Plasma Potassium and Blood pH following Physical Exercise in Dialysis Patients

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Dear Sir,

It is a known fact that under physical strain man experiences an increase of plasma potassium, possibly due to an efflux of K^+ ions from the working muscle [1, 5-7, 10]. After the physical strain has ceased, the plasma potassium level quickly returns to its original value. While the K^+ output is the main factor responsible for the K^+ steady state, quick changes in concentration are controlled by extrarenal mechanisms [3, 8].

The hyperkalemia which can often be observed in dialysis patients is not the result of an increase in potassium of the whole body, but is due to a disordered extrarenal regulation [8]. It is a known fact, that dialysis patients do not tolerate K^+ strain very well. Since an acute metabolic acidosis depolarizes the cell membrane through an increase in intracellular Na^+ and a decrease in intracellular K^+ , thus causing a disruption of the membrane transport, the risk of hyperkalemia in chronic renal insufficiency is considerably increased [2, 8].

Dialysis patients tend to have an acidotic metabolic state. Since severe physical strain leads to a drastic reduction of the blood pH, the aim of the investigation was to find out how dialysis patients tolerate physical strain as regards plasma potassium.

For this purpose, 17 male dialysis patients, who have been undergoing hemodialysis for an average of 4.8 years (3×5 h/week), and 17 healthy, untrained males were subjected to gradually increasing strain on a bicycle ergometer until subjective exhaustion was signalled or another reason for stopping was given. The initial load was 0.7 W/kg body weight; it was raised every 6 min by 25 W.

All measurements and blood samples were taken during the last 30 s of each load step. For the purpose of taking blood samples, a butterfly was implanted prior to the start of the test into the BC fistula or a forearm vein of the test persons. Plasma potassium was determined directly from venous whole blood by means of a fully automatic analyzer (Corning 902) in accordance with the ion-selective method. The pH and blood gases were determined using capillary blood from the hyperemic earlobe by means of a fully automatic analyzer (Corning 168). The statistical test was carried out with the t test in accordance with Student. An error possibility of 5% ($p = 0.05$) was chosen as significance level. A summary of the test persons' data and exercise findings is contained in table I. These data can be compared well with those of earlier authors [1, 4].

Figure 1 shows the course of blood pH and plasma potassium of dialysis patients and controls. For the purpose of determining the plasma potassium some patients ($n = 7$) had additional blood taken from the vein situated contralaterally to the fistula arm. These values showed no significant difference to the values obtained from fistula blood. In the case of 5 patients and controls the

blood pH during recovery was additionally determined after 5, 10, and 20 min. Due to the too few random samples, a SEM was not calculated in this case.

Alone the at rest value plasma potassium of patients was higher than that of controls, and rose clearly even more under strain. In the recovery phase the K⁺ dropped steeply in both groups, even below the at rest value. While

Table I. Personal data and results of ergometry (mean ± SEM)

Age years
Weight kg
Hb
Max. HR Imp/min
Max. performance W
Rel. max performance WorkingW/kg BW duration

Patients (n=17) Controls (n= 17)

34.0 ± 3.43 32.6 ± 2.83

66.1 ± 2.81 77.1 ± 3.26

9.5: 15.5:

:0.89 :0.39

133.0 ± 8.72 171.4 ± 3.42

89.4 ± 5.80 157.0 ± 14.52

1.37 2.15:

0.09 0.20

15.4 ± 1.21 29.3 ± 3.09

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pH

• pH iK*

Patients

^,r-

pH mmol/l Controls

0 max 5 10 20 30 min

0 max 5 10 20 30 min

Exercise Recovery Exercise Recovery

Fig. 1. Course of K⁺ and pH in controls (a) and patients (b).

during the further course of recovery the K⁺ of the controls came again closer to the at rest value, the patients' K⁺ rose once more and after 30 min following exercise it had reached again a value which was significantly higher (p < 0.0005) than the at rest value. The difference in the K⁺ movement between patients and controls was highly significant (p < 0.0005).

The blood pH at rest showed no significant difference between patients and controls. However, as a sign of smaller alkaline reserves, the patients showed a significantly lower (p < 0.05) standard bicarbonate (19.9 mval/l) than controls (21.3 mval/l). As expected, under physical strain the pH of both groups decreased, and had not reached the original value even 30 min following the exercise. In controls one could notice during recovery a continuous recovery of the blood pH. In patients, on the other hand, one found a strong regulation and counterre-gulation so that one can assume the presence of a strong instability of the acid-base balance. During this, both plasma

potassium and blood pH reacted in inverted proportion and correlated closely with each other ($r = 0.96$).

The rise in plasma potassium as well as the drop in blood pH during exercise (in some cases such extreme values as 8.42 for plasma potassium or 6.875 for blood pH were reached) were tolerated quite well by the dialysis patients. As early as 1972, Osnes and Hermensen [9] reported similar blood pH values following a brief period of strain in healthy persons. However, most of the patients complained of weakness and pain in the working musculature (reason for stopping the exercise), the cause of which is probably the increased acidosis [9].

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