A-15 The effect of hyperoxia on human being after exercise (III)

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The purpose of this study was to estimate how physiological recovery process after submaximal exercise differed with oxygen concentration(air, 30, 40, 60, 80 and 100%) in inspired gas. Subjects were fourteen healthy male students. Subjects were divided in two group by level of anaerobic threshold(AT). Recovery process was evaluated by blood lactate concentration(BLA), V_E, VCO_2 and HR in two AT-group. An electrically braked bicycle ergometer was used for work. Work load was 70%VO_2max. After subject rested for five minutes, a session, which was consisted of five minutes work and six minutes recovery, was repeated three times successively. V_E and VCO_2 were measured during experiments, HR and BLA were measured during recovery periods. Mixed inspired gas was used during recovery periods.

Compared with results of air inhalation, V_E and VCO_2 tended to be lower at hyperoxia in two AT group. The value of BLA was significantly lower at 30 and 40% in low-AT-group and at 60, 80 and 100% in high-AT-group. But it was suspected that this result might be influenced not only by AT level but also by level of BLA. As a result of analysis of covariance, BLA was adjusted by 130%AT work load. Adjusted value of BLA was significantly lower at hyperoxia in high-AT-group but was not significantly in low-AT-group.

A-16 Oxygen supplemented submaximal exercise with breathing resistance

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External breathing resistance (EBR) may impose work performance but oxygen suplementaion may contrarily improve it. We tested this antagonistic effect. Five young male subjects underwent cycle-ergometer exercise at a submaximal level (60%VO_2max) when breathing air or 30%O_2 with the inherent flow resistance of 10cmH_2O/L/sec and the increased flow resistance of 16cmH_2O/L/sec combined with the pressure resistance of 25 cmH_2O. During exersice and recovery periods, heart rate(HR), blood pressure (BP), oxygen uptake (VO_2) were continuously monitored. In the case of 30%O_2 breathing, HR became significantly less and oxygen uptake increased as compared to those observed in the other cases.

A-17 Effect of Velocity and Cadence on Attentional Demand during Treadmill Walking

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The purpose of this study was to examine the effect of velocity or cadence on attentional demand during walking. Twelve healthy adult subjects (6 male and 6 female) were instructed to walk a treadmill at the cadences of 60, 80, 100, 120, 140, and 160/min in accordance with a metronome at five different velocities of 2, 3, 4, 5, and 6 km/hr. They were further ordered to make a verval sign against a flash given from the light stimulus apparatus (SLS-3100, Nihon Koden, Tokyo) in front of them, and the probe-reaction time(Probe-RT) to the stimulus was measured at each velocity and cadence. There was a quadratic relation cadence and RT with an increase in velocity from 2 to 6 km/hr. Attention demand for walking was minimized in 132 steps/min at 3 km/hr, 140 steps/min at 4 km/hr, 140 steps/min at 5 km/hr, and 144 steps/min at 6 km/hr. Cadence at which attentional demand in walking was expected to become the minimum tended to increase with an increment of velocity. In walking, a highly automatized motion, attentional demand became the minimum at specific cadence, which suggests that walking may skillfully be adjusted by selecting the optimum combination of gait variables.

A-18 Relationships between Thresholds of Intracellular pH, Blood Lactate and Surface Electromyogram during Incremental Muscle Contraction

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The aim of this study is to examine the relationships between the thresholds of intracellular pH (pHT) and blood lactate (LT) and the change in surface electromyogram (EMG) during progressive wrist flexion. Eleven males volunteered as subject. Intracellular pH of wrist flexor muscles was evaluated by ^{31}P-MRS monitored continuously during exercise (MRS test). The pH value was calculated from the chemical shift between the peaks of phosphocreatine and inorganicphosphate of the spectra in every minute. Subjects were tested in another experimental session for EMG measurement (EMG test) with the same exercise protocol as MRS test, because of the technical difficulty on EMG measurement due to the effect of magnetic field of MRS apparatus. Bipolar silver electrodes were attached on the same area of skin as the surface coil for MRS. During exercise of both test, venous blood was sampled from antecubital vein in every minutes. The mean values (±SE) of pHT and LT by MRS test and by EMG test were 1.28±0.24, 0.56±0.08 and 0.52±0.03 W, respectively. Integral EMG (iEMG) increased during contraction and did not show the threshold behavior. Change in relative power of 43-83 Hz (RP_{s-s}) obtained by FFT analysis of EMG also increased with a point of rapid increase. The work rate of the onset of the rapid increase in RP_{s-s} was determine visually, and the mean of them was 0.92±0.10 W (43-83T). There were no significant correlation between pHT, LT and 43-83T. The 43-83T was higher than LT by EMG test significantly, and there was no significant difference between pHT and 43-83T. In conclusion, obvious relationship between intracellular pH and EMG was not demonstrated in this study.

A-19 Muscle Fatigue and Bioenergetics Study of Exercising Skeletal Muscle by ^{31}P-NMR

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To assess muscle metabolism and inorganic phosphate (Pi) peak splitting during exercise, a ^{31}P-NMR was obtained during ramp increment exercise and submaximal exercise with and without circulatory occlusion. Seven healthy male subjects performed calf flexion in a 2.1-T superconducting magnet with a 67-cm bore for determining ^{31}P-NMR, which were accumulated using 12 scans per spectrum requiring 5.0 s each. In a NMR machine, calf flexion exercise was performed as follows; ramp exercise test and submaximal exercise test with and without circulatory occlusion. Ramp exercise consisted of exercises that increased in intensity by 0.35W every 15 sec until exhaustion. Submaximal exercise was performed for 4 min at 60% of the exercise intensity attained during maximal exercise. Exercises were performed both while blood flow was occluded with a tourniquet at 280 Torr and without occlusion. In addition, during submaximal exercise, blood occlusion was also initiated at 2 min after the submaximal exercise started. During ramp incremental exercise the PCr decreased linearly with 0.07 ± 0.01 mM/sec, while the rate of PCr synthesis was significantly faster during occluded ramp exercise condition (0.15 ± 0.03 mM/sec, $P<0.001$). During submaximal exercise, PCr decreased linearly with a time of 0.15 mM/sec when the circulation was occluded. After exercise, PCr resysnthesis increased exponentially, while no PCr resynthesis was observed during circulatory occlusion. Pi peak split into two, high-pH Pi and low-pH Pi peaks, during occluded exercise, suggesting that additional lower pH region was observed within musculature. By examing exercise with circulation occlusion, it was determined that the ATP synthesis rate was calculated as 0.15 mM/sec regardless of exercise mode. In addition, PCr resynthesis was limited by the availability of oxygen.

A-22 An Overall Study of the Skin — Age-related changes in skinfold thickness and physiological on abdominal skin —

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With the participation of normal healthy females, we have been examining skinfold thickness over whole body and various other dermal physiological parameters, with special reference to these characteristics, age-related defferences and the mutual relationship. Data from women in their 20's and those in their 40's have been reported hitherto. To clarify more detailed age-related defferences, subjects were stratified more extensively to Earlier 20's, Later 20's, 30's, 40's and 50's; the measurements were perfomed using abdominal skin.

The subjects were 87 normal healthy females aged 20 to 58 years, and skinfold thickness, extensibility of the skin, sebaceous gland activity, skin surface form, and skin color were obtained from the abdomen.

As a result, we obtained about age-related defferences and the defferences between facial skin and abdominal one.

A-23 Inference of perceived fatigue with neural network system

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The purpose of this study which we tried to propose was an inferring method of perceived fatigue using neural network (NN) system. Seven healthy men performed the work at 10% maximum voluntary contraction. The tests were carried out in five intermittent handgrips (10 sec contraction + 10, 8, 6, 4 or 2 sec relaxation) for 10 min and one continuous handgrip for 10 min. The physiological responses were measured during the last 2 minutes of work at each handgrip pattern, thereafter the perceived fatigue (scale is 0 ~ 100) was immediately evaluated. Data obtained were 42 groups (7 subjects x 6 handgrip patterns). Learning-data used were 35 groups, and the remaining 7 groups were checking-data. 3 NNs had been made with different data combined in this study. The structure of NN was: 1) input layer included 7 units (oxygen uptake, forearm blood flow, heart rate, EMG of flexor carpi ulnaris, EMG of extensor digitorum, respiratory frequency and handgrip pattern), 2) output layer had 1 unit (perceived fatigue), and 3) hidden layer had 2 layers (6 and 4 units). Learning algorithm used was error back propagation. Every NN was continuously learned until total error was smaller than 0.01. The checking-data were put in to NN learned. It was found that average errors were respectively 10.1, 3.8 and 8.2 for 3 NNs learned. It seems that NN system can be used for the inference of perceived fatigue by the input of the physiological responses.

A-24 HRV Analysis Method for Field Data

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The purpose of this study is to improve an analysis method for estimating HRV as an indicator of driver's tension. The key of improvement is estimating HRV after removing non-stationary components, or so called 1/f-fluctuating components. In order to confirm the applicability of this method, test conditions which would cause distinctive driver's tension on proving ground were used.

Two types of vehicles which caused different degrees of tension were used, and heart rate data were taken with the same task given to drivers. Subjects were 4 males in good health and the task given to the subjects were lane-changing on a course marked with pylons on the proving ground. 8 tests were performed totally; Twice on each of two kind of vehicles ("A" with low, "B" with high tension level) at each vehicle speed (80km/h, 100 km/h); The order of performing the 8 tests was randomized for each subject, and during the test, subjects were kept uninformed about the vehicle characteristics.

Power spectrum of HRV was estimated by using the present method, and LF/HF, (LF:HF ratio), and AI, ((HF-LF) : (HF+LF) ratio), were chosen as indices from the estimated spectrum.

Followings were observed as the results of the present test:

1) LF/HF: Vehicle "B" is higher than vehicle "A" at 80km/h ($P<0.01$), and 100km/h ($P<0.05$)
2) AI : Vehicle "A" is higher than vehicle "B" at 80km/h ($P<0.01$), and 100km/h ($P<0.05$)

As a result of the tests on proving ground, it was confirmed that a clear HRV could be determined even from heart rate data with sudden changes and large swells, taken under the actual vehicles running, by estimating HRV after removing non-stationary components from heart rate fluctuation wave.