Exercise Protocols in Patients with Chronic Kidney Disease (CKD) and on Renal Replacement Therapy: A Literature Review

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ABSTRACT

The aim of the present study is to look into the renal patients' ability to exercise. Three exercise protocols were found in the literature: at a rehabilitation centre, during haemodialysis session and at the patients' house. The aim of the exercise protocols is cardiorespiratory and muscular strengthening, as well as flexibility. The main principles of the exercise programmes are load, individualization and gradual implementation. In the article the changes in physical status, cardiovascular and muscular system and in endurance are presented. There is also a comparison of the advantages and disadvantages of all exercise protocols.

In conclusion, exercise in a rehabilitation centre has more advantages, as more and different exercises can be implemented. Even though, renal patients should be encouraged to participate in any exercise programme, as the positive outcomes can be seen in their quality of life.

Key words:
Chronic Kidney Disease, exercise protocols, endurance, strengthening, flexibility.

Introduction

Chronic Kidney Disease (CKD) is the progressive impairment of renal function and can be asymptomatic even when 70% of the nephrons are destroyed. The onset of End Stage Renal Disease (ESRD) varies and depends on primary disease and coexisting factors (hypertension, infections and heart failure).

Managing CKD can be conservative, where balancing the dietary intake with the output is required. Thus, sodium and water intake is limited, so as to achieve balance. At this stage, intense exercise or participation in organized programs is prohibited, as during exercise blood supply to the already problematic kidneys is reduced. A light exercise program with daily walking is proposed, for improving muscle strength, aerobic capacity and blood pressure. Nevertheless, exercise does not alter blood parameters and heart function.

As CKD progresses, patients have to choose Renal Replacement Therapy (RRT). Haemodialysis (HD), a type of RRT, during which the patient's blood, with the help of the Dialysis Machine, passes through a filter, is diluted and returns to him/her «purified». Another method of RRT is Peritoneal Dialysis (PD), during which a solution, similar to extracellular fluid, is infused through a permanent peritoneal catheter in the patients' abdomen. The solution remains for few hours in the peritoneal cavity and toxic metabolites pass from the blood, through the peritoneum into the solution. Then the solution is drained in a special bag and the cycle is repeated, some hours later. Optimal treatment of CKD is Transplantation (Tx), during which a congenital or cadaveric kidney is transplanted to a patient in HD or PD

Exercise programmes

Patients with CKD have severe functional limitations (reduced cardio-respiratory capacity, fatigue, poor physical condition) and various psychosocial problems that increase the medical care cost and constitute risk factors and indicators of poor quality of life (Gutman et al., 1981, Moore et al., 1993a, Kouidi, 2001, Konstantinidou et al., 2002). One of their most important problems is reduced physical capacity, which restricts any physical activity and exercise (Kouidi, 2001).

Renal patients' aerobic capacity (VO2peak) is 15.0 to 21.0 ml/ Kg/min, half of a healthy persons' (35.0-40.0 ml/Kg/min) (Konstantinidou et al., 2002). These values do not improve, even when patients undergo HD or PD (Barnea et al., 1980, Painter et al., 1986a), or when erythropoietin agents (ESAs) are administered (for anaemia correction). It is shown, that oxygen is not the only factor affecting renal patients' aerobic capacity. There is problematic functional capacity of HD and PD patients with co-morbidities (diabetes mellitus, cardiovascular diseases) (Evans et al., 1985, Mayer et al., 1989, Painter, 1994).

Since the late '70s and early '80s researchers started to investigate renal patients' ability to exercise aiming at improving their quality of life (Fitts et al., 1999, Kouidi, 2002). The trends were two: exercise in the days between HD sessions (Goldberg, 1980, Hagberg, 1983) and exercise during HD (Painter, 1986b). The newest trend is exercise at home. The objective of the exercise programs is the cardiorespiratory and muscle strengthening and flexibility. The principles that rule are load, individualization and gradual implementation.

Prior to starting an exercise program, renal patients undergo full physical examination and exercise test (stress test) with spyrometry in order to spot possible myocardial ischeamia. The test is carried out with low intensity protocols, preferably Nephron. In this protocol the patient starts with 3' walking, speed 2.4Km/h and inclination 0%, continues with increasing inclination of 3.3% every 3' and a steady speed until the slope reaches 10%. At this point speed and inclination is increased gradually until the person is exhausted. The protocol aims in longer duration of exercise (Kouidi, 2002).

Simple tests can be performed in order to determine patients' functional capacity, group type, baseline values. The seat-stand test is performed to a patient sitting with straight back and hands folded on the chest. The patient sits down and stands up for 1' without using his/hers hands. The leg extent test is applied to sitting person, which is extending and bending each leg during 1'. The range of motion is measured in degrees for each leg using a special instrument. The hand muscular strength test is performed with a special instrument. The Kidney Disease Quality of Life (KDQOL) test is a modified form the SF-36 questionnaire that investigates risk and quality of life (Martin et al., 2003). Following the initial tests, an exercise program depending on individual clinical and functional capacity is implemented. Renal patients exercise programs are described below:

Exercise program in an organised rehabilitation centre

In a rehabilitation centre a team of experts (physical education trainers, physiotherapists, medical and nursing staff) supervise and exercise renal (HD, PD and Tx) patients. The exercise schedule consists of 3 times a week exercise, for 60-90' on the days between HD. The program consists of 10' warming up on a ramp or bicycle (low cardiovascular load), 60' aerobic exercises, 10' muscle strains and 10' recovery (Kouidi et al., 1998). After the first trimester of aerobic capacity and muscle strength is improved, and muscle loss is minimised. Then some stretching with light resistance exercises (Kouidi et al., 2000, Castaneda et al., 2001, Copley, 2001), light weight lifting

and rhythmic strengthening exercises can be added. Muscular strength can be achieved with lighter weights and more repetitions, while muscular strengthening is improved with the use of heavier weights and fewer repetitions. In the second trimester sports (swimming, football, volleyball and basketball) can be added once a week. Attention should be paid to gradually increase of exercise intensity, which usually reaches 70-80% of the, achieved during the exercise test, heart rate (Kouidi et al., 1998).

Participation in rehabilitation centre exercise programme is low because it is hard to convince the HD patients to participate on the non dialysis day (not interested, do not want to "close" other days of the week for exercise). Twenty percent of the participants stop for transportation problems, lack of time and changes in the health status (Shalom et al., 1984, Williams et al., 1991, Tawney, 2000, Konstantinidou et al., 2002).

Exercise during haemodialysis

This type of exercise was applied for the first time in 1982 in the Dialysis Unit of the Borgess Medical Center. Static bicycles were adjusted to patients' chairs or beds and patients exercised for 15-30' aiming at muscle and cardiovascular strengthening. During this programme the exercise coordinator is responsible for organising and cooperating with medical and nursing staff who will implement it. The coordinator is cooperating with the hospitals' physiotherapist for planning and purchasing of bicycles used. The selection of patients is either voluntarily or after referral by the doctors (Martin, 2003).

The programme begins with cycling (passive and later active), without resistance (gradually increased), takes place 3 times a week for 70', starting with 5' warming up. Then the main programme starts with bicycle and some exercises for muscle strengthening, flexibility, coordination and stretching and finishes with 5' recovery (Painter, 1986, Kutner et al, 2000). The intensity of the programme is 60-70%, achieved with the exercise test, heart rate. The exercise programme should be applied during the first 2 hours of the HD session, because it is common to have hypotension episodes at the 3rd and 4th hour of HD. Researchers emphasise that exercise in the first two hours increases the urea removal and offers better quality of life (Doutsiou et al., 2004).

Exercise during HD is effective and convenient for patients. No more days of exercise are needed and no additional transportations are required as the patients come to the HD unit three times a week, already (Kouidi, 2001, Konstantinidou et al., 2002, Kouidi, 2002). Painter et al (1986b) found that participation and retention in similar programmes reached 75% during the second trimester of exercise, while Konstantinidou et al (2002) indicate 16.7% rate of interruption.

Exercise at patients' home

Exercise programmes at the patients' home are performed without the supervision of qualified personnel. This form of exercise costs less in an organized rehabilitation centre, is more convenient and practical for the person (no more transportation) and promotes independence. After the person is subjected to the necessary tests a static bike is delivered and the exercise programme is taught by a member of the training team. The programme includes cycling for 15'-30', 5 times/week and then exercises for flexibility and muscle stretches of the upper limb. The intensity of the programme is 60-70% of the actual heart rate.

Exercise at home is a good alternative for patients who live away from the dialysis unit and for those with transportation problems (Tawney, 2000, Konstantinidou et al., 2002, Kouidi, 2002). Compliance with the exercise programme and correct implementation depends on the individual and the family support.

Outcome of exercise programmes

There are no complications listed from musculoskeletal and cardiovascular system due to exercise (Konstantinidou et al., 2002). Instead there are reported improvements in fatigue, activities of daily life, symptoms of peripheral neuropathy and myopathy, depression and anxiety (Kouidi et al., 1997, Kouidi et al., 1998, Painter et al., 2000). An important finding is a trend to improve blood sugar control (glucose and resistance to insulin sensitivity) in HD patients (Cappy et al., 1999, Goodman et al., 2004).

Aerobic capacity

All forms of exercise (centre, HD, home) have positive effects on renal patients' aerobic capacity (VO2). A significant increase in VO2max (20-40%) was found during exercise programmes lasting 3-12 months (Zabetakis et al., 1982, Goldberg et al., 1983, Shalom et al., 1984, Deligiannis et al., 1999), but is still lower than healthy individuals (20-23ml/Kg/min). Maximum aerobic capacity (VO2peak) after 6-12 months of exercise is improved in HD and PD patients (15-20% and 15-40%, respectively) (Hagberg et al., 1983, Kouidi, 2001, Konstantinidou et al., 2002) due to peripheral adjustments rather than central haemodynamic changes.

Cardiovascular System

Cardiovascular system benefits are greater in patients exercising in a rehabilitation centre, due to exercise variety and different load of each session. The programme includes a combination of aerobic and strengthening exercises and sports activities. Recent surveys indicate that long-term, moderate intensity exercise increases the heart rate variability (HRV) in HD patients and reduces heart arrhythmias (Coats et al., 1990, Goldsmith et al., 1992, Shi et al., 1995, Deligiannis et al., 1999, Kouidi, 2002, Goodman et al, 2004). Exercise programmes are causing morphological and functional adjustments in left ventricle, fraction extrusion, pulse volume and heart output (in calm and in sub-maximal exercise). It is found that exercise reduces blood pressure, mainly due to reduction of peripheral vascular resistances (Kouidi, 2001, Konstantinidou et al., 2002, Goodman, 2004).

Muscular System

Muscle weakness, fatigue and cramps that renal patients face every day dramatically restrict the everyday life activities. The reasons for muscular atrophy are multifactorial: malnutrition, uraemic neuropathy and myopathy, neurohormonic disorders, uraemic toxins, and limited mobility (Brandley et al., 1990, Moore et al., 1993a, Kouidi et al., 1998, Kouidi, 2002).

Researchers have shown that exercise causes changes in skeletal muscles histology, metabolism, endurance (Brandely et al., 1990, Moore et al., 1993b, Kouidi, 2002) and bears optimal sport output (Kouidi et al., 1998, Cappy et al., 1999). Studies made by muscle biopsy in renal patients undergoing exercise programmes, have shown an increase in type I and II muscle fibres after endurance and empowerment exercise (Castaneda et al., 2001, Kouidi, 2002). Moreover, fibber regeneration, increase in small vessels transparency and changes in mitochondria structure and number are described. Exercise improves maximum leg isometric strength, as well as conductivity of stimuli to the peripheral nerves (Kouidi et al., 1998, Cappy et al., 1999, Castaneda et al., 2001, Kouidi, 2002). These findings are in contrast to Moore et al (1993 a+b) which did not identify significant morphological changes in HD patients skeletal muscles probably due to the fact that the research lasted 12 weeks and involved only cycling.

Endurance

Konstantinidou et al (2002) in a study of patients that were exercising in a rehabilitation centre, HD unit and at home found increased endurance to running ramp (33%, 22% and 14% respectively) showing that systematic exercise improves renal patients' daily life and quality of life.

Epilogue

There are no evidence to clearly answer about the effects of exercise on the prognosis and development of kidney disease. The benefits are functional (in cardiovascular and autonomic nervous system) as well as practical (reduce of heart disease risk). In conclusion, exercise in a rehabilitation centre has better results than all other methods due to the fact that more and different exercises are implemented. Nevertheless, patients should be encouraged to participate in exercise programmes according on their needs and daily schedule. The first positive changes in functional capacity appear after 4 weeks and maximum adjustments in 16-26 weeks. Central and peripheral adjustments in exercise cause an increase in functional capacity (easier and more pleasant everyday activities). Moreover, improvement of endocrine and metabolic disorders, anaemia, mood and social relationships are found, leading to a better quality of life. Patients should be encouraged to include physical activity in their daily lives.

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