

## Tai Chi Chuan for Cardiac Rehabilitation in Patients with Coronary Arterial Disease

Rosane Maria Nery<sup>1,2</sup>, Maurice Zanini<sup>1,2</sup>, Juliana Nery Ferrari<sup>1,2</sup>, César Augusto Silva<sup>1</sup>, Leonardo Fontanive Farias<sup>1</sup>, João Carlos Comel<sup>1,2</sup>, Karlyse Claudino Belli<sup>1,2</sup>, Anderson Donelli da Silveira<sup>1,3</sup>, Antonio Cardoso Santos<sup>2</sup>, Ricardo Stein<sup>1,3</sup>

Hospital de Clínicas de Porto Alegre<sup>1</sup>, Porto Alegre; Universidade Federal do Rio Grande do Sul (UFRGS)<sup>2</sup>, Porto Alegre; Vitta Centro de Bem-Estar Físico<sup>3</sup>, Porto Alegre, RS – Brazil

### Abstract

**Background:** Several studies have shown that Tai Chi Chuan can improve cardiac function in patients with heart disease.

**Objective:** To conduct a systematic review of the literature to assess the effects of Tai Chi Chuan on cardiac rehabilitation for patients with coronary artery disease.

**Methods:** We performed a search for studies published in English, Portuguese and Spanish in the following databases: MEDLINE, EMBASE, LILACS and Cochrane Register of Controlled Trials. Data were extracted in a standardized manner by three independent investigators, who were responsible for assessing the methodological quality of the manuscripts.

**Results:** The initial search found 201 studies that, after review of titles and abstracts, resulted in a selection of 12 manuscripts. They were fully analyzed and of these, nine were excluded. As a final result, three randomized controlled trials remained. The studies analyzed in this systematic review included patients with a confirmed diagnosis of coronary artery disease, all were clinically stable and able to exercise. The three experiments had a control group that practiced structured exercise training or received counseling for exercise. Follow-up ranged from 2 to 12 months.

**Conclusion:** Preliminary evidence suggests that Tai Chi Chuan can be an unconventional form of cardiac rehabilitation, being an adjunctive therapy in the treatment of patients with stable coronary artery disease. However, the methodological quality of the included articles and the small sample sizes clearly indicate that new randomized controlled trials are needed in this regard. (Arq Bras Cardiol. 2014; 102(6):588-592)

**Keywords:** Coronary Artery Disease / rehabilitation; Tai Ji; Exercise.

### Introduction

In Brazil, cardiovascular diseases, in particular coronary arterial disease (CAD), are one of the major causes of morbidity/mortality and are responsible for a significant share of costs associated with hospitalizations in the Sistema Único de Saúde (National Health System) and pharmacological management<sup>1-3</sup>. In this context, nonpharmacological approaches such as lifestyle modifications and regular practice of physical exercise have been investigated with the aim of offering patients better treatment and decreasing the overall cost for the Brazilian healthcare system<sup>3,4</sup>. Patients who undergo exercise-based therapy are likely to exhibit an improvement in several aspects of cardiopulmonary function, which optimizes

the balance between oxygen supply and demand in the ischemic myocardium<sup>5-11</sup>.

Some oriental exercises deserve special attention because they are accessible, inexpensive, and can be performed within the community<sup>12</sup>. Of the various techniques available, we highlight Tai Chi Chuan (TCC), an ancient Chinese martial art that includes low to moderate intensity traditional aerobic exercises<sup>13</sup>. This practice essentially involves learning a sequence of movements that can vary according to different styles. Most preliminary exercises include circular displacements with circular and spiral body movements. The sequence is nothing more than a basis for detailed work on the body and mind<sup>12</sup>. In China, TCC has been used for centuries as an exercise for people of various age groups; it is very popular among the elderly<sup>14</sup>. Individuals practice TCC primarily to develop mind-body interaction, breathing and movement control, eye-hand coordination, and a peaceful state of mind. With the aging of the world population and increasing healthcare costs, the interest toward TCC has increased, and it is now used for the management of chronic diseases of various etiologies<sup>14-18</sup>.

The present study aimed to conduct a systematic review of the literature on studies that examine TCC as a modality for cardiac rehabilitation and raise questions for future research on the use of TCC in CAD patients.

#### Mailing Address: Ricardo Stein •

Grupo de Pesquisa em Cardiologia do Exercício (CardioEx); Serviço de Cardiologia - Hospital de Clínicas de Porto Alegre - Rua Ramiro Barcelos, 2.350, sala 2061. Postal Code 90035-007, Porto Alegre, RS - Brazil

E-mail: rstein@cardiol.br

Manuscript received August 29, 2013; revised manuscript October 16, 2013; accepted October 16, 2013.

DOI: 10.5935/abc.20140049

## Methods

### Eligibility criteria

Randomized clinical trials (RCT) published in English, Spanish, and Portuguese that reported on TCC training in patients aged > 18 years with confirmed CAD were included. It was necessary to include a control group that practiced any type of structured physical exercise (aerobic, resistance, or a combination of both) and/or received counseling for physical exercise.

Structured physical exercise was defined as an intervention wherein patients were engaged in a planned program with individualized exercises under the supervision of qualified professionals. Counseling for physical exercise was defined as an intervention wherein the patients, although not involved or partially involved in supervised physical training, received formal instructions to perform regular exercise with or without individualized prescription.

### Exclusion criteria

Studies that examined cardiovascular outcomes in healthy individuals, RCTs conducted in patients with stroke, duplicated publications or substudies of the included studies, and studies with a follow-up duration of < 8 weeks were excluded.

### Search strategy and study selection

We searched the electronic databases MEDLINE (accessed via PubMed), EMBASE, LILACS, and Cochrane Controlled Trials Register (Cochrane CENTRAL) without data restriction. In addition, we assessed the references cited in the included studies. The literature search was conducted in July 2012, and the review of articles was performed in triplicate by independent investigators. The search strategy via MEDLINE included the following terms: ["Ischemic heart disease"(Mesh) OR "Ischemia, Myocardial" OR "Ischemias, Myocardial" OR "Myocardial Ischemias" OR "Ischemic Heart Disease" OR "Heart Disease, Ischemic" OR "Disease, Ischemic Heart" OR "Diseases, Ischemic Heart" OR "Heart Diseases, Ischemic" OR "Ischemic Heart Diseases"] OR ["Coronary disease"(Mesh) OR "Coronary Diseases" OR "Disease, Coronary" OR "Diseases, Coronary" OR "Coronary Heart Disease" OR "Coronary Heart Diseases" OR "Disease, Coronary Heart" OR "Diseases, Coronary Heart" OR "Heart Disease, Coronary" OR "Heart Diseases, Coronary"] AND ["Tai ji"(Mesh) OR "Tai-ji" OR "Tai Chi" OR "Chi, Tai" OR "Tai Ji Quan" OR "Ji Quan, Tai" OR "Quan, Tai Ji" OR "Taiji" OR "Taijiquan" OR "Tai Chi" OR "Tai Chi Chuan"].

First, a reference database was created and duplicates were excluded. Subsequently, three independent investigators (CAS, LFF, and JNF) reviewed the titles and abstracts. Abstracts that did not meet the eligibility criteria were excluded, and the full text of Abstracts that did not provide sufficient information about inclusion and exclusion criteria was reviewed. In a second stage, the same reviewers assessed and selected the full texts, blinded to each other's review. Differences among the reviewers were solved by consensus.

### Data extraction and quality assessment

The three reviewers used the same standardized forms to independently perform data extraction. We collected data referring to the studies' methodological characteristics, interventions, and outcomes (maximum or peak oxygen consumption, arterial pressure, and heart rate); the differences were solved by consensus.

### Assessment of the risk of bias

The quality of the studies in terms of randomization was assessed independently as follows: blinding of the patients and evaluators of outcomes regarding allocation, analysis of intention-to-treat, and report of losses or exclusions. The authors' description of the analysis of intention-to-treat was assumed as a criterion for assurance that both baseline and final evaluations used the same number of patients, excluding those who were lost or eliminated from the study. Studies that did not describe an analysis of intention-to-treat, those that did not describe the total number of patients at the end of the study, and those in which the number of patients at the beginning and end was not the same were considered to not meet this criterion. The methodological quality of each study was assessed using the Cochrane Handbook<sup>19</sup>. (Table 1).

## Results

### Description of the studies

Our search resulted in 201 abstracts with language restrictions (English, Portuguese, and Spanish). After the titles and abstracts were reviewed, a total of 12 articles met the eligibility criteria and were completely analyzed (Figure 1). Of these 12 articles, nine were excluded: three that did not mention the use of randomization in patient allocation, two in which the control group did not receive guidance with regard to physical exercise, one that was a systematic review, one that was a report of preliminary data, and two that did not provide the full text of the article (one only had the abstract, and we could not buy it or contact the authors). Therefore, three studies were included in this systematic review. The latter included samples of patients diagnosed with ischemic disease who were clinically stable and able to exercise (Table 2). The follow-up duration varied between 2 and 12 months.

### Risk of bias

Of the studies included in the systematic review, 100% were randomized. None of them described the blinding of allocation, blinding of patients and researchers, or blinding of the evaluators of outcomes in detail. None of the studies made explicit use of the intention-to-treat principle in their statistical analyses.

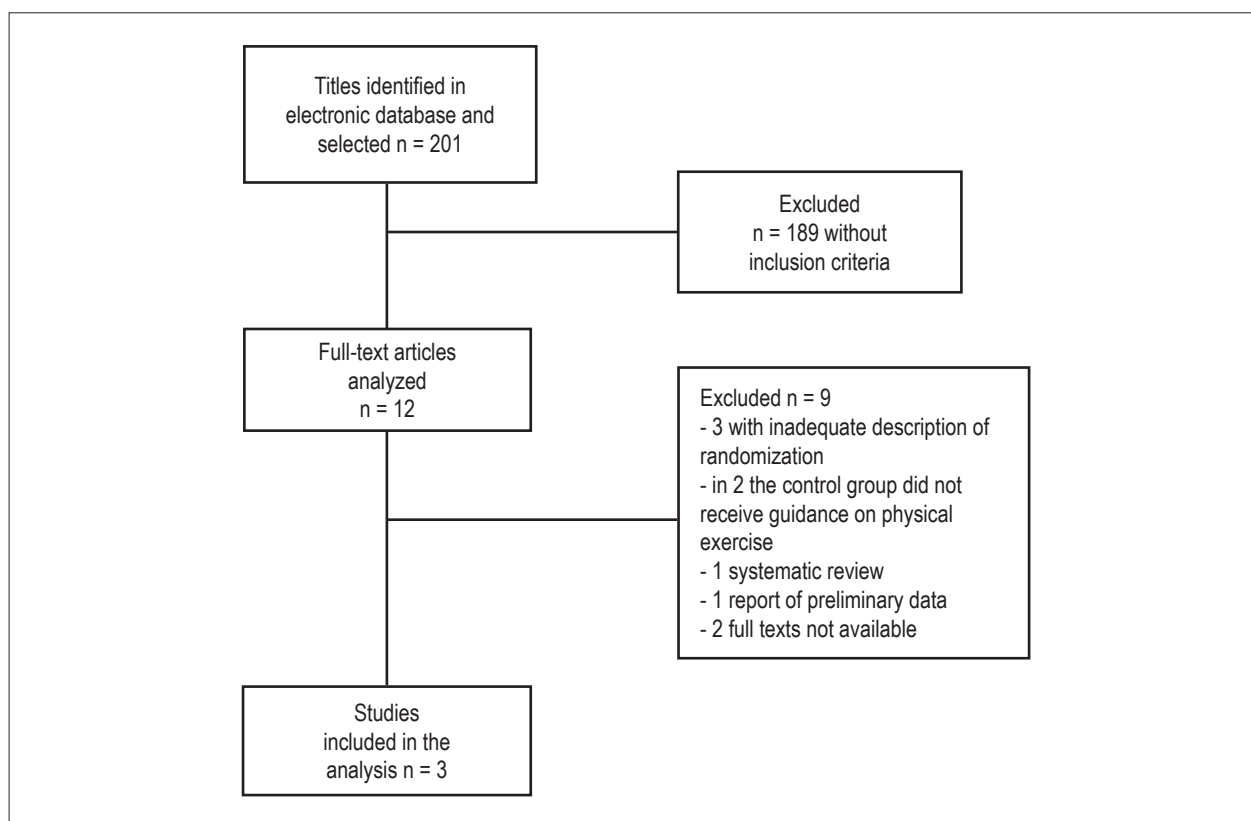
### Effects of interventions

In the first clinical trial, Channer et al<sup>20</sup> randomized patients with acute myocardial infarction into a group that practiced TCC, a group that practiced conventional aerobic exercise, and a control group that was given health and relaxation advice. After 2 months, the TCC and aerobic exercise groups

**Table 1 – Criteria for the evaluation of the methodological quality adapted from the Cochrane handbook**

Study	The study mentions randomization in the text	Generation of the sequence of randomization	Blinding of allocation	Blinding of the participants and personal evaluations	Blinding of the evaluation of results	The evaluation of results of incomplete data	Selected publications
Channer et al <sup>20</sup>	A	NC	NC	NC	NC	I	I
Sato et al <sup>21</sup>	A	NC	NC	NC	NC	NC	A
Liu et al <sup>22</sup>	A	NC	NC	I	NC	A	A

A, adequate; NC, not clear; I, inadequate



**Figure 1 – Study selection flowchart.**

exhibited a decreased systolic arterial pressure. Patients in the TCC group, in addition to a decrease in resting heart rate after exercise, exhibited greater adherence to the training sessions. There was no comparison between groups.

In the study by Sato et al<sup>21</sup>, the randomized subjects in the TCC group exhibited a significant increase in baroreflex sensitivity after 12 months of follow-up, whereas those in the control group did not. The results were adjusted for age, gender, ejection fraction, and body mass index. Changes in the parameters of heart rate variability did not exhibit differences between the groups.

The third RCT included in this review assessed outcomes related to the patients' functional capacity. After 3 months of follow-up, the participants in the TCC group exhibited an

increase in the chair stand test score and one-leg stand test time and were faster than individuals in the control group in the 8-foot up-and-go test. In addition, the TCC group exhibited increased flexibility and an increased number of repetitions in the step test<sup>22</sup>.

## Discussion

### Summary of the evidence

The results of this systematic review suggest that the use of TCC as an exercise and cardiac rehabilitation strategy can have beneficial effects in CAD patients. However, evidence from the western literature is limited, and the studies lack methodological rigor as well as more relevant outcomes.

**Table 2 – Studies that compared Tai Chi Chuan to structured physical training or counseling for physical activity in patients with ischemic cardiac disease**

Study	Total number of individuals (men/women)	Age (years)	Main diagnosis	Intervention/control	Duration (months)	Mean Delta in the Tai Chi Chuan group
Channer et al <sup>20</sup>	126 (90/36)	56 (39– 80)	Acute myocardial infarction	Tai Chi Chuan, aerobic exercise, Health and relaxation education group	2	Heart rate: +2 bpm Systolic arterial pressure: -3 mmHg Diastolic arterial pressure: -2 mmHg
Sato et al <sup>21</sup>	20 (13/7)	68 ± 4	Coronary arterial disease	Tai Chi Chuan Usual care group with physical activity counseling	12	Peak oxygen consumption: +0.1 L.min <sup>-1</sup> Heart rate: -4 bpm Systolic arterial pressure: -6 mmHg Baroreflex sensitivity: +2,2 ms/mmHg; variability in heart rate Low frequency: -16 ms <sup>2</sup> High frequency: +18 ms <sup>2</sup>
Liu et al <sup>22</sup>	30 (18/12)	NA	Post-event or heart surgery	Tai Chi Chuan Cardiac rehabilitation group	3	Chair stand: +3 repetitions Sit and stand test: +3 repetitions Step test: +29 repetitions 8-foot up-and-go: -1 s One-leg stand: +29 s

NA: not available.

### Positive aspects

This systematic review had some strengths. First, it was a focused review. Second, it was based on a comprehensive and systematic bibliographic search. Third, it employed methodology that used explicit and reproducible eligibility criteria. Lastly, it was conducted in collaboration with a multidisciplinary team of researchers (physicians, physiotherapists, and physical exercise counselors).

### Limitations

This systematic review also has some limitations. Because most of the results reported were positive, the possibility of publication bias cannot be ruled out. Moreover, we observed that these RCTs were methodologically limited by a certain degree of measurement bias because there was no reference to blinding (patients, therapists, and evaluators) or confidentiality regarding blinding of allocation. Finally, our search was restricted to studies published in English, Spanish, and Portuguese. It is possible that articles on TCC as a form of CAD rehabilitation have been published in Mandarin or in other languages.

### Conclusions

This review analyzed the literature on the beneficial use of TCC, a nonconventional therapy, for the rehabilitation of patients with CAD through a systematic search of various electronic databases. However, the methodological quality of the included articles and the small size of the samples indicate a clear need for new randomized clinical trials on this subject.

It is worth noting that, because of the small number of studies published in this area of knowledge and the limited variety of outcomes, it was not possible to conduct a systematic review with a meta-analysis.

### Author contributions

Conception and design of the research: Nery RM, Stein R; Acquisition of data: Nery RM, Zanini M, Ferrari JN, Silva CA, Farias LF, Comel JC; Analysis and interpretation of the data: Nery RM, Zanini M, Ferrari JN, Silva CA, Farias LF, Comel JC, Belli KC, Silveira AD; Statistical analysis: Nery RM, Zanini M, Belli KC; Obtaining financing: Nery RM; Writing of the manuscript: Nery RM, Zanini M, Belli KC, Silveira AD, Santos AC, Stein R; Critical revision of the manuscript for intellectual content: Nery RM, Zanini M, Ferrari JN, Silva CA, Farias LF, Comel JC, Belli KC, Silveira AD, Santos AC, Stein R.

### Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

### Sources of Funding

This study was funded by FIPE - HCPA - CNPq. Ricardo Stein is Level 2 CNPq investigator.

### Study Association

This article is part of the thesis of Doctoral submitted by Rosane Maria Nery from Universidade Federal do Rio Grande do Sul.

## References

1. Lloyd-Jones D, Adams RJ, Brown TM, Carnethon M, Dai S, De Simone G, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics--2010 update: a report from the American Heart Association. *Circulation*. 2010;121(7):948-54.
2. Szwarcwald CL, Viacava F, Vasconcellos MT, Leal MC, Azevedo LO, Queiroz RS, et al. Pesquisa mundial de saúde 2003. *Radis/FIOCRUZ*. 2004;23:14-33.
3. Ribeiro RA, Mello RC, Melchior R, Dill JC, Hohmann CB, Lucchese AM, et al. [Annual cost of ischemic heart disease in Brazil. Public and private perspective]. *Arq Bras Cardiol*. 2005;85(1):3-8.
4. Yeh CY, Wang C, Wayne PM, Phillips R. Tai chi exercise for patients with cardiovascular conditions and risk factors: a systematic review. *J Cardiopulm Rehabil Prev*. 2009;29(3):152-60.
5. Piegas LS, Feitosa C, Mattos LA, Nicolau JC, Rossi Neto JM, Timerman A, et al; Sociedade Brasileira de Cardiologia. Diretriz da Sociedade Brasileira de Cardiologia sobre tratamento do infarto agudo do miocárdio com supradesnível do segmento ST. *Arq Bras Cardiol*. 2009;93(6 supl.2):e179-264.
6. Franklin BA, Kahn JK. Delayed progression or regression of coronary atherosclerosis with intensive risk factor modification: effects of diet, drugs, and exercise. *Sports Med*. 1996;22(5):306-20.
7. Oldridge N. Exercise-based cardiac rehabilitation in patients with coronary heart disease: meta-analysis outcomes revisited. *Future Cardiol*. 2012;8(5):729-51.
8. Briffa TG, Eckermann SD, Griffiths AD, Harris PJ, Heath MR, Freedman SB, et al. Cost-effectiveness of rehabilitation after an acute coronary event: a randomised controlled trial. *Med J Aust*. 2005;183(9):450-5.
9. Yeh CY, Wood MJ, Lorell BH, Stevenson LW, Eisenberg DM, Wayne PM, et al. Effects of tai chi mind-body movement therapy on functional status and exercise capacity in patients with chronic heart failure: a randomized controlled trial. *Am J Med*. 2004;117(8):541-8.
10. O'Connor GT, Buring JE, Yusuf S, Goldhaber SZ, Olmstead EM, Paffenbarger RS, et al. An overview of randomized trials of rehabilitation with exercise after myocardial infarction. *Circulation*. 1989;80(2):234-44.
11. Lu WA, Kuo CD. The effect of Tai Chi Chuan on the autonomic nervous modulation in older persons. *Med Sci Sports Exerc*. 2003;35(12):1972-6.
12. Lan C, Lai JS, Chen SY. Tai Chi Chuan: an ancient wisdom on exercise and health promotion. *Sports Med*. 2002;32(4):217-24.
13. Hong Y, Li JX, Robinson PD. Balance control, flexibility, and cardiorespiratory fitness among older Tai Chi practitioners. *Br J Sports Med*. 2000;34(1):29-34.
14. Li F, Harmer P, Glasgow R, Mack KA, Sleet D, Fisher KJ, et al. Translation of an effective tai chi intervention into a community-based falls-prevention program. *Am J Public Health*. 2008;98(7):1195-8.
15. Zeeuwe PE, Verhagen AP, Bierma-Zeinstra SM, Van Rossum E, Faber MJ, Koes BW. The effect of Tai Chi Chuan in reducing falls among elderly people: design of a randomized clinical trial in the Netherlands [ISRCTN98840266]. *BMC Geriatr*. 2006;6:6.
16. Mustian KM, Palesh OG, Flecksteiner SA. Tai Chi Chuan for breast cancer survivors. *Med Sport Sci*. 2008;52:209-17.
17. Tsang T, Orr R, Lam P, Comino EJ, Singh MF. Health benefits of Tai Chi for older patients with type 2 diabetes: the "Move it For Diabetes Study"--a randomized controlled trial. *Clin Interv Aging*. 2007;2(3):429-39.
18. Fransen M, Nairn L, Winstanley J, Lam P, Edmonds J. Physical activity for osteoarthritis management: a randomized controlled clinical trial evaluating hydrotherapy or tai chi classes. *Arthritis Rheum*. 2007;57(3):407-14.
19. Cochrane handbook for systematic reviews of interventions. 4.2.6. [Cited in 2012 Nov 11]. Disponível em: <http://www.cochrane.org/training/cochrane-handbook>.
20. Channer KS, Barrow D, Barrow R, Osborne M, Ives G. Changes in haemodynamic parameters following tai chi chuan and aerobic exercise in patients recovering from acute myocardial infarction. *Postgrad Med J*. 1996;72(848):349-51.
21. Sato S, Makita S, Uchida R, Ishihara S, Masuda M. Effect of Tai Chi training on baroreflex sensitivity and heart rate variability in patients with coronary heart disease. *Int Heart J*. 2010;51(4):238-41.
22. Liu J, Li B, Shnyder R. Effects of tai chi training on improving physical function in patients with coronary heart disease. *J Exerc Sci Fit*. 2010;8(2):78-84.