

PHYSICAL WORK CAPACITY AND MUSCULAR STRENGTH IN PATIENT UNDERGOING REHABILITATION

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ABSTRACT. From patients undergoing rehabilitation, groups with three different types of disorder were chosen: dorsal insufficiency, mental retardation and below-knee amputation. To obtain an objective evaluation of their physical capabilities they were examined by various physiologic methods. These methods included mainly bicycle ergometry (submaximum load, W_{170}) and maximum isometric muscular strength.

The results showed normal physical work capacity in patients with dorsal insufficiency but slightly lowered values in the mentally retarded patients. The muscular strength was not significantly lowered in the mentally retarded group. Back pain and/or lowered strength restricted the group of dorsal insufficiencies in 13 out of 23 patients. The most important limiting factor in the below-knee amputees was pain in the amputation stump during walking, not impaired muscular strength.

With the methods used an objective assessment of the physical condition of the patient, including physical capability and abnormally limiting factors, could be obtained.

When patients are undergoing rehabilitation it is often useful to be able to evaluate their physical capacity objectively. As a rule the actual situation of the patient depends on a number of factors of which due account must be taken in any accurate assessment; muscular strength and respiratory and circulatory function are such factors. In our opinion, measurements of these are of value in about 80 per cent of such patients.

Patients are referred to the Rehabilitation Centre both from the County re-training authorities and the County hospitals. Since the Centre opened in 1962 patients have been referred there in increasing numbers; in 1966 454 were investigated. Treatment is given for both physical

and mental conditions, and most of the patients are suffering from a combination of these forms of handicap. This is why it is sometimes difficult to analyse the effect of an isolated functional impairment, even though this is invariably desirable.

In the present study, to obtain information about functional capacity and to examine isolated functions patients with only one main handicap were selected, namely dorsal insufficiency, mental retardation, or one-sided below-knee amputation.

METHODS

The circulatory type of the physical work capacity at a heart rate of 170/min (W_{170} , kgm/min) was determined by bicycle ergometry as graded sub-maximum work (Sjöstrand, 1960). The maximum isometric muscular strength in the extremities and the trunk was measured in kilogramme-force (kgf) according to either Asmussen *et al.* (2) or Bäcklund & Nordgren (4), who have also discussed the respective advantages of the two methods.

MATERIAL

Patients with dorsal insufficiency or mental retardation examined during the period 1963-66 were selected for this study. Some data of these groups are given in Table 1. The below-knee amputees numbered 18 men and 2 women; in all of them amputation had followed trauma and all were wearing below-knee prostheses. This material has been presented in detail by Bäcklund *et al.* (3). The control group consisted of 25 healthy young males (4).

RESULTS

In the patients with dorsal insufficiency the mean physical work capacity W_{170} (\bar{X}) was normal and in the mentally retarded patients slightly lower values were obtained (Table 1). The values of

Table I. Age and physical work capacity for dorsal insufficiency and mental retardation groups

	Dorsal insufficiency		Mental retardation	
	Men	Women	Men	Women
Age				
Mean	38.1	40.9	24.3	21.6
Range	18-57	17-57	16-58	16-30
n	46	11	15	11
W_{170}				
Mean	983	715	893	535
Range	680-1356	550-850	600-1150	350-680
n	34	7	14	11

muscular strength for patients examined in 1966 are given in Tables 2 and 3. The values were limited to that year, so that a comparison could be made with the control group studied by the same method and reported by Bäcklund & Nordgren (4). Between 1963 and 1965 the Asmussen technique was used in the laboratory and the relevant data will not be presented here except in respect of the below-knee amputees. In 13 out of 23 patients with dorsal insufficiency, back pains that restricted their capacity were elicited when the trunk muscles were tested. The test values for the amputees are given in Table 4. These patients were divided into two groups according to their maximum walking distance (arbitrary boundary, 1 km).

Table II. Mean maximum isometric muscular strength, kgf. Men, dorsal insufficiency

Mean age: patients, 40.2 yrs; control group, 22.5 yrs

	Isometric muscle strength, kgf					
	Patients			Control group		
	Right	Left	n	Right	Left	n
Horizontal						
Pull	41.1	38.8	23	41.6	40.5	25
Push	36.2	35.0	23	39.0	35.6	25
Knee						
Flexion	22.9	21.1	23	28.9	28.0	25
Extension	59.2	57.2	23	65.1	64.0	25
Trunk bending						
Forward		48.0	23	63.8		25
Backward		56.7	23	74.9		25

Table III. Mean maximum isometric muscular strength, kgf. Men, mental retardation

Mean age: patients, 23.0 yrs; control group, 22.5 yrs

	Isometric muscle strength, kgf					
	Patients			Control group		
	Right	Left	n	Right	Left	n
Horizontal						
Pull	39.2	37.0	6	41.6	40.5	25
Push	37.3	37.5	6	39.0	35.6	25
Knee						
Flexion	24.3	25.7	6	28.9	28.0	25
Extension	66.2	77.8	6	65.1	64.0	25
Trunk bending						
Forward		59.2	6	63.8		25
Backward		71.3	6	74.9		25

Table IV. Maximum isometric muscular strength, kgf. Men, below-knee amputees

Mean and percentage of the predicted value according to Asmussen *et al.* (From Bäcklund, Lemperg & Ottosson)

	Hip flexion				Hip extension			
	Sound leg		Amputated leg		Sound leg		Amputated leg	
	kgf	%	kgf	%	kgf	%	kgf	%
<i>Able to walk 1 km (n=16)</i>								
Mean	46	79	44	76	49	107	48	105
Range	20-74	38-113	22-60	36-92	21-72	51-156	31-70	71-149
<i>Unable to walk 1 km (n=4)</i>								
Mean	43	77	40	72	43	95	33	73
Range	32-49	57-85	21-47	36-81	38-48	85-109	22-40	50-91

DISCUSSION

The mentally retarded patients were younger than those with dorsal insufficiency; this is due to the fact that a (severely) mentally retarded person cannot as a rule master a normal task and is therefore often referred to a rehabilitation centre within a few years of leaving school. However, such patients generally have no physical handicaps. In the present material the W_{170} was found to be on the low side but, for women at least, not lower than the values found by Adolfsson (1) in the same age group of a female material of uncomplicated gall-stone disease.

Many patients referred with a diagnosis of dorsal insufficiency were found to be physically handicapped. During effort involving the dorsal muscles, and also to some extent the leg muscles, these patients often showed signs of impaired function (pain and/or abnormally decreased muscular strength).

The muscular strength of the mentally retarded patients could not be shown to differ from that of the control group; in some tests a tendency for lower values was observed. However, the mentally retarded patients require more detailed and more time-consuming instructions for them to be able to develop their maximum strength. Some patients obviously have difficulty in grasping the instructions.

The leg muscular strength of the amputees (i.e. hip flexion and extension) was as a rule slightly lowered on the amputation side, but considered in relation to the reference material (2) this difference cannot be regarded as significant. The analysis of the walking distance provided no

evidence that a lowered muscular strength can account for an impaired walking capacity. Nor was a short walking distance related to a low circulatory capacity. In their discussion Bäcklund *et al.* (3) concluded that pain in the amputation stump during walking is a more important limiting factor than is impaired muscular strength.

The value of ergometry in routine clinical examination

From determinations of the circulatory capacity and the maximum isometric muscular strength it is possible to make an objective assessment of the physical condition of a patient. At the same time the measurements disclose the existence of abnormally limiting factors—such as pain—the intensity of effort at which they appear, the patient's co-operation and his attitude to examination. As all the ergometric results are related to the physical requirements of the patient's place of work, the most suitable type of occupation can thus be chosen. Ergometric methods can also be applied in evaluating, for instance, the effects of therapy, medical gymnastics and physical training.

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