

Effect of Kao-Ta (9-Square Step Exercise) and Kao-Ten (9-Square Dance Exercise) on Balance Rehabilitation in Patients with Balance Disorders

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ABSTRACT

Objective: To study the effect of Kao-ta (9-square step exercise) and Kao-ten (9-square dance exercise) on balance improvement in patients with balance disorders.

Methods: This prospective pilot study in patients with balance disorders was conducted at the outpatient clinic, Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand from December 2015 to December 2016. Patients diagnosed by clinical symptoms and at least one abnormal condition on posturography were taught how to perform Kao-ta and Kao-ten exercise. Participants were provided with the equipment necessary to create a nine square grid at home. They were instructed to perform 3 minutes of Kao-ta followed by 2 minutes of Kao-ten twice per day for at least 45 days in an 8-week period. Posturography and visual analogue scale (VAS) of balance symptom severity were compared between before and after exercise program.

Results: Eleven patients with balance disorders were included. The mean age was 57.2 ± 12.9 years (range: 33-70), and all patients were women. The average composite equilibrium score at baseline was 64.4 ± 8.1 . After 8 weeks of Kao-ta and Kao-ten, the average composite equilibrium score increased to 73.8 ± 10.2 ($p < 0.01$). The median (P25, P75) of the abnormal equilibrium score condition decreased from 2 (1, 3) at baseline to 1 (0, 2) after 8 weeks ($p = 0.016$). The median VAS of balance symptom severity decreased from 4 (3, 6) at baseline to 2 (0.2, 5.5) after 8 weeks ($p = 0.028$).

Conclusion: Kao-ta and Kao-ten exercise can improve symptoms in patients with balance disorders after 8 weeks of exercise

Keywords: Kao-ta, Kao-ten, balance rehabilitation, patients, balance disorders, Thai traditional medicine (Siriraj Med J 2019;71: 1-7)

INTRODUCTION

Balance disorders can be found in any age group, but they are more commonly observed in older adults. The prevalence of balance disorder complaints is 5-10% of patients among general practitioners, and 10-20% of patients among otorhinolaryngologists.¹ During

2014-2016, about 12% of the patients (7,250 patients) that visited the outpatient clinic of the Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital had balance disorder, and 48.12% of those were aged greater than 60 years.

Balance requires coordination among the visual,

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Received 13 June 2018 Revised 28 September 2018 Accepted 7 November 2018

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doi: <http://dx.doi.org/10.33192/Smj.2019.01>

proprioceptive, and inner ear vestibular systems. The central nervous system receives inputs from these systems, and then sends back information to effectuate muscle control of the eyes, neck, torso, and extremities to maintain balance. Any impairment along any of these pathways can cause balance disorders and/or vertigo.

Treatments of balance disorders and vertigo include:

1. Specific treatment, such as canalith repositioning for benign paroxysmal positional vertigo. It should be noted that many diseases have no specific treatment, and some diseases are incurable.

2. Symptomatic treatment, which consists mostly of medication therapy

3. Balance rehabilitation

When balance disorders occur, the vestibular system will initiate compensatory adaptations in an effort to correct the aberration. These adaptations and recovery of defective functions can take days to weeks. However, balance may not fully recover in all patients, and rehabilitation plays a key role in the recovery of balance in this group.

The goal of rehabilitation is to improve overall body balance. Cawthorne-Cooksey exercise, which was introduced in 1940, is one of the most well-known imbalance rehabilitation methods.² This exercise is indicated in patients with prolonged symptoms or partial recovery. Cawthorne-Cooksey exercise can improve balance in up to 50-80% of patients³⁻⁵, and it has demonstrated benefit in patients with acute vertigo. Other traditional exercises, such as Tai chi⁵⁻⁷ and Wii Fit⁸, have shown rehabilitation benefit in patients with balance disorders. A 2008 study in aquatic physiotherapy using whirlpool as part of an exercise protocol revealed positive effects on unilateral vestibular hypofunction.⁹

Kao-ta (9-square step exercise) or Ouay's Test is a form of exercise invented in 1970 by Professor Dr. Ouay Ketusinh, a renowned Professor of Physiology from the Faculty of Medicine Siriraj Hospital, Mahidol University. Professor Dr. Ouay Ketusinh also founded a Thai traditional medical school that was later named the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. In 1972, he presented his invention Nine Square Test or Ouay's Test to the International Committee on the Standardization of Physical Fitness Test (ICSPFT) in Cologne, Germany. He later presented his Nine Square Health Twist exercise (original name of the 9-square dance exercise) at the Olympic Conference in the same year. He published his article describing Kao-ta and Kao-ten in Thai language in 1984.¹⁰

Kao-ta was originally employed as a speed test.

Kao-ten (9-square dance exercise), which was developed from Kao-ta, requires more coordination than Kao-ta because it includes many body turns.¹¹ A user of either exercise maneuvers his/her body within a square somehow drawn or represented on the floor or ground. The box, which can have overall dimensions of 90 x 90 cm, 120 x 120 cm, or 150 x 150 cm, is divided into 9 equal sized boxes – 3 at the bottom, 3 at the middle, and 3 at the top (Fig 1 and 2). Both exercises are safe and easy to perform without elaborate equipment, and both are health promotion techniques that are taught in Thai traditional medicine. Although another original goal of these exercises was to strengthen the cardiovascular system among older adults, the fact that both involve head turning and body balance indicates that they are rooted in the same principles as other balance improvement exercises.

The aim of this first ever pilot study was to investigate the efficacy of Kao-ta and Kao-ten Thai exercises for improving symptoms in patients with balance disorders. Subjective evaluation using VAS symptom score, and objective evaluation using posturography score were compared between before and after the prescribed 8-week Thai exercise program.

MATERIALS AND METHODS

This prospective pilot study in patients with balance disorders was conducted at the outpatient clinic of the Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during the December 2015 to December 2016 study period. Siriraj Hospital is Thailand's largest national tertiary referral center. Patients aged 18-70 years with persistent and prolonged (more than 4 weeks) balance disorder were enrolled. Balance disorders included vestibular neuritis, dizziness in the elderly or vestibulopathy, and inability to maintain balance in at least one (out of six) condition on posturography. Patients having one or more of the following were excluded: inability to properly or adequately perform Kao-ta and/or Kao-ten (e.g., neuromuscular disorder, vision defect); having central cause of balance disorders; having psychiatric problems; and/or, having disease with specific treatment (e.g., benign paroxysmal positional vertigo). The protocol for this study as approved by the Siriraj Institutional Review Board (COA no. SI 704/2015), and all included patients provided written informed consent.

The objective evaluation of balance was performed using SMART Equitest® Computerized Dynamic Posturography (NeuroCom International, Inc., Clackamas, OR, USA). Briefly, patients stand on a support surface that can be

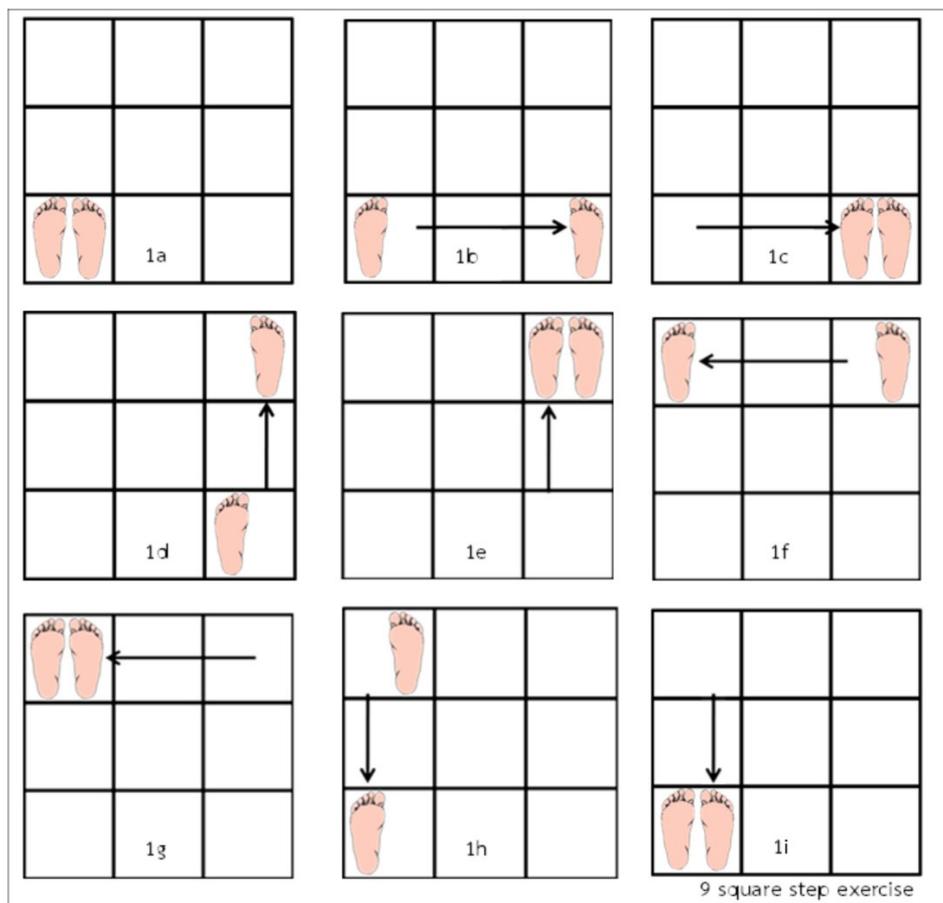


Fig 1. Kao-ta (9-square step exercise)

Preparatory position: Stand with both feet within the bottom left square (1a).

Exercise steps: Moving in a counterclockwise direction, move your right foot directly to the right into the bottom right square (1b), followed then by your left foot. Now both of your feet are once again in the same square (1c). Now move your right foot straight ahead to the top right square (1d), followed then by your left foot (1e). Now move your left foot directly to the left into the top left square (1f), followed then by your right foot (1g). Now, move your left foot directly backwards to the bottom left square, which is where you first started (1h), followed then by your right foot (1i). Now that you have completed one cycle of the exercise, move to the bottom right square to begin, except now you will repeat these movements going in the opposite (clockwise) direction.

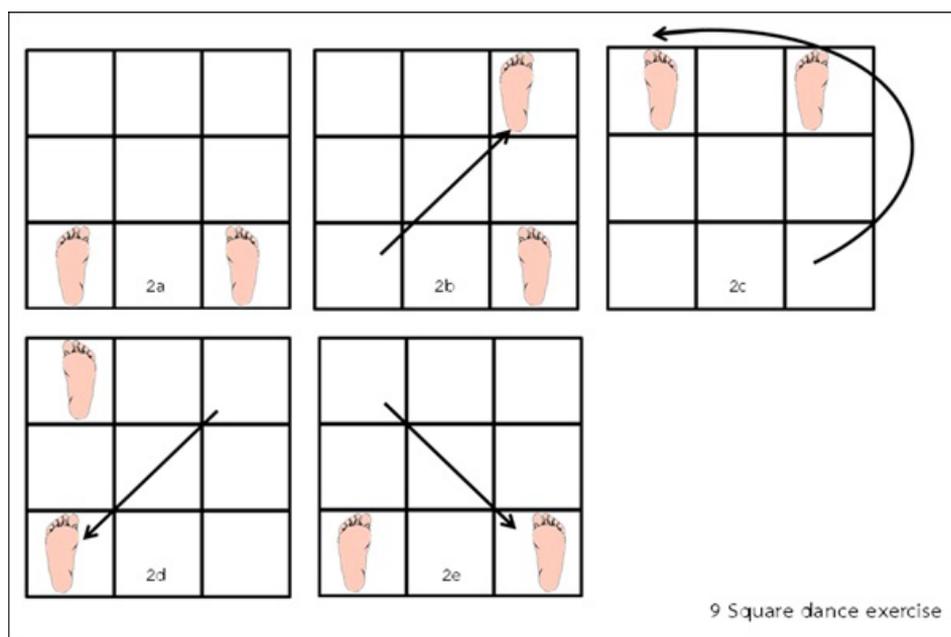


Fig 2. Kao-ten (9-square dance exercise)

Preparatory position: Stand with your feet apart, with your left foot in the bottom left square, and your right foot in the bottom right square (2a).

Exercise steps: Move your left foot diagonally to the top right square (2b). Now bring your right leg around the front of your left leg, and position your right foot in the top left square (2c). Now move your left foot back to the bottom left square where you started with your left foot (2d), followed by movement of your right foot to the bottom right square where you started with your right foot (2e). Then you will repeat these movements going in the opposite direction.

controlled to be level or tilted. Located in front of the patient is a visual field that can be stable or moved in and out. The result of this test is the “equilibrium score”, which is an average of body balance in 6 different conditions. Persons with normal balance have normal results in all conditions. The result is also reported as how many of the equilibrium conditions are abnormal out of the six conditions. The program then uses the equilibrium score and the degrees of sway to calculate a “composite equilibrium score”, which is a weighted average of all 6 tested conditions. An improvement in the composite equilibrium score of greater than 2 standard deviations or 8 points compared to age-matched normative data within the system is considered a meaningful improvement in balance.^{12,13}

The subjective evaluation of the severity of patient imbalance was performed using a visual analogue scale (VAS). Patients rated the intensity of their imbalance using a 10 cm VAS, with a 0 indicating no symptoms of imbalance, and a 10 indicating the worst possible level of imbalance.¹⁴

Patients were taught how to correctly perform the Kao-ta and Kao-ten exercises by instructors from the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University. Each participant was also given an instruction manual (Fig 1 and 2), a music CD (with a rhythm and beat matched to the steps of the exercises), and corrugated plastic sheets with a roll of colored adhesive tape that were together used to make a nine square grid. A video clip of the Kao-ta and Kao-ten exercises is available at http://www.si.mahidol.ac.th/ent/knowledge/videos/kao-ta_kao-ten_exercise.php.

Patients had to perform the Kao-ta and Kao-ten exercises to music twice a day for a total of 5 minutes per session. Each session consisted of Kao-ta for 3 minutes, followed by Kao-ten for 2 minutes. Each patient had to perform at least 45 days of exercise within the 8-week study period (80% of days). Since balance disorder patients are at higher risk for falling, all study participants were asked to perform their exercises in their bare feet. No socks or slippers were allowed. Moreover, it was recommended that a caretaker participate as an observer during each exercise session in case of a fall or some other unexpected event. Patients were advised to take a dimenhydrinate tablet as rescue medication if severe symptoms developed. Patients were instructed to record the time and date of their exercises, and any adverse events in a logbook that was provided to each study participant.

The results of posturography testing and VAS scores of all patients were recorded at baseline and after the

8-week exercise program. Patients were asked to return to the clinic for a follow-up visit at 4 weeks so that we could check their logbooks, inquire about adverse events, evaluate patient satisfaction, and ensure that the exercises were being performed correctly.

Statistical analysis

PASW Statistics for Windows version 18.0 (SPSS, Inc., Chicago, IL, USA) was used to perform all statistical analyses. Descriptive statistics are reported as mean \pm standard deviation, number and percentage, or median (P25, P75). Paired t-test was used to compare composite equilibrium scores, and Wilcoxon signed-rank test was used to compare equilibrium scores and VAS symptom scores between baseline and after 8 weeks of exercise. A *p*-value less than 0.05 was regarded as being statistically significant.

RESULTS

Of the 12 patients that initially enrolled, one patient was not able to complete the study due to imbalance symptoms that were too severe to perform Kao-ta and Kao-ten. The remaining 11 patients completed the study and were included in the final analysis. The mean age of patients was 57.2 ± 12.9 years (range: 33-70), and all of them were women. The diagnoses of study participants were, as follows: nonspecific dizziness (7 patients, 63.6%), vestibulopathy (3 patients, 27.3%), and probably Meniere's disease (1 patient, 9.1%) (Table 1).

Posturography

The average composite equilibrium score at baseline was 64.4 ± 8.1 . After 8 weeks of Kao-ta and Kao-ten, the mean \pm standard deviation composite equilibrium score increased to 73.8 ± 10.2 ($p < 0.01$). The median (P25, P75) of abnormal equilibrium score condition decreased from 2 (1, 3) at baseline to 1 (0, 2) after 8 weeks ($p = 0.016$). After 8 weeks of exercise, 10 patients (90.9%) had improvement in their composite equilibrium score, and 6 of them (54.5%) had scores that increased by at least 8 points. Seven of 11 patients (63.6%) had at least one condition that returned to normal after completion of the 8-week exercise program (Tables 2 and 3).

Visual analogue scale (VAS)

The median (p25, P75) VAS of balance symptom severity decreased from 4 (3, 6) at baseline to 2 (0.2, 5.5) after 8 weeks ($p = 0.028$). Nine patients (81.8%) rated their severity of imbalance as improved (Tables 2 and 3). Four patients (36.6%) were unable to complete a full 5 minutes of exercise during the first one or two days; however,

TABLE 1. Demographic characteristics and clinical diagnosis of the 11 study participants.

Age (years), mean±SD (range)	57.2 ± 12.9 (range: 33-70)
Gender, n (%)	
Male	0 (0.0%)
Female	11 (100%)
Diagnosis, n (%)	
Nonspecific dizziness	7 (63.6%)
Vestibulopathy	3 (27.3%)
Probable Meniere's disease	1 (9.1%)

Abbreviation: SD=standard deviation

TABLE 2. Clinical diagnosis and result of objective test and subjective VAS symptom score.

Patient	Age (yr)	Diagnosis	Composite equilibrium score		Equilibrium score (number of abnormal conditions)		VAS	
			Pre	Post	Pre	Post	Pre	Post
1	51	Probable Meniere's disease	43	50	5	5	6.8	6
2	69	Vestibulopathy	66	72	2	1 [†]	4.5	5.5
3	70	Vestibulopathy	65	73*	1	1	3	1
4	33	Vestibulopathy	67	85*	3	0 [†]	3	2
5	65	Nonspecific dizziness	69	76	2	1 [†]	7.5	5.5
6	67	Nonspecific dizziness	70	70	2	2	4	0.2
7	68	Nonspecific dizziness	69	78*	1	0 [†]	5	3
8	42	Nonspecific dizziness	71	84*	1	0 [†]	4	1
9	58	Nonspecific dizziness	68	81*	2	0 [†]	6	0
10	43	Nonspecific dizziness	63	80*	2	0 [†]	0	0
11	63	Nonspecific dizziness	57	63	3	3	3	4

*Composite equilibrium score increased ≥8 points

[†]Abnormal equilibrium score that returned to normal in at least 1 condition

Abbreviations: VAS=visual analog scale; Pre=before exercise; Post=after 8 weeks of exercise

TABLE 3. Comparison of composite equilibrium score, abnormal equilibrium score condition, visual analogue score (VAS) before and after 8 weeks of exercise.

	Before exercise	After exercise	P-value
Composite equilibrium score	64.4 ± 8.1	73.8 ± 10.2	<0.01
Abnormal equilibrium score condition*	2 (1, 3)	1 (0, 2)	0.016
VAS	4 (3, 6)	2 (0.2, 5.5)	0.028

Data are presented as mean ± standard deviation or median (P25, P75)

A p-value<0.05 indicates statistical significance

*Abnormal equilibrium score condition indicates the median (range) number of the total of 6 conditions that had an abnormal equilibrium score at baseline and after 8 weeks of exercise

those patients developed the stamina to exercise for a full 5 minutes in all subsequent exercise sessions. No patients had to take rescue medication, and no adverse events were reported or observed in this study.

DISCUSSION

Balance rehabilitation is one of the most effective methods for treating balance disorders. Kao-ta and Kao-ten Thai exercises, which were invented by Professor Dr. Ouay Ketusinh, were designed to improve coordination among the eyes, head, torso, and extremities. The design features of Kao-ta and Kao-ten inspired this research team to investigate these exercises for balance benefit in patients with balance disorders.

After 8 weeks of Kao-ta and Kao-ten exercise in this study, 90.9% of patients had a better composite equilibrium score, and 54.5% of those had an increase at least 8 points, which indicates that they had better balance.^{12,13} Moreover, the equilibrium score of at least one condition returned to normal in 63.6% of patients. Nine patients (81.8%) reported improved balance. These results are comparable to those observed after Cawthorne-Cooksey exercise in Thai elderly population with imbalance disorders.⁴ Cawthorne-Cooksey exercise was reported to effectuate 50-80% improvement in patient balance.³⁻⁵

Compensation usually occurs 2-3 days after symptoms of balance disorders develop, but 30% of patients do not compensate well enough.¹⁵ Therefore, we only recruited patients with symptoms for 4 weeks or more in order to exclude patients that might develop spontaneous compensation.

All patients in our study were female, so there were no gender or physical strength biases. We also endeavored to reduce the probability of incorrect exercise technique by inviting instructors from the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University to teach correct Kao-ta and Kao-ten technique to our study patients. A logbook was given to each patient to record daily exercise times, and to note any accidents or adverse events that occurred during the study period. In addition, all patients attended our outpatient clinic at 4 weeks for a follow-up to assess patient satisfaction and to inquire about adverse events. During that visit, patient logbooks were checked, and questions were asked to elicit information specific to the correctness and regularity of the 2 prescribed Thai exercises.

The results of this pilot study revealed that Kao-ta and Kao-ten exercise can significantly improve patient balance. However, a controlled study in a larger study population is needed confirm our findings, and to further

elucidate the scope of the benefit conferred by these Thai exercises. Comparatives studies that compare Kao-ta and Kao-ten with other balance rehabilitation methods are also recommended.

Limitations

This pilot study has a mentionable limitation. Patients were required to perform at least 45 days of exercise (80%) during the 8-week study period. It is, therefore, possible that patients that performed more than 45 days of exercise may have realized better outcomes than patients that performed only the minimum 45 days of exercise. No provision was made in this study to evaluate performance based on the number of days of exercise beyond the 45-day minimum.

CONCLUSION

The results of the first ever pilot study revealed that Kao-ta and Kao-ten exercise can improve symptoms in patients with balance disorders after 8 weeks of exercise when evaluated by visual analogue scale and computerized dynamic posturography. No exercise-related adverse events were observed or reported.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Mr. Suthipol Udompunturak of the Division of Clinical Epidemiology, Department of Research and Development, Faculty of Medicine Siriraj Hospital, Mahidol University for assistance with statistical analysis; Dr. Premyot Ngaoteprutaram of the Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital, Mahidol University for his contributions to this study; Ms. Narisara Nateluecha and Ms. Sukritta Pongsitthichok of the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University for their contributions to this study; and, Mrs. Jeerapa Kerdnoppakhun for her assistance with manuscript development.

Conflict of interest declaration

All authors declare no personal or professional conflicts of interest relating to any aspect of this study.

Funding disclosure

This study was funded by a grant from the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (grant no. R15931030).

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