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Effect of Acute Infectious Disease on Human Isometric Muscle Endurance

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ABSTRACT

Capacity for isometric endurance work of different muscle groups was recorded in 32 male patients suffering a variety of acute infectious diseases, predominantly of viral or mycoplasmal aetiology. Recordings were performed after abatement of fever, and 1, and 4 months thereafter. Control measurements took place 1 year later. As a result of the illness the subjects' endurance capacity was reduced to 82.5–86.9 % of the control values. Complete recovery was attained later than 4 months after the acute disease. In 21 healthy male control subjects confined to bed for the same period of time as the patients no reduction of endurance capacity was observed as a result of bed rest. The illness-induced and long-lasting impairment of static endurance after acute febrile infections might be related to observations in similar patients of reduced activity in muscle tissue of glyceraldehyde-3-phosphate dehydrogenase being a key enzyme in glycolysis.

INTRODUCTION

Myalgia is a prominent symptom in the acute phase of several acute infectious diseases (5, 6), while in the convalescent phase tiredness and a feeling of weakness in the legs is often reported (6, 7, 8). Reduced maximal isometric muscle strength has recently been demonstrated in patients convalescing from these illnesses (8). Further, the activity of some glycolytic enzymes of skeletal muscle has been found to be reduced after acute febrile infections (1).

Therefore, it seemed to be of interest to investigate whether the capacity for isometric endurance work (anaerobic work) was also affected by these illnesses.

STUDY GROUP

The study group consisted of 32 male patients, aged 25.2±1.4 years, and 21 healthy male control subjects, aged 25.1±0.7 years. The patients were hospitalized with various acute infectious diseases as described in a previous paper (8). Only 7 patients and 1 control in that study did not participate in the present investigation. They were excluded for practical reasons. These patients all suffered viral infections and the exclusion did not influence means of anthropometric data or intervals between measurements to any appreciable extent.

The clinical findings and diagnoses of the patients, and the clinical routine have been described elsewhere (7, 8).

The control subjects (7) were confined to bed for seven days on a ward, the aim being to achieve the same degree of physical activity (clinical bed rest) and energy intake as the patients had.

METHODS

Procedures

Procedures are described in detail elsewhere (8). Thus, the measurements were made on four comparable occasions: directly after illness/bed rest (occasion I), about one month later (occasion II), and about four months later (occasion III). Further, in the patients, control measurements were made one day after occasion I (occasion I 2) and a follow-up investigation was carried out after one year (occasion IV). In the control subjects, comparable measurements were made on two successive days prior to bed rest (occasions 0 and 0 2).

Measurements

Measurements were made using an equipment with pressductors as transducers (ASEA, Sweden) (3). After testing maximal isometric strength of various muscle groups (8), the subject was allowed to rest for 15–20 min. Isometric endurance was then tested in three muscle groups at 2/3 of the previously recorded maximal strength. Horizontal pull, knee extension and handgrip in the right hand were tested with resting periods of 10 min between each test.

The electrical output of the pressductor was recorded on an ink writer (Servogor RE 511, AB Transfer, Sweden) and simultaneously conveyed to a force comparator and indicator (AB Medivox, Sweden). The signal was displayed in front of the subject, a hand and control lamps indicating when the desired strength was achieved.

Calculations were performed from the endurance curves obtained using a 24-inch VW 01 Writing Tablet (Digital Equipment), each curve sampled with a pen creating a spark, the ultramicrosound of which was recovered

Table I. *Isometric endurance capacity expressed as the "area under the curve" (Newtonsec) and endurance time (sec) in male patients suffering various acute infectious diseases (series M) and in control subjects confined to bed (series C)*

Measurements were performed at different times (occasions I, II and III) after illness/bed rest. Occasion IV refers to series M (about 1 year after illness), and occasion 0 to series C (prior to bed rest). $\bar{X}$=means, S.E.M.=standard errors of the mean, and N=number of subjects. Asterisks before values refer to comparisons with values from column IV/0 (control values), and asterisks after values to comparisons with values at occasion III (*=$p<0.05$; **=$p<0.01$)

			I		II		III		IV/0	
Variables	Test	Series	$\bar{X}$±S.E.M.	N	$\bar{X}$±S.E.M.	N	$\bar{X}$±S.E.M.	N	$\bar{X}$±S.E.M.	N
Area under the curve	Arm pull	M	**108.2± 4.4*	29	114.9± 4.9	28	**114.0± 3.8	28	131.1± 6.0	17
			39.4± 1.8		*38.3± 1.3*		**37.3± 1.2*		*42.3± 2.0*	
		C	117.8± 4.2	21	117.9± 4.5	21	117.9± 4.9	20	119.2± 5.4	20
			43.3± 1.4		*42.6± 1.4*		*41.2± 1.6*		*43.1± 1.9*	
Endurance time at 2/3 of maximal strength	Handgrip	M	170.8±10.3	28	190.4±12.0	26	179.0±12.1	21	196.6±14.6	18
			49.4± 2.5		*52.7± 3.1*		*48.5± 2.6*		*52.4± 3.8*	
		C	163.6±12.7	17	175.8±13.4	14	176.7±12.5	16	170.6±14.6	14
			51.8± 3.3		*54.1± 3.5*		*56.4± 3.1*		*55.2± 4.1*	
	Knee extension	M	*175.5± 9.1	27	185.2± 9.8	26	195.6± 9.7	24	211.2±24.0	14
			44.5± 1.7		*43.7± 2.2*		*44.8± 2.2*		*45.8± 3.9*	
		C	210.7±10.2	20	211.2±12.2	21	228.4±12.6	20	209.0±16.4	20
			52.7± 2.4		*50.3± 2.8*		*53.2± 2.9*		*50.6± 3.8*	

by microphones in the coordinates of the tablet. Fatigue was defined as the time at which the pre-determined contraction force could no longer be sustained.

The area under the curve, the endurance time, the mean strength expressed in percentage of the maximal strength, and the endurance time obtained (according to the formula of Rohmert (12)) when the percentage was set to 66.67% of the maximal strength were calculated.

Statistical methods

Observations from occasion I were compared to those from occasions III and IV/0, and those from occasion III were compared to those from occasions IV/0 using Student's t-test for paired observations. The levels of significance were $0.05>p>0.01$ probably significant (*), and $0.01>p>0.001$ significant (**).

RESULTS

Results are included in Table I and Fig. 1. Thus, when testing arm pull in the patients after illness the capacity for isometric endurance work, measured as the area under the curve, was significantly reduced to 82.5% of the capacity recorded after one year. For handgrip and knee extension the corresponding values were 86.9 and 83.1%, respectively. In the control subjects after bed rest no significant reduction of endurance capacity was recorded (95.9–100.8%).

In tests 1 and 4 months after illness results were intermediate, the 4-month value for arm pull being significantly higher than that recorded after illness.

Since those patients taking part one year after illness (occasion IV) were fewer than on previous occasions mean values were calculated on occasions I–III for that limited group. These values were on the same level as those of the rest of the groups thus indicating that no selection had occurred on occasion IV.

A trend was observed for the endurance time to be shorter on occasions I–III than on occasion IV, however significant only for knee extension.

Measurements performed on two successive days showed, for the three tests, coefficients of variation for the area under the curve of 10.5–19.7% in the patients and 8.0–16.5% in the control subjects, arm pull showing the lowest variation. However, there were no significant differences between the duplicate recordings for any of the tests and no trend was

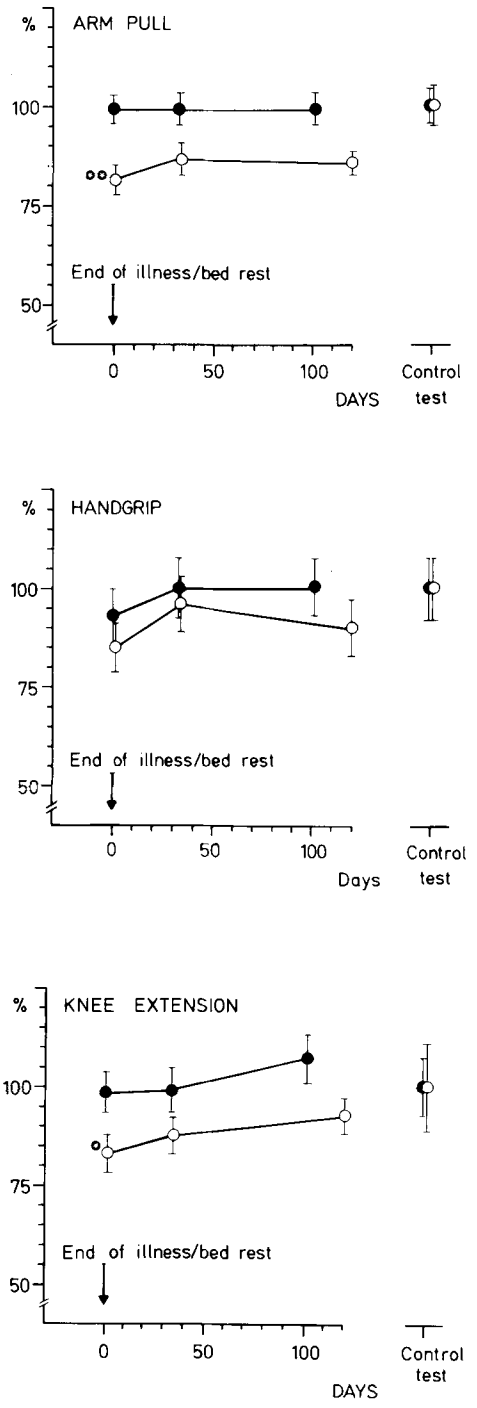

Fig. 1 a–c. Isometric endurance capacity ("area under the curve") in patients after illness (open symbols) and control subjects after bed rest (filled symbols) expressed as percentages of the values recorded on occasions IV (patients) and 0 (control subjects) set to 100% in each group (control test). Means±S.E.M. are given. Asterisks: See text of Table I.

observed suggesting an effect of habituation (practice).

DISCUSSION

The present results indicate a deterioration in the capacity for isometric endurance work performed at 2/3 of the peak strength as a result of acute febrile infections, such as influenza or pneumonia. The individual's normal capacity was reached later than 4 months after the acute disease.

It might be argued that an effect of habituation or training might have occurred during the observation period to account for the differences recorded. However, the duplicate recordings did not suggest a habituation effect and, as to a possible training effect, each subject was requested to resume his normal living habits after illness/bed rest and neither the endurance capacity (present study) nor the maximal isometric strength (8) of the control subjects showed any significant change during that period. Furthermore, the capacity for dynamic work in several of these patients did not change between occasions III (4 months after illness) and IV (1 year after illness) (7) making a training effect still less probable.

Thus, the present results indicate a degree of reduction of isometric endurance capacity as a result of infection being of the same order of magnitude as that of the maximal isometric strength in the same patients (8). The latter, however, had resumed the individual's normal value 4 months after the acute disease, whilst the endurance capacity thus showed a remarkably slow restitution still being depressed at that time.

In a recent morphometric study of the quadriceps muscle in some of the present patients and control subjects signs of hypotrophy (atrophy) were demonstrated, probably mainly caused by inactivity, and were found to have normalized 4 months after illness/bed rest (2).

Thus, some of the maximal isometric strength reduction and even some of the reduction of isometric endurance capacity (as estimated as the area under the curve) in the present study might be caused by hypotrophy. However, since the endurance capacity reduction to the greater part is illness-induced and longer-lasting it might be caused mainly by metabolic impairment. As a matter of fact, in biopsy studies of the quadriceps muscle in similar patients to those in the present study two

glycolytic enzymes (lactate dehydrogenase, LDH, and glyceraldehyde-3-phosphate dehydrogenase, TPD) showed reduced activities as a result of the illness, and 4 months after illness, the activity of TPD had still not reached that of bed rest-confined controls (1).

Since TPD is considered as a key enzyme in glycolysis (13) and the endurance work of the present study was performed at as much as 2/3 of the maximal strength, which results in arrest of the blood circulation (4), it seems suggestive that reduced glycolytic capacity might cause the reduction in static endurance in our patients. However, results in the literature on the relationship between glycolytic enzyme activity and capacity for static work seem somewhat contradictory and are by no means fully elucidating. Thus, Gollnick et al. (10) found no difference in phospho-fructokinase activity in the quadriceps in strength athletes when compared to sedentary controls. Hickson et al. (11), on the other hand, in a recent study in rats found sprint training to cause an unexpected trend towards a decrease in the activity of some glycolytic enzymes.

Since in some viral infections a limited disturbance in neuromuscular transmission has been recorded at low voluntary contraction force (9) it cannot be excluded that a more pronounced disturbance might develop during a prolonged isometric contraction at the higher intensity used in the present study, possibly causing weakness and fatigue.

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