SHORT COMMUNICATION

ACUTE EFFECTS OF NEUROGENIC STRESS ON URINARY ELECTROLYTE EXCRETION

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Summary : Plasma Cortisol and urinary excretion of water, sodium, potassium, calcium and magnesium have been studied in the rat after application of 2 types of neurogenic stress :— (a) tight rubber band tourniquet and (b) electric shock. Plasma cortisol levels increased significantly after application of either type of stress. During both type of stress, there was statistically significant increase in the urinary excrerion of water, sodium and calcium but not of potassium and magnesium. Urinary calcium/magnesium ratio was also significantly elevated. The results suggest that stress may be one of the factors involved in the genesis of urolithiasis.

Key words : stress, sodium, magnesium, calcium, cortisol, urolithiasis

INTRODUCTION

Urolithiasis is highly prevalent in north-western India as well as in many other parts of the world. Inspite of extensive studies in India and abroad, it is still not clear why, in endemic areas, concretions develop in some persons but not in others. Stress, on clinical grounds, has been considered as one of the etiological factors (4, 5), but little experimental evidence is available in support of the hypothesis. This study was conducted in the rat to observe whether exposure to stress produces any alterations in the urine conducive to calculogenesis.

MATERIAL AND METHODS

The study was conducted on female rats weighing 200-250 *g* each. The rat was anesthetised by intraperitoneal injection of 30-40 *mg/kg* nembutal. Throughout the experiment normal saline was infused into a tail vein at the rat of 5 *ml/hr* with the help of continuous slow injector (INCO). A fine polyethylene catheter was introduced into the bladder and tied at the urethra. After allowing 90 min for equilibration, six 30 min urine samples were collected, i.e. two basal samples, one during 30 min of stress and 3 samples subsequently. Each sample was analysed for volume, sodium and potassium by flame photometry, magnesium by the method of Orange and Rhein (14) and calcium by the method of Connerty and Briggs (6). Three intracardiac blood samples were taken, just before and after application of the stress and another 90 min later. Plasma was analysed for cortisol level by the enzyme immunoassay (ELISA) technique according to the principle of Engval and Perlmann (8).

Neurogenic stress was produced in the rat by two methods (i) Application of a 3 *mm* thick rubber band tourniquet on a hind leg just above the ankle joint for 30 min. The rubber band was tied tight enough to produce visible ischemia of the foot (1). (ii) Application of three electric shocks (12 volts, 50 Hz, current pulse width of 5 msec.) for two minutes each at 10 minutes intervals (7).

RESULTS

Plasma cortisol level increased significantly ($P<0.001$) after application of either type of neurogenic stress and declined subsequently (Table I).

TABLE I : Effect of stress on plasma cortisol (mean±SE). Plasma samples were obtained before (A), just after (B) and 90 minutes after application of stress (C).

Stress	*Plasma cortisol µg/100 ml*		
	(A)	(B)	(C)
Rubber band tourniquet (n=6)	12.30±1.22	25.12±1.92*	13.92±1.32
Electric shock (n=6)	10.33±1.18	38.52±3.06*	12.66±1.74

*P = ∠0.001, paired 't' test

Application of both types neurogenic stress resulted in a significant increase in Urinary volume (Fig 1, 2). The change in urinary out-put was discernable within 5 min of the exposure to stress. During the period of stress there was a statistically significant increase in urinary excretion of sodium and calcium but the increase in potassium and megnesium did not reach significant level (Fig. 1, 2). Consequently, whereas urinary sodium/calcium ratio remained unchanged, urinary calcium/megnesium ratio was significantly elevated ($P<0.05$).

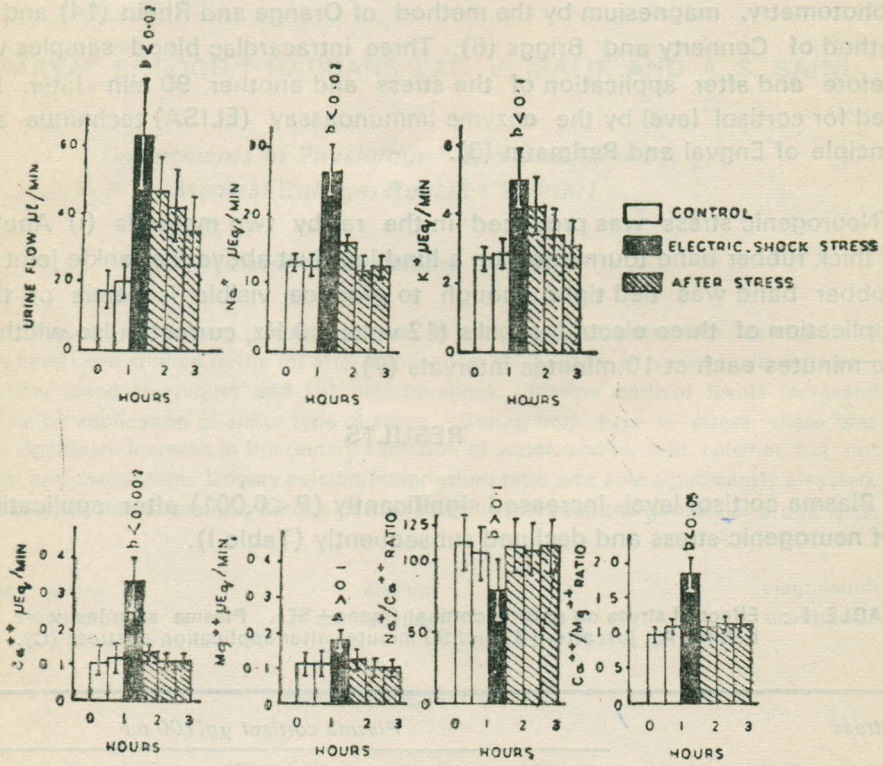

Fig. 1 : Effect of electric shock stress on urinary water and electrolyte excretion (mean ± SE, n=10).

DISCUSSION

The results of plasma cortisol estimation support the contention of Allen *et al.* (1) that rubber band tourniquet is simple and effective way of producing stress in small animals. The usual biochemical response to stress i.e. increased plasma levels of ACTH,

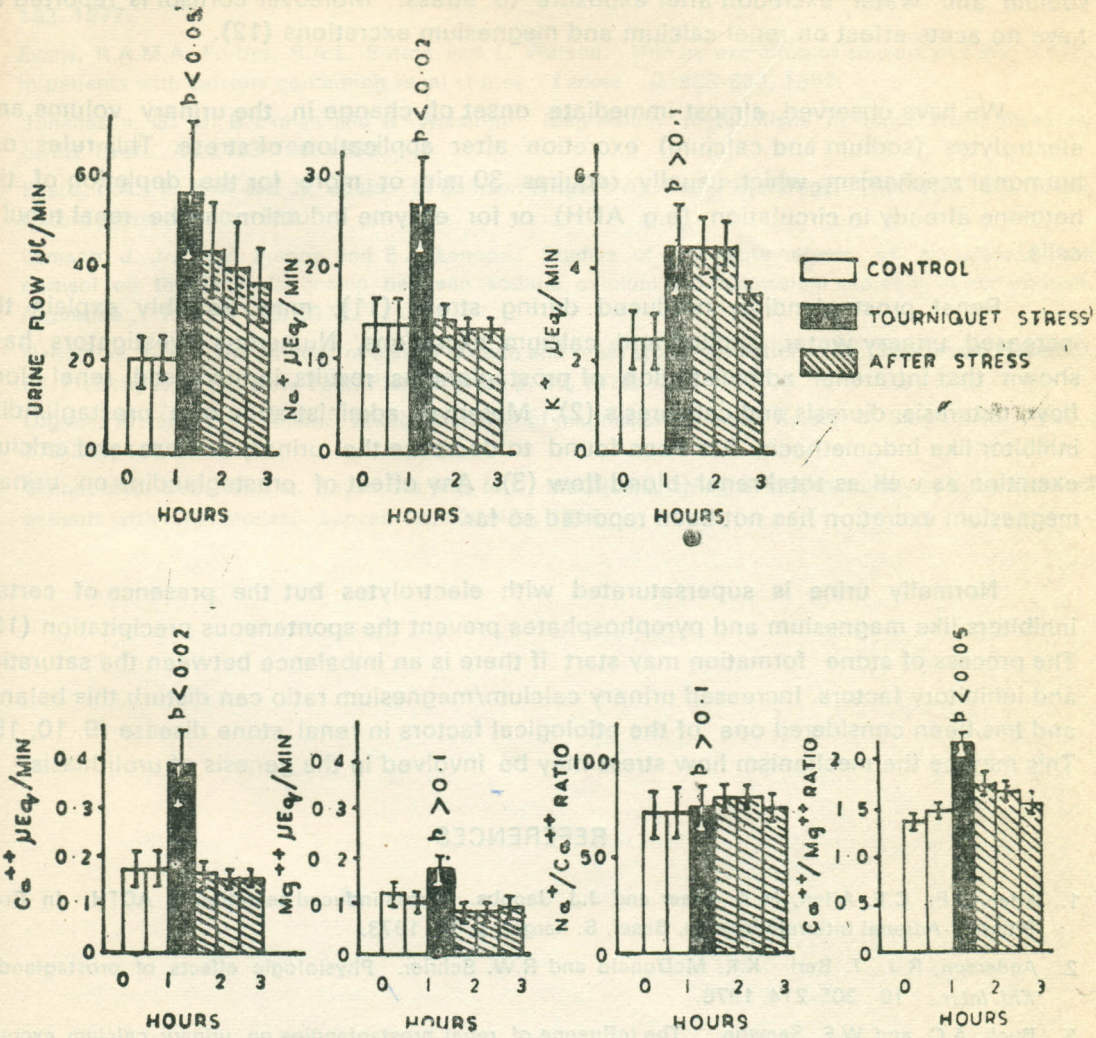

Fig. 2 : Effect of rubber band tourniquet stress on urinary water and electrolyte execretion (mean ± SE, n=10).

Cortisol & triglycerides, has been observed after application of rubber band tourniquet (1).

Elevated cortisol level however can not explain the urinary changes since corticosteroids produce sodium and water retention whereas we observed increased uninary

sodium and water excretion after exposure to stress. Moreover cortisol is reported to have no acute effect on renal calcium and megnesium excretions (12).

We have observed almost immediate onset of change in the urinary volume and electrolytes (sodium and calcium) excretion after application of stress. This rules out hormonal mechanism which usually requires 30 min or more for the depletion of the hormone already in circulation (e.g. ADH) or for enzyme induction in the renal tubular cells.

Renal prostaglandins, produced during stress (11), may possibly explain the increased urinary water, sodium and calcium excretions, Numerous investigators have shown that intrarenal administration of prostaglandins results in increased renal blood flow, naturesis, diuresis and calciuresis (2). Mereover, administration of a prostaglandin-inhibitor like indomethacin has been found to decrease the urinary sodium and calcium excretion as well as total renal blood flow (3). Any effect of prostaglandins on urinary megnesium excretion has not been reported so far.

Normally urine is supersaturated with electrolytes but the presence of certain inhibitors like magnesium and pyrophosphates prevent the spontaneous precipitation (13). The process of stone formation may start if there is an imbalance between the saturation and inhibitory factors. Increased urinary calcium/magnesium ratio can disturb this balance and has been considered one of the etiological factors in renal stone disease (9, 10, 15). This may be the mechanism how stress may be involved in the genesis of urolithiasis.

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