

THE INTENSITY OF SWIMMING FOR THE HANDICAPPED

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身体障害者における水泳の運動強度

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障害者のスポーツ参加は年々高まる傾向にある。スポーツを行う目的は様々であるが、今回は健康の維持増進という目的で行なっている水中運動の運動強度について検討した。身体障害者水泳クラブに所属しているクラブ員男子4名について水泳中の心拍数を測定し運動強度を算出した。その結果、水泳中平均心拍数は1名139(拍/分)と高い傾向を示したが他の3名は112~127(拍/分)であった。心拍数より推定した $\%VO_2max.$ は80%が1名、他の3名は51~66%であった。日常生活の身体活動のレベルが低い障害者にとって動的な生活という目的は達成できていると思われる。しかし、この程度の運動が健康の維持増進につながっていたかについては今後安全性をも含めて更に検討していきたい。

I. INTRODUCTION

The most important objective of sports for the physically handicapped is to increase physical activities in their daily living. It is our hope that they take active parts in sports for maintaining and promoting their health. In the present state, however, the chances to be involved in sports are available to only a small part of the physically handicapped, because of the lack of facilities and instructors, and the inadequacy of medical considerations to ensure safety during the exercise. Medical considerations are especially important for the handicapped to feel assured in involving in sports. The kind and intensity of exercise must be tailored for the individuals according to the state of their disabilities and the level of fitness. The intensity of exercise is considered to be most closely related to its effects and safety. In the present report, the intensity of exercise in the physically handicapped swimmers is evaluated.

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II. METHODS

The subjects were four persons belonging to a swimming club for the handicapped. Table 1 shows physical characteristics and swimming abilities of them. The swimming practice was started after a health check. Since their physical disabilities and swimming abilities vary widely, their practice was done in the form of free swimming. In this observation, the contents of exercise done by the individual persons in the same manner were recorded by the time study method.

The heart rate was used as an index of the intensity of exercise. A pulse recorder (TAKEI MEMORY H. R.) set in a water-proof case was attached to each the person before the practice, and the resting heart rate was measured for 20 minutes in a sitting position. Just after the practice the pulse recorder was removed and the records were analyzed. The intensity of exercise was calculated by the following formula by Karvonen.

$$\frac{\text{Heart rate during exercise} - \text{Resting heart rate}}{\text{Maximum heart rate for the age} - \text{Resting heart rate}} \times 100 = \% \text{HR reserve.}$$

The maximum heart rates for various ages were quoted from the Physical Fitness Standards of Japanese People.¹⁾ The blood pressure was measured, and hand grip strength and the time of balancing on one leg with open eyes were examined as indices of the physical fitness before and after the exercise.

III. RESULTS

Table 2 shows the body build, physical performance, mean heart rate during practice, %HR reserve, %VO₂max (estimated), and blood pressures of all persons (S. T., K.T., K.A. and T.I.) before and after the exercise. Fig. 1 shows changes in the heart rate during the practice in two persons.

A. Intensity of exercise based on the heart rate

The mean heart rate during swimming was 112-139 beats/min. the %HR reserve as an index of exercise strength was 44-73.9%. The maximum heart rate observed during swimming was 163 (beats/min.) in S.T., 151 in K. T., 156 in K.A., and 162 in T. I. The maximum heart rate in S.T. was observed 41 minutes after the beginning of practice when he swam 50m by the crawl, and in K.T. it was observed 21 minutes after the beginning of practice during back stroke kicking. The maximum heart rate in K.

A. was observed at 48 minutes when he crawled 25m×2, and in T.I. was observed at 22 minutes when he backstroked 25m×7.

B. Intensity of exercise based on %VO₂max

The %VO₂max could not be measured in this observation, because it would have caused marked stress to the persons. Therefore, the %VO₂max was estimated from the %HRmax, which is known to be closely correlated with the %VO₂max, by the formula of Hellerstein et al. (Y=1.41 X-42.0).²¹ The estimated %VO₂max was 51.9-80%.

C. Blood pressure before and after swimming

The systolic blood pressure increased in K.A. but decreased in the other three persons after swimming. The diastolic pressure increased in K.T. and T.I., decreased in S.T., and showed no change in K.A.

Table 1 : Physical characteristics and swimming ability of the subjects

Subjects(persons)	S.T.	K.T.	K.A.	T.I.
Age(years)	40	55	63	64
Sex	Male	Male	Male	Male
Disabilities	※ 1	※ 2	※ 3	※ 4
Division of disability	※ 5 32	33	42	33
Experience in swimming	4 years	1 year	1year and 3months	1year and 6months
Swimming ability	Butterfly stroke 50m Crawl 50m Back stroke 50m	Kicking with a kickboard 25m	Crawl 50m Breast stroke 100m Back stroke 50m	Back stroke 25m Crawl 25m
Records	25m crawl 32.9 sec.	—	50m crawl 42.8 sec.	25m crawl 44.6 sec.

※ 1 Functional impairment of the trunk due to cerebral palsy (Grade 1)

※ 2 Functional impairment of the right upper and lower limbs due to cerebral infarction (Grade 2)

- ※ 3 Impairments of respiratory function due to chronic bronchial asthma and bronchiectasis Impairment of hearing (Grade 3)
- ※ 4 Functional impairment of the trunk due to cerebral hemorrhage (Grade 2)
- ※ 5 Divisions of disability by National Athletic Games of the Handicapped Disability Division
 - 32 Functional impairments due to cerebral palsy
 - Paralysis of bilateral lower limbs requiring a wheel chair
 - 33 Functional impairments due to cerebral palsy
 - Capable of walking with a cane or crutches
 - 42 Impairments of hearing, equilibrium, phonation, or speech

Table 2 : Characteristics of subjects and changes in the heart rate and blood pressure

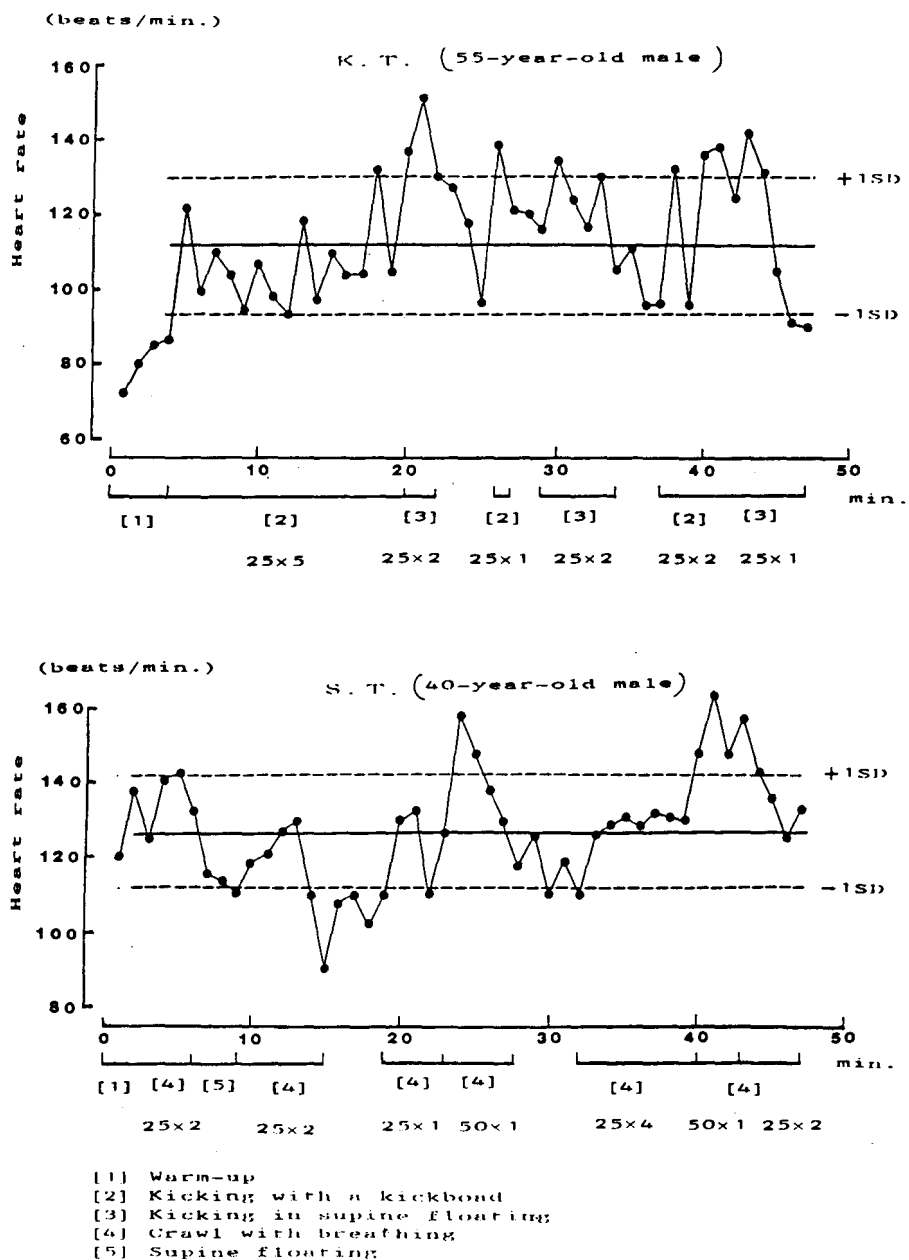
Subjects (persons)	S.T.	K.T.	K.A.	T.I.
Height (cm)	155.0	165.0	165.5	153.0
Weight (kg)	75.0	66.0	67.0	46.0
Grip strength				
(kg) Right	43.5	16.0 (Impaired)	43.0	36.0 (Intact)
Left	37.0	42.5 (Intact)	38.0	19.0 (Impaired)
Balancing on one leg with open eyes (seconds)				
	—	89	—	10
Resting heart (beats/min.)				
	64	68	84	78
Maximum heart rate during swimming (beats/min.)				
	163	151	156	162
Mean heart rate during swimming (beats/min.)				
	127.4 (15.0)	112.3 (18.3)	124.1 (19.7)	139.7 (14.8)
% HR reserve(%)				
	55.6	44.0	51.2	73.9
% VO ₂ max.(%) ※				
	58.8	51.9	65.9	80.0
Systolic blood pressure				
Before exercise	144	128	112	130
After exercise	122	120	120	126

Diastolic blood pressure

Before exercise	96	68	82	85
After exercise	70	88	82	92

※ Estimated %VO₂max calculated by the formula of Hellerstein, H.K. et al. (1973) Values in () are standard deviations.

Fig. 1 : Heart rate during swimming



IV. DISCUSSION

It is difficult to determine how much exercise is needed to maintain their health in the physically handicapped whose physical activity level in daily living is considered to be low. At present, there are no clear standards of the necessary exercise level for the handicapped. Although a universal standard will be difficult to set because of the wide individual variations in the state of their disability and their fitness level, it is important in these persons who exercise regularly to evaluate whether the strength of the exercise is appropriate or not. The %HR reserve of T. I. was 44-55% except and the %VO₂max estimated from the heart rate was 51%-65%. Ishihara et al.³⁾ prescribed a swimming training at 30-50% of VO₂max in hemiplegic patients and observed objective and subjective improvements in the physiological responses. From these observations, the strength of exercise done by the persons in this observation is thought to have been appropriate to develop the aerobic abilities.

From the viewpoint of safety, in the exercise the upper limit of the intensity of exercise is a major problem. In the present observation, the %HR reserve of T.I. was relatively high at 73.9%, probably because he has recently been practicing for swimming races from his own wishes. However, the essential objective of exercise should be to improve the health and fitness even when the person is aiming at racing. The heart rate during swimming, blood pressure and subjective symptoms before and after the exercise, and fatigue after exercise must be checked, and care must be taken to avoid overtraining.

V. SUMMARY

The primary objective of sports for the handicapped, who tend to have a sedentary life-style, is to increase the activity level of their life. In this observation, the exercise intensity of regular swimming practice was measured in four physically handicapped. The following results were obtained.

- 1) The mean heart rate was 139 beats/min. in T.I. but was 112-127 beats/min. in the others.
- 2) The %HR reserve as an index of exercise strength was 73.9% in T.I. but was 44-

55% in the others.

- 3) The %VO₂max estimated from the heart rate was 80% in T.I. but was 51-66% in the others.
- 4) The diastolic blood pressure increased after swimming in K.T. and T.I. from 68 to 88 mmHg and from 85 to 92 mmHg, respectively, but no other major changes were observed in the blood pressure.

These results suggest that swimming is effective for solving the problem of lack of exercise in the handicapped. However, whether exercise at this intensity has contributed to maintenance and promotion of their or not needs further evaluation along with the safety of exercise.

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