INTRODUCTION

Exercise produces an increase in the number of circulating leukocytes (McCarthy & Dale 1988). Because cells and mediators of the immune system are involved in degeneration and regeneration processes of muscle (Northoff et al. 1995), eccentric exercise that causes muscle damage may cause leucocytosis. Smith et al. (1989) have shown larger increases in neutrophils (the increase from pre-exercise level was approximately 2,500 cells/ul) at 1-2 h after downhill jogging than uphill walking (approximately 1,500 cells/ul, but not statistically significant from the pre-exercise level) when the two exercises were performed at a same intensity (46% VO2max) for 40 min. If exercise-induced muscle damage is a cause of increase in neutrophils after exercise, eccentric exercise that produces substantially greater muscle damage than downhill running should result in a larger increase in neutrophils and other leukocytes. Therefore, the purpose of this study was to investigate changes in leukocytes following eccentric exercise of the elbow flexors known to produce severe damage to the biceps brachii and brachioradialis muscles.

METHODS

The eccentric exercise was performed by eight male students who had not participated in any resistance training program using their non-dominant arm. The subject's forearm was forcibly extended from an elbow flexed (1.57 rad: 90°) to an extended (3.14 rad: 180°) position in 5 s. This action was repeated every 15 s with 24 times. Blood sampling and criterion measurements were taken immediately before and after, as well as 2,4,6,8,12,24, 36, 48, 60,72, 96, and 120 h after exercise. Blood samples collected by tubes contained EDTA-2K were used for all hematological analyses (cell counts of neutrophils, lymphocytes, monocytes, eosinophils, basophils, erythrocyte, platelet, and hematocrit), and the analyses were performed by COULTER Hematology Analyzer STKS (COULTER Co., FL, USA). Other blood samples collected by lithium-heparin coated tubes were centrifuged for 10 min and plasma samples were used to analyze creatine kinase (CK) activity, myoglobin (Mb) and C-reactive protein concentrations. Maximal isometric force of the elbow flexors (MIF), range of motion of the elbow joint, upper arm circumference, muscle thickness by B-mode ultrasonography, and muscle soreness were also measured as indicators of muscle damage. Changes in all measures were analyzed using a repeated measures ANOVA and statistical significance was set at P<0.05.
RESULTS
All muscle damage indicators showed significant changes (P<0.05) after exercise and suggested that severe muscle damage occurred to the elbow flexors. For example, MIF dropped to approximately 40% of the pre-exercise value immediately after exercise and showed slow recovery to approximately 60% of the pre-value at 120 h post exercise. CK and Mb increased significantly (P<0.01) after exercise and the peak values (1,679-44,630 IU/L for CK and 171-2,982 ng/ml for Mb) were more than 10 times the pre-exercise values. No significant changes in CRP, erythrocyte number, hematocrit and platelets were observed following exercise. Neutrophils increased significantly (P<0.01) and peaked 12 h after exercise (the amount of increase was approximately 2,000 cells/ul from the pre-exercise level), and additional peaks were observed at 36 and 60 h after exercise. Monocytes increased significantly (P<0.05) and peaked at 8 h after exercise. Lymphocytes, eosinophils and basophils showed no change. The amount of increase in neutrophils and monocytes was not related to the amount of change in any indicator of muscle damage. For example, the subject who showed the largest increase in CK activity (44,630 IU/L) showed the lowest increase in neutrophils (1,000 cells/ul) and monocytes (100 cells/ul).

DISCUSSION
The increase in neutrophils after eccentric exercise of the elbow flexors was not larger than that found after downhill running (Smith et al., 1989), despite greater evidence of muscle damage in the present study. It seemed that the peak of neutrophils at 12 h after exercise was within a range of daily fluctuation, because similar peaks were observed at 36 and 60 h after exercise when the blood samples were taken at night. Moreover, the increase in neutrophils and monocytes was not related to the change in indicators of muscle damage. These results suggest that the increases in leukocytes in the blood after exercise is probably not the result of exercise-induced muscle damage after eccentric exercise. The larger increases in neutrophils after downhill running than uphill walking (Smith et al., 1989) might be explained by larger increases in heart rate during running that mobilizes more non-circulating leukocytes to the circulation.

REFERENCES