CHAPTER I

Introduction

Much of the metabolic energy produced by the body is used to establish high intracellular concentration of potassium (K^+) and low concentration of sodium (Na^+), the reverse of the relative concentrations of these ions in the extracellular fluids. The extrusion of sodium requires its movement against a gradient of concentration (higher outside than inside) and electrical potential (inside about 70 mV more negative than outside); work is therefore needed to overcome this electrical gradient. The transmembrane pumping of sodium and potassium that establishes these gradients has been studied intensively and is among the best understood membrane transport processes. A salient finding is that a specific enzyme in the cell membrane, the sodium and potassium-dependent adenosine triphosphatase (sodium-potassium-ATPase), is responsible for the active transport of these cations.

Essentially the same molecular machinery for the transport of sodium and potassium performs various tasks in the body. To prevent the rupture of the fragile membrane of animal cells, active extrusion of sodium helps maintain nearly complete osmotic equilibrium across the membrane. Many metabolic processes depend on a high intracellular concentration of potassium. The sodium and potassium gradients are involved in propagation of the nerve impulse, reabsorption of solutes by the kidney, uptake of nutrients by the intestine, and other functions. The cardiac glycosides responsible for the theraperutic effect of digitalis on the heart have been shown to inhibit specifically this active transport of cations. Whether a cell is specialized for electrical excitability, absorption, secretion, or any other process requiring the electrochemical energy of the ion gradients, it appears to use basically the same sodium-potassium-ATPase in its membrane. It simply adds to the membrane other components designed to use the cation gradients to carry out the business the cell. Thus, two organs that appear functionally unrelated, such as the kidney and the brain, have a striking homology on the molecular level.

As a result of physical exercise in humans, the plasma concentrations of electrolytes are elevated; this is mainly due to osmoconcentration(Coester, Elliott and Luft., 1973., Tibes, et al.,1974). However, plasma potassium increases proportionally more than the plasma level of other electrolytes during exercise, chiefly reflecting an efflux of potassium from the working skeletal muscles(Hirche, Schumacher and Hagemann., 1980., Hnik, et al., 1976., Kilburn, 1966., Tibes, Haberkorn and Hammersen., 1977.). Hespel, et al(1986) observed in athletes a decreased in intraerythrocyte potassium in blood withdrawn within 90 s after a 50-min cross-country run. This suggests that during exercise potassium is also released from the erythrocytes. The mechanism responsible for this decrease in the intraerythrocyte concentration of potassium immediately after exercise as well as the time course of the possible changes in the intraerythrocyte concentration of potassium and of other cations, such as sodium and magnesium, during and immediately after exercise is, however, not known. Hespel, et al.(1986), studied the effect of exercise on the intracellular cationic concentrations and Na-K-ATPase in 11 normal male volunteers. The conclusion of this data provide evidence that severe exercise is accompanied by a decrease of the intraerythrocyte potassium concentration, whereas the intracellular concentrations of sodium and magnesium are not altered by exercise. The mechanism responsible for the decrease of the intracellular potassium concentration during exercise remains to be explained. Furthermore, this data show that exercise does not change the activity of the erythrocyte Na-K-ATPase pump.

In Thailand, The study of Na-K-ATPase or sodium pump was first reported by Tosukhowong, et al(1992) and reveal that Northeast (NE) Thai population, who were ethnic Thai-Lao, had significantly higher concentration of erythrocyte sodium, lower serum potassium and lower activity of erythrocyte Na-K-ATPase than Central Thai population who were ethnic Central Thai or Thai-Chinese. In this study, erythrocyte Na^+ of both population groups correlated inversrely with erythrocyte Na-K-ATPase. Sudden unexplained nocturnal death is prevalent in summer among the northeasterners of Thailand. The victims are usually healthy mascular young men of low socioeconomic level who died in their sleep. The causes are perhaps multiple, including thiamine deficiency, genetic variations, cardiac conduction system defect, potassium depletion and unidentified toxic factors (Sitprija, et al., 1991). Ishiyama, et al., 1982 speculated that multiple necroses of myocardial fibers from coronary artery spasm leaded to diffusion of potassium to the circulation. The terminal event might be ventricular fibrillation. It is interesting that more than 80% of Thai workers in Singapore, who had a high incidence of sudden unexplained death syndrome, were previous native residents of NE Thailand. Therefore, high work load or exercise can lead to electrolyte imbalance and sudden death. There are no any studies of plasma electrolytes, erythrocyte Na-K-ATPase, erythrocyte sodium and erythrocyte potassium that related to exercise in Thailand.

The aim of this study is to investigate the changes in plasma electrolytes and intraerythrocyte cationic concentration during and after exercise, and whether these changes are related to changes in erythrocyte membrane Na-K-ATPase. Moreover, to elucidate whether the changed activity of membrane Na-K-ATPase is due to the change in the number or in the function of the enzyme. We studied both activity and number of erythrocyte membrane Na-K-ATPase. In this study, we have compared the changes of these parameters both in athletes and in non-athletes, for the purpose to elucidate that trained subjects has any changes different from non-trained subjects.

OBJECTIVES

The objectives of the study are as follow:

to investigate the changes in

1. Plasma and erythrocyte electrolytes.
2. Number and activity of erythrocyte Na-K-ATPase.
3. Blood lactate and plasma osmolality.

in Thai athletes and non-athletes during and after exercise. Therefore we can compare the differences of changes between trained subject (athletes) and non-trained(control) subjects.