CHANGE OF FOREARM MUSCLE OXYGEN CONSUMPTION IN PEDIATRIC KIDNEY TRANSPLANT PATIENTS

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Abstract

The aim of the present study is to clarify the improvement of peripheral muscle oxygen consumption after successful renal transplantation. We investigated change of forearm (brachioradial muscle) muscular oxygen consumption in chronic renal failure children before and after renal transplantation, by using near-infrared spectroscopy.

Oxygen consumption of brachioradial muscle was increased significantly after successful renal transplantation. And half recovery time of brachioradial muscle oxygenation in arterial occlusion and exercise were decreased after renal transplantation.

These results suggest that increased muscular blood flow and increased oxidative generation of ATP might contribute to the increased oxygen turn over after renal transplantation.


key word : Near infrared spectroscopy, Oxygen consumption, brachioradial muscle, renal transplantation, and children

Introduction

In daily clinical situation it is always noticed that chronic renal failure children become more active in their physical performance after successful renal transplantation³.

The hypothesis in the present study is that the improvement of QOL in chronic renal failure children after kidney transplantation could depend on the improvement of peripheral muscle oxygen consumption.

We investigated change of forearm (brachioradial muscle) muscular oxygen consumption in chronic renal failure children before and after renal transplantation.

Methods

Ten chronic renal failure patients (7 boys and 3 girls) were studied.

The measurements were 1) 6 minutes distance (walk), 2) the knee extensor muscle power by hand-held dynamometer and the maximal voluntary contraction by grasping power meter, 3) forearm muscle (brachioradial muscle) oxygen consumption by rhythmic handgrip exercise and half recovery time of muscle oxygenation after 30 seconds arterial occlusion and exercise by using near-infrared spectroscopy.

Exercise set-up and protocol. Dynamic hand-grip exercise was done on a custom designed hand-grip dynamometer. The patients performed rhythmic hand-grip exercise in a seated position. At the start of each study, patients performed three maximal voluntary contractions. The greatest force was considered a maximal voluntary contraction (MVC). Rhythmic hand-grip exercise consisted of 1-second isometric hand-grip at 30% of MVC alternated with 1-second relaxation (30 grips/min) for 1.5 min and 1 min respectively.

Statistical Analysis. The values were expressed as mean ± standard deviation. The paired t-test and wilcoxon t-test were used when comparisons were
made between the values obtained from the pre renal transplant patients and post renal transplant patients. P<0.05 was considered statistically significant.

Results

6 minutes walk (distance) increased significantly after successful renal transplantation. That is 6 minutes walk (distance) was 429.8±85.7 m before renal transplantation and 506.1±91.6 m after renal transplantation which was statistically significant (p <0.05) (Figure 1). The knee extensor muscle power by hand-held dynamometer and maximal voluntary contractions by grasping power meter showed no statistical change before and after renal transplantation.

Forearm muscle O₂ consumption increased significantly after successful renal transplantation in ratio gradient from exercise loading (2.4±0.5) to resting (3.7±1.0) (Figure 2).

Half recovery time after 30 seconds arterial occlusion significantly decreased from 6.70±1.86 to 4.90±1.20 in contrast to forearm muscle O₂ consumption after successful transplantation (Figure 3).

Half recovery time after exercise also decreased from 9.8±6.03 to 4.8±1.97 after renal transplantation (Figure 4).

Ht values were significantly lower in 1 month after renal transplantation. That is Ht value was 35.6±2.9% before and 33.0±3.6% after renal transplantation which is statistically significant (p<0.05) (Figure 5).

Discussion

Exercise capacity is substantially reduced in
Figure 3. HbO half recovery time after 30 sec artery occlusion in pre and post renal transplant children.

Figure 4. HbO half recovery time after exercise in pre and post renal transplant children.

dead-stage renal disease (ESRD) patients, being approximately 50% of that observed in healthy adult, age-matched individuals\(^1,2\). On the other hand, exercise capacities in pediatric renal failure patients are also significantly reduced. Motoyama et al reported that Kidney Disease Quality of Life (KDQOL) in physical strength of chronic renal failure pediatric patient was 45 to 65% of that observed in healthy children\(^3\). However, there has been no report on the objective proof of the reduce physical strength in chronic renal failure pediatric patients. Present study enabled to prove the reduced capacity of exercise in chronic renal failure pediatric patients by 6 minute distance (walk) and brachioradial muscle ox-
Figure 5. Ht values before and after renal transplant.

In this study, reduced exercise capacity in chronic renal failure children and recovery of exercise capacity after successful renal transplantation by using near-infrared spectroscopy technique is highly acceptable with chronic renal failure patients especially pediatric patients because it is painless and non-invasive. Although the anaerobic threshold was not measured in this study, recovery of the anaerobic threshold was speculated after successful transplantation because 6 minute distance (walk) is thought to be correlated with anaerobic threshold.

This reduced exercise tolerance has been attributed to anemia, and muscle metabolic abnormalities with ESRD including acidosis and impaired oxidative generation of ATP, impaired phosphorylation of creatine to creatine phosphate and impaired oxygen conductance to muscle cells. As the result of present study shows, Ht values were significantly lowered after successful renal transplantation suggesting that there is no correlation between recovered exercise capacity and Ht values in this study. Acidosis is not likely to be the cause for the impaired exercise capacity because the intracellular pH difference between hemodialysis (HD) patients and renal transplant patients was not significant. Hand-grip dynamic exercise is thought to be independent to cardiac function. And also hand-grip dynamic exercise ability is determined by the coupling of the intrinsic metabolic capacity to the oxygen delivery capacity of blood circulation to muscle. Therefore improved oxidative ATP generation and oxygen conductance to muscle cells might be responsible for the recovery of exercise after successful renal transplantation because phosphocreatine level of HD patients was significantly lower in comparison to that of post renal transplant and normal controls.

References