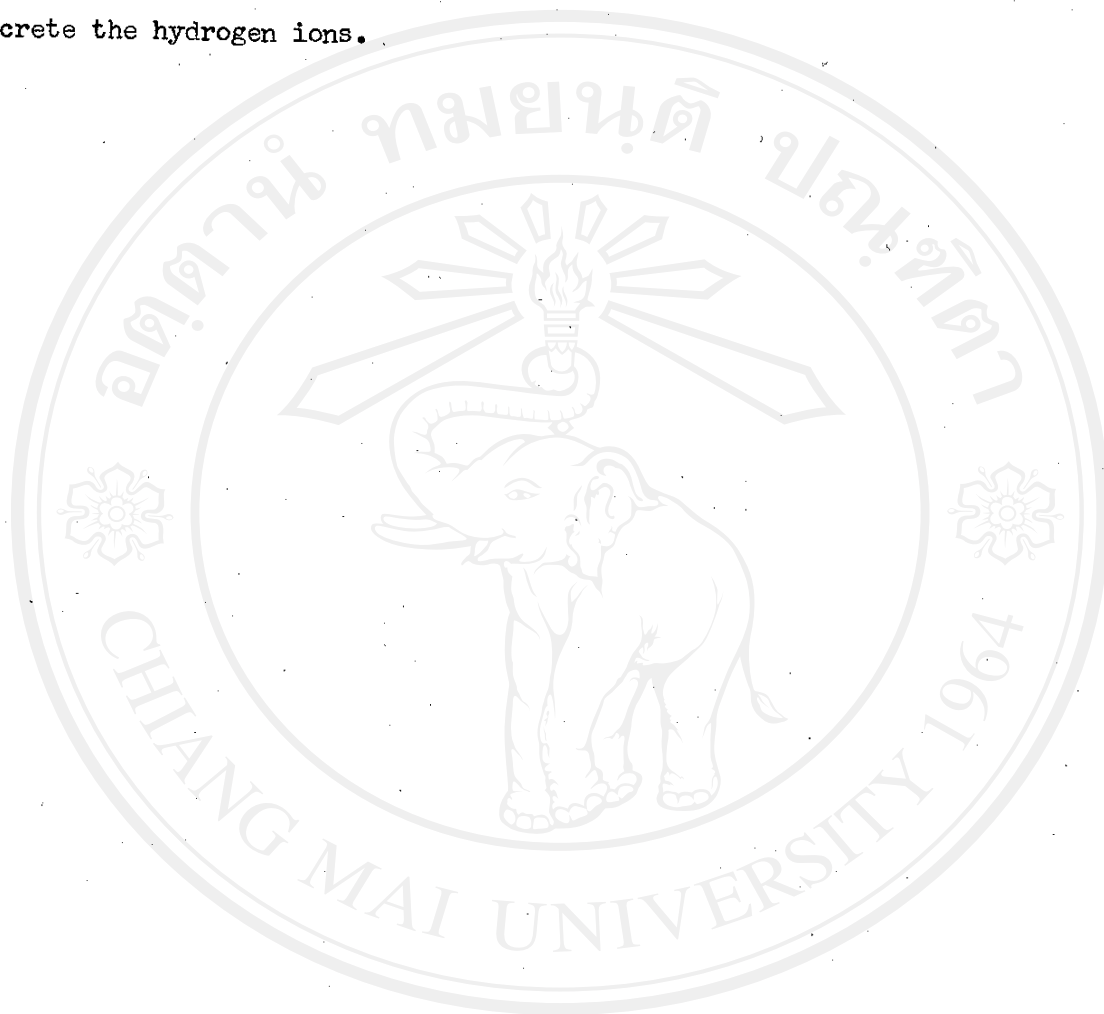


## SUMMARY

The effect of renal hypothermia on renal function and acute renal compensatory adaptation were studied in dogs. The animals were divided into 3 groups. The first group was renal hypothermic group which renal cooling was performed during one-hour occlusion of the left renal artery and vein. Intrarenal temperature of the left kidney was decreased to approximately 8-12 °C with iced-saline. In the second group, renal normothermic group, the similar technique was performed but no iced-saline was applied. In the third group, acute renal compensatory group, the compensatory adaptation of the right kidney was determined during occlusion of the left renal artery and vein.

The results show that in the first group, after releasing of the occlusion and removal of iced-saline, RPF and GFR significantly decrease to approximately 60 and 63 per cent, respectively, while urine flow rate is relatively constant throughout the experiment. In the second group, these parameters markedly decrease to approximately 15 per cent of controls. These values are significantly lower than those of the first group. In renal compensatory group, GFR, solute and water excretions, and potassium excretion are all relatively constant throughout the experimental period. The plasma urea nitrogen and potassium concentrations tend to increase above the controls. The urine pH seems to be the only one parameter of the acute renal compensatory response. It decrease significantly from the control even at the early period of the study.

The results indicate that renal cooling may prevent renal damages resulting from renal ischemia, and the first event of renal compensatory responses may be an acceleration of tubular activity to secrete the hydrogen ions.



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## BIBLIOGRAPHY

- Addis, T. and Lew, W.: The restoration of loss organ tissue. The rate and degree of restoration. *J. Exp. Med.* 71:325-333, 1940.
- Allen, R.B. and Mann, F.C.: Experiments on compensatory renal hypertrophy. *Arch. Pathol.* 19:341-363, 1935.
- Arataki, M.: Experimental researches on the compensatory enlargement of the surviving kidney after unilateral nephrectomy (albino rat). *Amer. J. Anat.* 36:437-450, 1926.
- Bickford, R.C. and Winton, F.R.: The influence of temperature on the isolated kidney of the dog. *J. Physiol.* 89:198-219, 1937.
- Birkeland, S., Vogt, A., Krog, J. and Semb, C.: Renal circulatory occlusion and local cooling. *J. Appl. Physiol.* 14:227, 1959.
- Bogardus, G.M. and Schlosser, R.J.: The influence of temperature upon ischemic renal damage. *Surgery* 39:970-974, 1956.
- Bollman, J.L. and Mann, F.C.: Compensatory hypertrophy of the remaining kidney after nephrectomy following transplantation of its ureter into the duodenum. *Arch. Pathol.* 19:28-33, 1935.
- Braun-Menendez, E.: Evidence for renotropin as a causal factor in renal hypertension. *Circulation* 17:696, 1958.
- Brun, C.: A rapid method for the determination of para-aminohippuric acid in kidney function tests. *J. Lab. Clin. Med.* 37:955-958, 1951.

- Bugge-Asperheim, B. and Kiil, F.: Examination of growth-mediated changes in hemodynamics and tubular transport of sodium, glucose and hippurate after nephrectomy. *Scand. J. Clin. Lab. Invest.* 22:255-265, 1968.
- Chopra, D.P. and Simnett, J.D.: Demonstration of an organ-specific mitotic inhibitor in amphibian kidney. *Exp. Cell Res.* 58:319, 1969.
- Coe, F.L., Suki, W.N., Kurtzman, N.A., Rector, F.C.Jr. and Seldin, D.W.: The mechanism of natriuresis immediately following unilateral nephrectomy. *Clin. Res.* 16:380, 1968.
- Diethelm, A.G.: Effect of ischemic upon the renal microcirculation. I. Preliminary observations. *Amer. Surg.* 35:833-835, 1969.
- Donadio, J.V., Farmer, C.D., Hunt, J.C., Tauxe, W.N., Hallenback, G.A. and Shorter, R.G.: Renal function in donors and recipients of renal allotransplantation. *Ann. Intern. Med.* 66:105, 1967.
- Dottori, O., Ekestrom, S. and Hanssen, L.O.: Local cooling of the kidney using perfusion technique. Animals experimental studies with special regard to the type of perfusion fluid and the perfusion pressure. *Acta Chir. Scand.* 124:80-86, 1962.
- Duguid, W.P., Seright, W. and Thomson, J.D.: The effect of hypothermia on the lesion of experimental renal ischemia. *Brit. J. Surg.* 46: 273-281, 1958-9.

- Fajers, C.M.: On compensatory renal hypertrophy after unilateral nephrectomy. 2. The immediate effect of unilateral nephrectomy as judged by some renal function tests and karyometric studies in hydrated rabbits. *Acta Pathol. Microbiol. Scand.* 41:34-43, 1957.
- Fuhrman, F.A. and Field, J.: The reversibility of the inhibition of rat brain and kidney metabolism by cold. *Amer. J. Physiol.* 139:193-196, 1943.
- Fuhrman, G.J., Fuhrman, F.A. and Field, J.: Metabolism of rat heart slices with special reference to effects of temperature and anoxia. *Amer. J. Physiol.* 163:642, 1950.
- Galla, J.H., Klein-Robbenhaar, T. and Hayslett, J.P.: Influence of age on the compensatory response in growth and function to unilateral nephrectomy. *Yale J. Biol. Med.* 47:218-226, 1974.
- Goss, R.J.: Mitotic responses of the compensatory rat kidney to injections of tissue homogenates. *Cancer Res.* 23:1031, 1963.
- Halliburton, I.W. and Thomson, R.Y.: The effect of diet and of unilateral nephrectomy on the composition of the kidney. *Cancer Res.* 27:1632-1638, 1967.
- Hardaway, R.M., McKay, D.G. and Hollowell, O.W.: Vascular spasm and disseminated intravascular coagulation. *Arch. Surg.* 83:173-180, 1961.
- Harper, A.M., Bain, W.H., Glass, H.I., Glover, M.M. and Mackay, W.M.: Temperature differences in organs and tissues with observations in profound hypothermia. *Surg. Gynec. Obstet.* 112:519-525, 1961.

- Hinshaw, L.B., Page, B.B., Emerson, T.E.Jr. and Brake, C.M.: Intrarenal hemodynamics following release of acute renal artery occlusion. Fed. Proc. 22:172, 1963.
- Hogeman, O.: Clearance tests in renal disorders and hypertension. Acta Med. Scand. 132:1, 1948.
- Jackson, C.M. and Shiels, M.: Compensatory hypertrophy of the kidney during various periods after unilateral nephrectomy in very young albino rats. Anat. Rec. 36:221-237, 1928.
- Johnson, H.A. and Roman, J.M.V.: Compensatory renal enlargement. Hypertrophy versus hyperplasia. Amer. J. Pathol. 49:1-13, 1966.
- Karsner, H.T., Hanzal, R.F. and Moore, R.A.: Urea clearance after unilateral nephrectomy in dogs. Arch. Pathol. 17:46-49, 1934.
- Katz, A.I.: Renal function immediately after contralateral nephrectomy: Relation to the mechanism of compensatory kidney growth. Yale J. Biol. Med. 43:164-172, 1970.
- Katz, A.I. and Epstein, F.H.: Relation of glomerular filtration rate and sodium reabsorption to kidney size in compensatory renal hypertrophy. Yale J. Biol. Med. 40:222-230, 1967.
- Kauker, M.L., Lassiter, W.E. and Gottschalk, C.W.: Micropuncture study of effects of urea infusion on tubular reabsorption in the rat. Amer. J. Physiol. 219:45-50, 1970.

- Kerr, W.K., Kyle, V.N., Keresteci, A.G. and Smythe, C.A.: Renal hypothermia. *J. Urol.* 84:236-242, 1960.
- Kohler, B.: The prognosis after nephrectomy. A clinical study of early and late results. *Acta Chir. Scand.* 91:(Suppl. 94), 1944.
- Krohn, A.G., Peng, B.B.K., Antell, H.I., Stein, S. and Waterhouse, K.: Compensatory renal hypertrophy: The role of immediate vascular changes in its production. *J. Urol.* 103:564-568, 1970.
- Kulka, R.G.: Colorimetric estimation of ketopentose and ketohexoses. *Biochem. J.* 63:542-548, 1956.
- Levy, M.N.: Oxygen consumption and blood flow in the hypothermic perfused kidney. *Amer. J. Physiol.* 197:1111-1114, 1959.
- Levy, S.E. and Blalock, A.: The effects of unilateral nephrectomy on renal blood flow and oxygen consumption of unanesthetized dog. *Amer. J. Physiol.* 122:609-613, 1938.
- Lowenstein, L.M. and Stern, A.: Serum factor in renal compensatory hyperplasia. *Science* 142:1479-1480, 1963.
- Lytton, B.: Current problems in compensatory renal growth. *Bull. N.Y. Acad. Med.* 50:1147-1156, 1974.
- Lytton, B., Schiff, M. and Bloom, N.: Compensatory renal growth: Evidence for tissue specific factor of renal origin. *J. Urol.* 101:648-652, 1969.



- Machiero, T.L., Huntly, R.T., Waddel, W.L. and Starzl, T.E.: Extracorporeal perfusion for obtaining post-mortem homografts. *Surgery* 54: 900-911, 1963.
- Malt, R.A.: Compensatory growth of the kidney. *New Engl. J. Med.* 280: 1446-1459, 1969.
- Manax, W.G., Bloch, J.H., Longerbeam, J.K. and Lillehei, R.C.: Successful 24-hour in vitro preservation of canine kidney by the combined use of hyperbaric oxygenation and hypothermia. *Surgery* 56:275-282, 1964.
- Markland, C. and Parsons, F.M.: Preservation of kidneys for homotransplantation. *Brit. J. Urol.* 35:457-480, 1963.
- Marshall, S.: Collective review: Renal compensatory hypertrophy in unilateral disease of the kidney. *Intern. Abstr. Surg.* 117:307-313, 1963.
- Martin, D.C., Smith, G. and Farced, D.O.: Experimental renal preservation. *J. Urol.* 103:681-685, 1970.
- Moore, R.A.: Number of glomeruli in kidney of adult white rat unilaterally nephrectomized in early life. *J. Exp. Med.* 50:709-712, 1929.
- Matloff, D.B. and Gowen, G.F.: Hypothermic perfusion. Protection for the ischemic kidney. *Arch. Surg.* 85:999-1003, 1962.
- Metzner, P.J. and Boyce, W.H.: Simplified renal hypothermia: An adjunct to conservative renal surgery. *Brit. J. Urol.* 44:76-85, 1972.



- Mitchell, R.M.: Renal cooling and ischemia. *Brit. J. Surg.* 46:593-597, 1959.
- Mitchell, R.M. and Woodruff, M.F.A.: The effects of local hypothermia in increasing tolerance of the kidney to ischemia. *Transplant Bull.* 4: 15-17, 1957.
- Moyer, J.H., Heider, C., Morris, G.C.Jr. and Hardley, C.: Hypothermia: III. The effect of hypothermia on renal damage resulting from ischemia. *Ann. Surg.* 146:152-166, 1957.
- Newman, H.: Renal hypothermia produced by direct application of ice. *J. Urol.* 89:319-324, 1963.
- Ogawa, K. and Nowinski, W.W.: Mitosis stimulating factor in serum of unilaterally nephrectomized rats. *Proc. Soc. Exp. Biol. Med.* 99: 350-354, 1958.
- Ogden, D.A.: The effect of unilateral nephrectomy on renal function in man. *Amer. Heart J.* 73:434-435, 1967.
- Oliver, J., MacDowell, M. and Tracey, A.: The pathogenesis of acute renal failure associated with traumatic and toxic injury. Renal ischemia, nephrotoxic damage and ischemic episode. *J. Clin. Invest.* 30: 1307-1440, 1951.
- Perlmutter, J.H.: Renal compensation during mild water diuresis and its inhibition by vagotomy. *Proc. Soc. Exp. Biol. (N.Y.)* 125:696-700, 1967.

- Peters, G.: Compensatory adaptation of renal functions in the unanesthetized rat. *Amer. J. Physiol.* 205:1042-1048, 1963.
- Pfeiffer, C. A. and Gardner, W. V.: Renal hypertrophy in mice receiving estrogens and androgens. *Yale J. Biol. Med.* 12:493, 1940.
- Pitts, R.F. and Alexander, R.S.: The nature of the renal tubular mechanism for acidifying the urine. *Amer. J. Physiol.* 144:239, 1945.
- Porch, P.P.Jr., Chamberlain, N.O. and Edwards, W.H.: The effects of temporary renal vascular occlusion in dogs. *Surg. Forum.* 10:892-895, 1960.
- Potter, D., Sakai, T., Harrah, J. and Holliday, M.A.: Renal function and structure within 18 hours following uninephrectomy. *Clin. Res.* 17:169, 1969.
- Preuss, H.G., Terryi, E.E. and Keller, A.I.: Renotropic factor(s) in plasma from uninephrectomized rats. *Nephron.* 7:459, 1970.
- Rama Raju, B.V., Prakash, Atm., Kapur, M. and Gulati, S.M.: Acute renal ischemia and the effect of local hypothermia on the histological changes. An experimental study. *Indian J. Med. Res.* 57:925-931, 1969.
- Rheinlander, H.F. and Wallace, H.W.: The effects of coronary artery perfusion on myocardial metabolism during hypothermic cardiac arrest. *Surgery* 52:47-54, 1962.

- Rhoads, C.P., Alving, A.S., Hiller, A. and Van Slyke, D.D.: Functional effect of explanting one kidney and removing other. *Amer. J. Physiol.* 109:329-335, 1934.
- Rollason, H.D.: Compensatory hypertrophy of kidney of young rat with special emphasis on role of cellular hyperplasia. *Anat. Rec.* 104: 263, 1949.
- Ross, J. and Goldman, J.K.: Compensatory renal hypertrophy in hypophysectomized rats. *Endocrinology* 87:620-624, 1970.
- Rous, S.N. and Wakim, K.G.: Kidney function before, during and after compensatory hypertrophy. *J. Urol.* 98:30-35, 1967.
- Schloerb, P.R., Waldorf, R.D. and Welsh, J.S.: The protective effect of kidney hypothermia on total renal ischemia. *Surg. Forum.* 8:633-635, 1957.
- Schloerb, P.R., Waldorf, R.D. and Welsh, J.S.: The protective effect of kidney hypothermia on total renal ischemia. *Surg. Gynec. Obstet.* 109:561-565, 1959.
- Selkurt, E.E.: The changes in renal clearance following complete ischemia of the kidney. *Amer. J. Physiol.* 144:395-403, 1945.
- Semb, C.: Partial resection of the kidney : Anatomical, physiological, and clinical aspects. *Ann. Roy. Coll. Surg. Engl.* 19:137, 1956.

- Semb, G., Krog, J. and Johansen, K.: Renal metabolism and blood flow during local hypothermia, studied by means of renal perfusion in situ. Acta Chir. Scand. 253:196-202, 1960.
- Sheehan, H.L. and Davis, J.C.: Renal ischemia with failed reflow. J. Pathol. Bact. 78:105-120, 1959.
- Shipley, R.E. and Study, R.S.: Changes in renal blood flow, extraction of inulin, glomerular filtration rate, tissue pressure and urine flow with acute alterations of renal artery blood pressure. Amer. J. Physiol. 167:676-688, 1951.
- Steels, P. and Borghgraef, R.: Functional adaptation during renal compensatory growth. Arch. Int. Physiol. Biochim. 80:165-167, 1972.
- Steinmetz, P.R. and Bank, N.: Effects of acute increases in the excretion of solute and water on renal acid excretion in man. J. Clin. Invest. 42:1142-1149, 1963.
- Stueber, P., Kovacs, S., Koletsky, S. and Persky, L.: Regional renal hypothermia. Surgery 44:77-83, 1958.
- Thompson, J.W. and Lytton, B.: Compensatory renal hypertrophy in parabiotic rats. J. Urol. 98:548-551, 1967.
- Van Slyke, D.D., Rhoads, C.P., Hiller, A. and Alving, A.S.: Relationships between urea excretion, renal blood flow, renal oxygen consumption and diuresis. The mechanism of urea excretion. Amer. J. Physiol. 109:336-374, 1934.

Verney, E.B. and Vogt, M.: Observations on the effects of renal ischemia upon arterial pressure and urine flow in the dog. *Quart. J. Exp. Physiol.* 32:35-65, 1943.

Vroonhoven, T.J.van, Soler-Montessinas, L. and Malt, R.A.: Humoral regulation of renal mass. *Surgery* 72:300-305, 1972.

Welsh, C.A.: Changes in renal function accompanying the hypertrophy of the remaining kidney after unilateral nephrectomy. *J. Clin. Invest.* 23:750-754, 1944.

Wickham, J.E.A., Hanley, M.G. and Joekes, A.M.: Regional renal hypothermia. *Brit. J. Urol.* 39:737-743, 1967.

Williams, G.E.G.: Studies on the control of compensatory hyperplasia of the kidney in the rat. *Lab. Invest.* 11:1295-1302, 1962.

Wilson, G.S.M.: Clinical experience in renal hypothermia. *J. Urol.* 89: 666-669, 1963.

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