Changes in Serum Concentration of Uric Acid and Allantoin due to Exhaustive Treadmill Exercise

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In recent years, there have been reports that uric acid has an antioxidative effect, producing allantoin in a non-enzymatic fashion by reacting with uric acid, as the level of active oxygen increases in the body. We analyzed the changes in the serum concentration of uric acid and allantoin in horses before and after exercise by subjecting horses to kinetic loads in exhaustive treadmill exercise. The uric acid value showed an increase until 60 min after the exhaustive exercise was completed, and declined after 120 min almost to the pre-exercise value. Concentration of allantoin increased after starting exercise, reached maximum values at 30-60 min, and then decreased. No significant difference in the allantoin-uric acid ratio was observed. This suggested that the increase in the allantoin level was closely associated with uric acid present before exercise as well as uric acid produced during exercise.

Key words: allantoin, exhaustive treadmill exercise, uric acid

Uric acid is produced as a result of purine metabolism. In recent years, there have been reports that uric acid has an antioxidative effect, producing allantoin in a non-enzymatic fashion by reacting with uric acid, as the level of active oxygen increases in the body [2, 3, 8, 11]. Grootveld et al. [2] detected an increased allantoin level in synovial fluid and serum in patients with rheumatism, which is closely linked to oxidative stress. On the other hand, Ogihara et al. [11] reported a higher level of serum allantoin in patients with Wilson’s disease than in healthy persons. It is known that, in strenuous exercise, accumulation of blood in active muscles and ischemia of organs, as well as blood reflow after exercise, accelerate the conversion of xanthine dehydrogenase to xanthine oxidase, causing the production of various types of active oxygen such as superoxide (O2·−) and hydroxyl radical (OH·) [10, 12]. Further, during strenuous exercise, uric acid level shows a marked increase [4, 5], suggesting the association of uric acid with scavenging of the radicals. To investigate the antioxidative effect of uric acid after exercise, we analyzed the changes in the serum concentration of uric acid and allantoin in horses before and after exercise by subjecting horses to kinetic loads in exhaustive treadmill exercise in this study.

Four thoroughbreds were used in this study. By applying a gradually increasing kinetic load to the horses, we measured the maximum heart rate (HRmax) to determine the treadmill speeds equivalent to 80% HRmax and 105% HRmax. Horses were given five minutes of warm-up exercise (4 m/s) at a treadmill slope of 0%. Then, after standing at rest for 5 min, they began the main exercise session. The first phase of main exercise was continued for 3 min at a 10% slope at a speed equivalent to 80% HRmax (80% HRmax-V). Then the exercise was shifted to the speed corresponding to 105% HRmax (105% HRmax-V) within 10 sec. The exercise was finished when the horses were exhausted. After exercise, the horses were made to walk for 15 min at a 0% slope at 1.0 m/s to recover their normal heart rate. Blood was taken before exhaustive exercise, immediately after the exercise, and 5, 15, 30, 60, and 120 min after the exhaustive exercise was completed. Serum was separated and stored at -80°C before measurement. The serum concentration of allantoin was measured by a partly modified Young-Conway method.
Both protein and lipids were removed with chloroform to enable colorimetric determination. To measure the serum concentration of uric acid, we used a measuring kit (Wako Pure Chemical Industries, Ltd.) which is based on the Uricase-Peroxidase method. Malondialdehyde (MDA) in serum is a decomposed product of superoxide produced from polyunsaturated fatty acids and related esters [6]. In this measurement, we employed the LPO-586 method (BIOXYTECH, France), which is based on the fact that a bimolecular chromogenic reagent combines with a monomolecular MDA to produce a stable coloring substance with a maximum absorption level of 586 nm [1]. The results were expressed in terms of average and standard deviation. Student's *t*-test was used for statistical analysis, with a significant level of 5% or less.

Figure 1 shows the changes of uric acid concentration in serum before and after exercise. The level started to rise immediately after exercise was completed, and continued to increase until 60 min after exercise. Uric acid level decreased at 120 min after exercise, approaching the pre-exercise value.

Figure 2 shows changes in the allantoin level due to exercise. The level started to rise immediately after the completion of exercise, and continued to increase until 60 min after exercise. It then decreased at 120 min after exercise, approaching the pre-exercise value. Allantoin in living organisms is known to be produced when uric acid scavenges active oxygen and free radicals. Some studies showed that, compared with healthy persons, patients with some diseases closely associated with oxidative stress have a higher level of serum allantoin [2, 11]. Our study attempted to clarify the relationship between strenuous exercise and allantoin production in horses.

Although the LPO level increased slightly immediately after exercise, there was no significant change from the pre-exercise level.

Figure 3 shows changes in the ratio of allantoin to uric acid due to exercise. Although the ratio increased slightly, there was no significant change from the pre-exercise level.
designed to tire out human subjects in a short period of time on an ergometer-equipped bicycle, Hellsten et al. [3] measured the serum level of uric acid and allantoin, and observed a rise in the allantoin level earlier than in the uric acid level. In a further experiment, they blocked blood flow in the thigh to prevent intermixture into active muscles of uric acid from the blood, and measured the level of uric acid and allantoin in skeletal muscles during strenuous exercise. The results showed that uric acid level decreased while allantoin level increased. Our study indicated that during strenuous exercise, such as exhaustive treadmill exercise, the serum concentration of allantoin increased temporarily. Further, the absence of significant changes in the allantoin-uric acid ratio suggested that uric acid present before exercise, as well as uric acid newly produced after strenuous exercise, is involved in allantoin production.

References

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