HAEMODYNAMIC AND METABOLIC RESPONSES TO PHYSICAL TRAINING IN CHRONIC RENAL FAILURE

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Introduction

Physical working capacity (PWC) in patients with chronic renal failure (CRF) is reduced in relation to the degree of renal insufficiency.

The reduction of PWC in renal insufficiency is due to uraemic disturbances and physical inactivity [1–7]. The physical inactivity is caused by muscle weakness and false therapeutic recommendations by the physicians. On the one hand the impaired physical efficiency can diminish the attitude of the uraemic patients to physical activity; on the other hand it is customary to advise uraemic patients not to indulge in vigorous activity.

Exercise training has been used increasingly in the therapeutic management of a variety of afflictions, for example, angina pectoris, hypertension. In our opinion exercise training is possible and useful in uraemic patients too [8, 9].

The aim of our investigation was to study:
1. The effect of physical training on PWC in uraemic patients;
2. The influence of physical conditioning on cardiovascular and biochemical parameters at rest and during exercise;
3. The influence of training on renal insufficiency (represented by serum creatinine).

Methods

The patients were checked on a bicycle ergometer according to the rules of the WHO at the beginning and the end of a three month training programme. (The initial work load was 25 Watt. After six minutes on each load the exercise intensity was increased by steps of 25 Watt until well known criteria for stopping the exercise were reached.) Physical working capacity and metabolic and cardiovascular responses to work load were determined.

Physical working capacity was defined as maximal work load in steady state for six minutes (= PWC (Watt)) as well as time of exercise testing until indications
to stop the test occurred (= t (minutes)). At the beginning and during the sixth minute of each work load blood samples were analysed for lactate, heart rates were recorded by ECG, blood pressure was measured by auscultation and cardiac output and stroke volume were determined radiocardiographically.

**Patients**

Thirteen patients with CRF (six women, seven men) aged from 36 to 61 years, mean 47, participated in a training programme. Twelve patients were in different stages of renal insufficiency (serum creatinine ranged from 210μmole/L to 1560μmole/L, mean 810; haemoglobin ranged from 133g/L to 73g/L, mean 99g/L). One patient was transplanted (serum creatinine 160μmole/L, haemoglobin 132g/L).

**Training**

The physical training was performed on a Zimmermann bicycle ergometer (Leipzig/GDR) in sitting position. During training the patients were under medical supervision. The training load was determined for each patient individually and depended on PWC and the cardiovascular responses to exercise load.

The training programme lasted three months and was performed twice weekly. The training consisted of six minutes of pedalling at constant work at 50% maximal work load, which was considered as 'warm up' and of 30 minutes of pedalling at 80% maximal work load.

**Results**

The results are presented in Figures 1 and 2 and in the tables in Figures 1 and 2.

**Physical working capacity**

Physical training improved significantly. PWC increased from 73.2 to 98.2 Watt (women and men together, n = 13), while t = time of exercise testing increased from 17.4 to 23.1 minutes.

**Heart rate/blood pressure**

Ergometric training did not change heart rate and blood pressure at rest and at the end of exercise. During exercise at a work load of 50 W heart rate decreased from 121.9 to 110.5 beats/min and blood pressure decreased from 195 to 182 mmHg.

**Cardiac output/stroke volume**

At rest and at a work load of 50 Watt, a significant decrease of cardiac output from 10.4 to 7.2 at rest and 18.6 to 14.4L/min at 50 W respectively were observed.
INFLUENCE OF PHYSICAL TRAINING ON PHYSICAL WORK CAPACITY (PWC)

NORMAL SUBJECTS
(Aged 40 - 50 years)

- BEFORE
- AFTER TRAINING

♀ (n = 13)
73.2W = 100% 98.2W = 134% + 25.0W 34%
± 31.7 ± 35.9 ± 16.9

♂ (n = 7)
92.9W 117.8W + 24.9W
± 23.8 ± 34.9 ± 17.2

♀ (n = 6)
41.7W 66.7W + 25.0W
± 12.9 ± 12.9 ± 15.8

DURATION OF EXERCISE TESTING

Figure 1. Influence of physical training on physical work capacity (PWC (Watt)) and duration of exercise testing (t (min))
Figure 2. (a) Heart rate (HR); (b) cardiac output (CO); (c) stroke volume (SV); (d) lactate (LAC) at rest and during exercise before (○-----○) and after (–––) three months of physical training.
Stroke volume decreased from 138.3 to 103.0ml at rest and 173.5 to 149.2ml at 50 Watt respectively.

**Lactate**

Lactate decreased from 2.48 to 1.46mmole/L at 50 Watt work load.

No changes in cardiac output, stroke volume and lactate were observed at maximal work load.

**Conclusions**

1. Physical training significantly improved PWC in patients with CRF. Patients who underwent ergometric training had significantly better physical efficiency than untrained uraemic patients with the same degree of renal insufficiency.

2. The physical training resulted in improvement of cardiovascular reserve (heart rate, blood pressure, cardiac output as submaximal work loads decreased).

3. The improvement of PWC is not due to an increase in maximal cardiac output, but caused by improved oxygen and fuel utilisation in working muscles during exercise and/or increased tissue oxygen extraction manifested by a greater av-O₂-difference in blood (lactate at submaximal work loads decreased).

4. Our results indicate that the patients achieved some training effect without any discernible detrimental consequences and without progression of renal insufficiency (serum creatinine before training 810μmole/L, after training 830 μmole/L).

5. Recommendation for physical training in uraemic patients: the patients have to be under nephrological supervision. During the training period the training programme has to be adapted if patients PWC and/or state of health change.

6. Errors of training can result in decrease of physical work capacity and in progression of renal insufficiency.

**References**


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