**The Effects of Tai Chi on the Renal and Cardiac Functions of Patients with Chronic Kidney and Cardiovascular Diseases**

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**Abstract.** [Purpose] To assess the effects of Tai Chi on the renal and cardiac functions of patients with chronic kidney disease (CKD) and cardiovascular disease (CVD). [Subjects and Methods] Twenty-one patients with CKD and CVD were randomly divided into control and exercise groups. The exercise group performed Tai Chi training for 30 minutes three to five times a week for 12 weeks, while the control group did not. All patients’ renal and cardiac functions and blood lipid parameters were measured at baseline and after 12 weeks. [Results] The 12 weeks Tai Chi intervention improved the estimated glomerular filtration rate (eGFR), left ventricular ejection fraction (LVEF), and the high density lipoprotein (HDL) level, and decreased the serum creatinine (Scr) level, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and the total cholesterol (CH), triglyceride (TG) and low density lipoprotein (LDL) levels. The change in eGFR correlated negatively with the changes in CH, TG and LDL, and positively with the change in HDL. In addition, the change in SBP correlated positively with the changes in CH, TG and LDL, and negatively with the change in HDL. [Conclusion] Tai Chi training might improve the renal and cardiac functions of CKD and CVD patients via improved regulation of lipid metabolism.

**Key words:** Tai Chi, Renal function, Lipid metabolism

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**INTRODUCTION**

Chronic kidney disease (CKD), also known as chronic renal disease, is a gradual loss of kidney function over time. Many studies have demonstrated that CKD patients face increased risk of cardiovascular disease (CVD), which has a significant impact upon patient mortality[1–3]. Therefore, the prevention and treatment of CVD has become the key to the management of patients with CKD.

Patients with a range of CKD and CVD symptoms suffered from poor physical performance. Sietsema et al. found that reduced exercise capacity was associated with poorer survival among ambulatory patients with end-stage renal diseases[4]. Stack et al. also reported that physical exercise reduced by about 30% the risk of death of patients receiving hemodialysis[5]. Moreover, some studies have shown that appropriate physical activity such as aerobic exercise can improve the renal and cardiac functions of individuals with CKD[6–9]. Based on these observations, CKD patients are encouraged to exercise, particularly aerobic exercise exercises[8, 10]. Examples of aerobic exercise are brisk walking, jogging, swimming, cycling, climbing stairs, and Tai Chi. Tai Chi is a traditional Chinese exercise which has moderate intensity, and it has been found to benefit healthy persons and patients with Parkinson’s disease, heart failure, myocardial infarction, and hypertension, by improving the quality of life and cardiovascular function[11–13].

As a type of exercise for health and fitness, Tai Chi is widely practiced in many countries. However, the clinical effects and molecular mechanisms of Tai Chi in CKD patients have not been well studied. Therefore, it is important to further evaluate the effects of Tai Chi on CKD patients. In this study, we performed a clinical study and investigated whether Tai Chi can improve the renal and cardiac functions of patients with CKD and CVD.

**SUBJECTS AND METHODS**

This study was a 12 week randomized controlled trial which included 21 CKD patients with CVD. The patients were randomly divided into exercise (n=11) and control (n=10) groups. The exercise group performed Tai Chi training for 30 minutes three to five times a week for 12 weeks, while the control group did not. Both groups received routine medical treatment for CVD and CKD. We tested all patients’ renal and cardiac functions and blood lipid parameters at baseline and after 12 weeks.

The study protocol was carried out in accordance with the Declaration of Helsinki and was approved by the Medi...
We evaluated the effects of Tai Chi training on the renal, and cardiac functions and blood lipid parameters of patients.
with CKD and CVD. The 12 weeks of Tai Chi training resulted in significant changes in eGFR, CH, TG, LDL, HDL, HR, SBP, DBP, and LVEF in the exercise group while no changes were observed in the control group. To the best of our knowledge, this is the first clinical study to showing the potential benefits of Tai Chi training in CKD and CVD patients.

The presence of high TG and low HDL, as is well documented in previous reports, accelerates the progression of CKD. Aerobic exercise usually decreases TG and increases HDL in patients with CVD. Moreover, several studies have indicated that the elevation of the HDL level could improve renal function. Our results are consistent with these previous reports, which suggest that regular

Table 2. Comparison of renal function between baseline and 12 weeks

|                | Control group | Exercise group |
|----------------|---------------|----------------|
|                | Baseline      | 12 weeks       | Baseline      | 12 weeks       |
| BUN (mg/dl)    | 25.1±3.2      | 28.0±2.6       | 25.6±2.4      | 24.2±1.6       |
| Scr (mg/dl)    | 1.3±0.2       | 1.5±0.3        | 1.3±0.3       | 1.1±0.2        |
| eGFR (ml•min⁻¹•1.73m²⁻¹) | 45±8.5        | 43±7.8         | 45±7.6        | 51±6.5         |

*p<0.05 compared with the value at baseline, by the Wilcoxon’s test. ∆p<0.05 compared with the value in control group, by the Mann-Whitney U test. BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; Scr, serum creatinine

Table 3. Comparison of lipid parameters between baseline and 12 weeks

|                | Control group | Exercise group |
|----------------|---------------|----------------|
|                | Baseline      | 12 weeks       | Baseline      | 12 weeks       |
| CH (mmol/L)    | 5.63±0.77     | 5.70±0.83      | 5.60±0.81     | 5.03±0.92      |
| TG (mmol/L)    | 1.51±0.78     | 1.54±0.68      | 1.56±0.73     | 1.41±0.55      |
| LDL (mmol/L)   | 3.73±0.82     | 3.78±0.56      | 3.67±0.89     | 3.36±0.44      |
| HDL (mmol/L)   | 1.15±0.51     | 1.11±0.60      | 1.08±0.56     | 1.18±0.37      |

*p<0.05 compared with the value at baseline, by the Wilcoxon’s test. ∆p<0.05 compared with the value in control group, by the Mann-Whitney U test. CH, total cholesterol; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglyceride

Table 4. Comparison of cardiac function between baseline and 12 weeks

|                | Control group | Exercise group |
|----------------|---------------|----------------|
|                | Baseline      | 12 weeks       | Baseline      | 12 weeks       |
| SBP (mmHg)     | 145±21        | 149±19         | 142±18        | 129±16         |
| DBP (mmHg)     | 89±12         | 92±11          | 88±13         | 80±10          |
| HR (bpm)       | 72±11         | 73±12          | 74±10         | 65±8           |
| LVEF (%)       | 56.3±13.9     | 57.1±12.2      | 56.5±12.3     | 63.5±10        |
| LVDD (mm)      | 44.0±6.0      | 43.9±6.9       | 44.2±6.6      | 43.8±4.7       |
| LVSD (mm)      | 31.9±5.7      | 32.5±4.5       | 32.4±4.4      | 31.2±3.8       |

*p<0.05 compared with the value at baseline, by the Wilcoxon’s test. ∆p<0.05 compared with the value in control group, by the Mann-Whitney U test. DBP, diastolic blood pressure; HR, heart rate; LVDD, left ventricular diastolic diameter; LVEF, left ventricular ejection fraction; LVSD, left ventricular systolic diameter; SBP, systolic blood pressure

Table 5. Correlation of exercise group changes in eGFR, SBP and lipid parameters

|                | eGFR          | SBP            |
|----------------|---------------|----------------|
|                | r  | p  | r  | p  |
| CH (mmol/L)    | -0.462        | 0.036          | 0.487 | 0.035 |
| TG (mmol/L)    | -0.512        | 0.025          | 0.545 | 0.012 |
| LDL (mmol/L)   | -0.536        | 0.018          | 0.529 | 0.021 |
| HDL (mmol/L)   | 0.675         | 0.001          | -0.633 | 0.002 |

CH, total cholesterol; eGFR, estimated glomerular filtration rate; HDL, high density lipoprotein; LDL, low density lipoprotein; SBP, systolic blood pressure; TG, triglyceride
Tai Chi training can improve the renal and cardiac functions by promoting blood lipid metabolism, and especially HDL elevation. Consequently, Tai Chi appears to be an effective exercise for preventing the progression of CKD and CVD.

In spite of abundant evidence of the benefits of exercise for CKD and CVD patients, and the fact that exercise was first reported to improve abnormal metabolism in patients with CKD was first introduced 3 decades ago, therapeutic exercise for advanced CKD patients is still not widespread. What are the causes of the current situation? One possibility is that there is no specific exercise guideline for this group of patients yet. Another reason may be that the majority CKD and CVD patients fail to keep walking, jogging, swimming, cycling or climbing, because their condition makes them susceptible to fatigue rendering them to persist with such exercises. A third possibility is that some exercises require equipment which is unavailable for outpatients. Therefore, it is necessary to find a simple, easy, suitable available and effective way of exercise for patients with CKD and CVD. In view of the above requirements, Tai Chi is undoubtedly the best choice. Ours and others studies have demonstrated the broad benefits of Tai Chi for CKD and CVD patients.

Our study had several limitations. First, the present study was a small sample size pilot study, which only included 21 patients, and our results need to be confirmed in further larger trials. Second, the intervention period was only 12 weeks, and it is necessary to examine the long-term effects of Tai Chi training. Third, the lack of blinding with patients may have influenced our results. Furthermore, our study didn’t take gender, social status or severity of the disease into account. In addition, further studies are also needed to explore the combination effect of Tai Chi with resistance exercise on CKD and CVD. However, since the aim of our study was to confirm the beneficial effects of Tai Chi training on the renal and cardiac functions of patients with CKD and CVD, and we believe it is a valuable study in that it has provided results which warrant.

Our results confirmed Tai Chi training might improve the renal and cardiac functions of patients with CKD and CVD through modification of blood lipid metabolism. Although further investigations are needed to uncover the mechanisms behind the improvements, Tai Chi may be an easy and effective clinical treatment strategy for preventing the progression of CKD and CVD, enhancing live quality of life, and increasing life span.

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