C-TYPE NATRIURETIC PEPTIDE DOES NOT INCREASE RENAL CHLORIDE EXCRETION IN SQUALUS ACANTHIAS

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In mammals, natriuretic peptides increase the renal excretion of sodium, chloride, and water. These effects are mediated by hemodynamic changes which increase glomerular filtration rate and therefore sodium delivery to the nephron and by inhibition of sodium reabsorption, particularly in the terminal portion of the collecting tubule. We have recently described the effects of C-type natriuretic peptides (CNP) on the function of the shark rectal gland (Solomon et al, Am. J. Physiol., 262: R707, 1992). It appears that this class of natriuretic peptide is the only member for which mRNA has been found in shark tissue (Schofield et al, Am. J. Physiol. 261: F734, 1991). As the effects of CNP in the rectal gland suggest an important role in salt and water homeostasis, it was important to determine whether this peptide also contributed to renal salt and water excretion.

Live male sharks were gently restrained in a tank with running seawater and given 500 units of heparin sulfate intravascularly. Two PE90 catheters were placed in the dorsal aorta, one for measurement of mean arterial pressure via manometry and the second for the perfusion of an explanted rectal gland. The explanted rectal gland was perfused using blood from the donor fish as described previously (Solomon et al, Am. J. Physiol. 246: R63, 1984). A PE90 catheter was inserted into the urinary bladder via the renal papilla and secured with a purse string suture. Urine and rectal gland secretions were collected at 30 minute intervals. Bladder emptying was accomplished by gentle suction on the catheter at the end of each collection period. Blood perfusing the rectal gland was collected and returned to the donor animal. Urine and rectal gland fluid chloride concentration was measured and the rate of chloride excretion (urine) and chloride secretion (rectal gland) calculated. Three to four baseline collections, each of 30 minutes duration, were made to establish a stable control period. pCNP (porcine CNP 1-22) was then given as a bolus of 15 μg/kg wt of donor fish. Mean arterial pressure, renal chloride excretion and rectal gland chloride secretion were followed for an additional 4 collection periods.

Five animals completed the protocol. The bolus injection of pCNP resulted in an increase in rectal gland chloride secretion evident in the first 30 minutes. Chloride secretion continued to rise through 90 minutes. At 120 minutes after the injection of pCNP, rectal gland chloride secretion was still approximately 3 fold greater than the basal secretory rate (Figure 1). During this same interval of time, no change in renal chloride excretion was observed. Urine flow rate remained constant and there was no consistent change in the concentration of chloride in the urine (between 60-90 mEq/l).

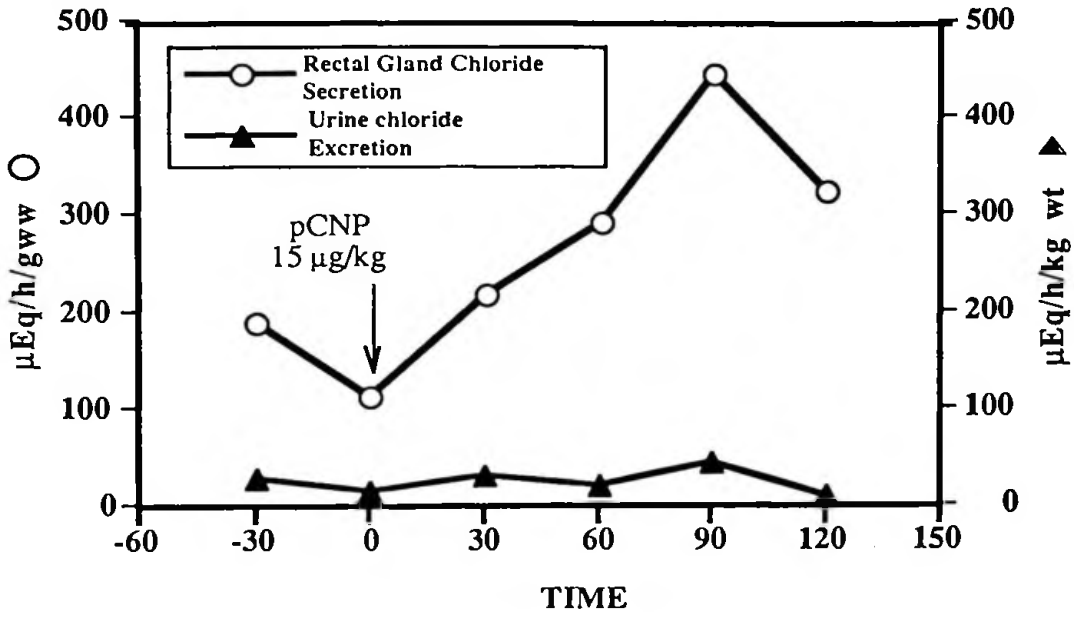

FIGURE 1.

During this same time period, mean arterial pressure fell from 17.0±1.1 mmHg to 14.7±1.6 mmHg at 30 minutes and remained depressed for the remainder of the period of observation (13.5±1.6 at 120 minutes). The initial pressure perfusing the rectal gland was higher than systemic pressure because we set the rectal gland below the level of the donor animal. This pressure was necessary to maintain adequate rectal gland blood flow. Initial pressure was 32.4 mmHg±3.2, fell to 28.2±2.6 at 30 minutes and remained depressed at 27.5±3.9 at 120 minutes.

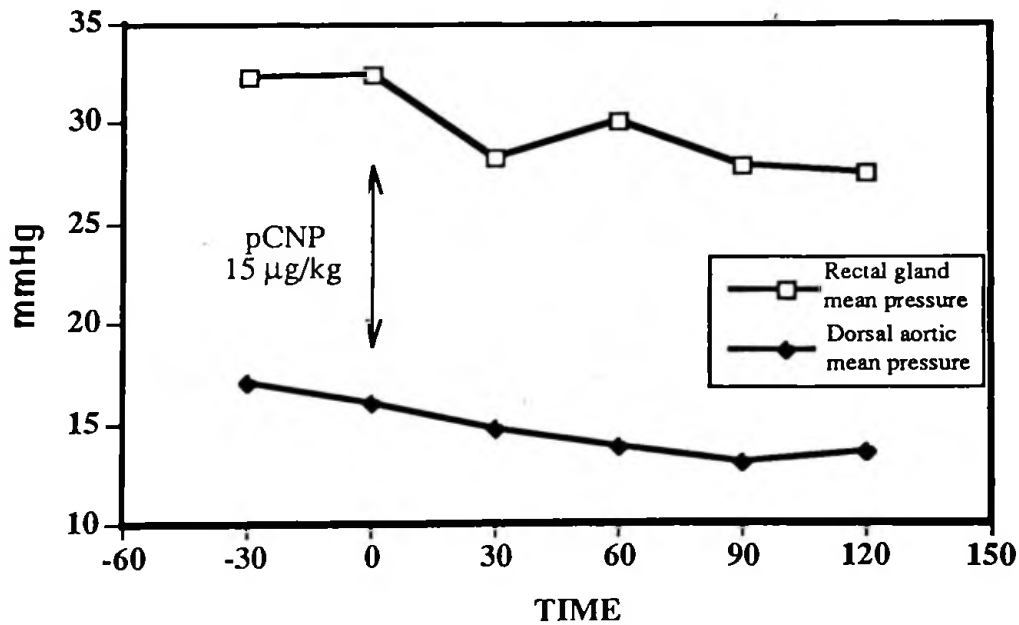

FIGURE 2.

These observations confirm our previous report that natriuretic peptides in the shark affect vascular tone and rectal gland function but have little effect on renal function. In our previous report, ANP, 10 μg/kg bolus, was associated with a fall in systemic pressure (18.2±1.8 to 14.6±.05 mmHg), a four fold increase in rectal gland chloride secretion, and no change in urinary volume (Solomon et al, Am. J. Physiol. 249: R348, 1985). Similar effects of pCNP are noted in the present study.

The reason for the lack of effect of natriuretic peptides (ANP and CNP) on renal function in the shark is unclear. One possibility is that the receptor for ANP and pCNP is not present in renal tissue. This possibility has not been directly tested. Alternatively, ANP and pCNP may have effects on renal function but these effects are too small to be detected under basal conditions. When the kidney is stimulated to increase salt and water excretion, the effect of inhibition of sodium/chloride reabsorption by natriuretic peptides becomes evident. Support for this latter explanation is the observation that ANP increases renal sodium and water excretion in animals subjected to a dilute seawater environment (Solomon et al, Bull. MDIBL 27: 18, 1988. Under these experimental conditions, there is an increase in glomerular filtration rate and an increase in sodium delivery to the nephron (Benyajati and Yokota, Bull. MDIBL 27: 56, 1988).

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