

CASE REPORT

Three dimensional motion analyses for rehabilitation version of Awa Odori exercise and the expectancy of physical effects

Shigetaka Nakao^{1,3}, Shinjiro Takata², Koji Komatsu³, Toshio Tanaka⁴, Eiji Tamura⁵, Michiharu Kashihara², Toshifumi Osawa³, Yuki Masuda³, Koji Nishikawa³, Megumi Yamada³, Yoshimi Ogata³, Yuka Nakamura³, and Natsuo Yasui²

¹Department of Orthopedics, Institute of Health Biosciences, the University of Tokushima Graduate School, ²Department of Orthopedics, ³Division of Rehabilitation, Tokushima University Hospital, ⁴Center for University extension, the University of Tokushima, Tokushima, Japan ; and ⁵Department of Rehabilitation, Kamojima Hospital, Tokushima, Japan

Abstract : ‘Awa Odori Exercise -Rehabilitation version- was developed in 2006 for the new trial of physical exercise for the aging and the impaired person with lower balance performance in Tokushima prefecture, Japan. Public relations of this exercise had been spreading over Tokushima since then. The characteristics of the exercise were highly familiar with most of people in Tokushima because of popularity in original ‘Awa Odori’. This study proposed the efficacies of Awa Odori Exercise as a rehabilitation exercise. This exercise expected the flexible balance reinforcements and the substitution for walking training with prevention of fall, bedridden and participating restriction for the old people, also promoting the health in Tokushima. *J. Med. Invest.* 58 : 259-263, August, 2011

Keywords : Awa Odori Exercise rehabilitation version, balance, aging, three dimensional motion analysis

BACKGROUNDS AND PURPOSES

It was said that the first time Awa Odori appeared in publication was in 1908 (1). Since then, people in Tokushima have enjoyed Awa Odori. Awa Odori Festival has been well known all over Japan as one of the famous events in Tokushima prefecture. This festival has been held for five days in every August. Awa Odori Exercise (2) was developed by Hiroshi Tanaka (2006), professor of Center for University Extension, the University of Tokushima in Japan.

The number of aging (more than 65 years old)

takes up 24.8% of total population in Tokushima Prefecture in 2009 (3). The aging for the bedridden are 0.2% (648/267,000) in Tokushima city and 0.4% (247/64,000) in Naruto city, which is estimated approximately 3,000 of aging population in the whole (3). Tokushima has also been popular in the high mortality by diabetes mellitus in Japan, which might be due to poor activities or exercises in daily life (4).

Awa Odori Exercise modified the original Awa Odori gave birth as a daily exercise for the aging to have worth living and achieve the health promotion. This exercise expects to prevent the dependence on care, withdrawal, bedridden and locomotorium disorder. The physical motions of Awa Odori exercise consists of stretching and range of motion exercises. The characteristics of this exercise as follows : exercise takes three minutes thirty seconds for the basic version, it includes limbs activities and

Received for publication May 12, 2011 ; accepted June 27, 2011.

Address correspondence and reprint requests to Shigetaka Nakao, PT, Department of Orthopedics Institute of Health Biosciences, the University of Tokushima Graduate School, 3-18-15, Kuramoto-cho, Tokushima 770-8503, Japan and Fax : +81-88-633-7204.

various directions' movements of center of mass (COM), rating of perceived exertion for 70 percent of maximal heart rate (feeling a little hard). Awa Odori Exercise also has other versions, for senior, metabolic syndrome, training and rehabilitation.

Awa Odori Exercise rehabilitation version (AOER) differs from basic and other versions. This version takes five minutes with slow movements with back ground music, mainly targets for the subjects who are the latter stage of aging, patients after stroke, patients with bone and joint disease with lower balance performance (5), consisting of two types of exercise (sitting with safe and standing), stretching and whole body exercise including limbs' activities. One of the merits of this version is that people who are physically impaired could easily participate in it. The meanings of such an exercise as have close relationship with the communities and society, although many kinds of exercise exist. This trial was proved to reduce the rate of the aging withdrawal (43%) and anxiety for falling (20%) by two times a week for a month at several hospitals in 2009 (3). We aimed to analyze 'AOER' in another aspects, focused on balance function and clarify the prospective effectiveness in this study, which leads to prevent the bedridden and fall with their handicaps.

METHODS

Two normal subjects who had no experiences of this exercise participated in this study. The characteristics of the subjects were shown in Table 1. The subjects were checked in static balance at standing position for one minute and walking five meters'

Table 1. The characteristics of the subjects (n=2)

	Subject 1	Subject 2
Age	21	31
Gender	male	female
Height (m)	1.61	1.54
Body weight (kg)	64.0	53.0
BMI (kg/m ²)	24.7	22.4

walkway and AOER with three-dimensional recording data respectively, the standing type for a male and the sitting type for a female. Data were collected at 150 Hz with use of a passive eight-camera system (Vicon MX T20 ; Vicon Motion Systems Ltd, UK). Thirty-five reflective markers (14-mm diameter) were placed on the land marks to form a human body, following PIG. Nexus 1.4 (Vicon Motion Systems Ltd, UK) derived from markers' coordinates in the space, processed and output c3d data that attached the parameters of plug in gait model (PIG, Vicon Motion Systems Ltd, UK). Polygon 3.1 visualized the c3d as a human body (skeletal model) and simulated the movement. These procedures were shown in Fig. 1.

The effects on balance at each direction (antero-posterior, lateral and vertical) were investigated for COM displacements on the exercise. The COM data normalized with subjects' heights, generated by PIG made the ranges and total length of postural sway (LNG) during this exercise (five minutes) (6). LNG ratio was calculated to correspond to five meters walking. The parameters (ranges and LNG) of COM were compared with static, sitting and standing of the exercise. The speeds of COM displacement were also measured for five minutes (7).

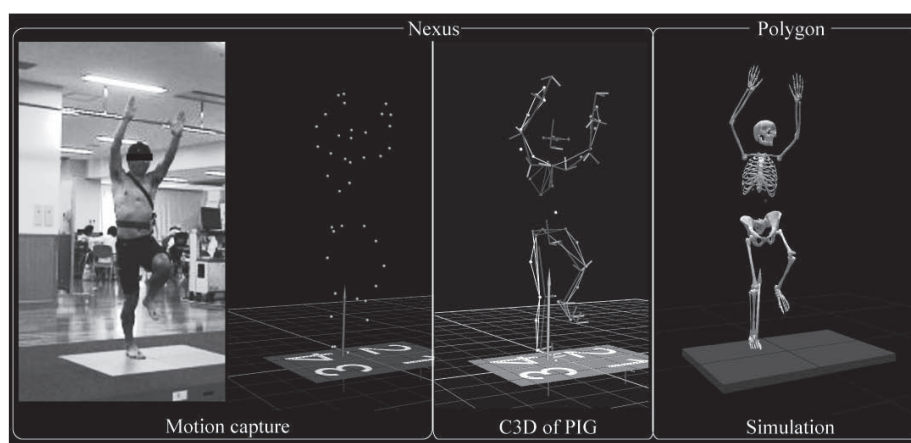


Figure 1. The procedure of motion analysis

Motion analyses had three steps, motion capture, reconstruction in three dimensions from markers' position, attached the PIG model with stick pictures running dynamic motion to output c3d and simulation of rigid body by deriving from c3d.

RESULTS

The postural sway of the exercise had wide ranges compared with the static for five minutes at every direction (Fig. 2). LNGs which proved the COM displacements were longer distance during

the exercise than static for one minute or gait for five meters (Fig. 3). The parameters which expressed the postural sway had higher values than the others. The COM displacements showed various regions of speeds for five minutes' exercise (Fig. 4).

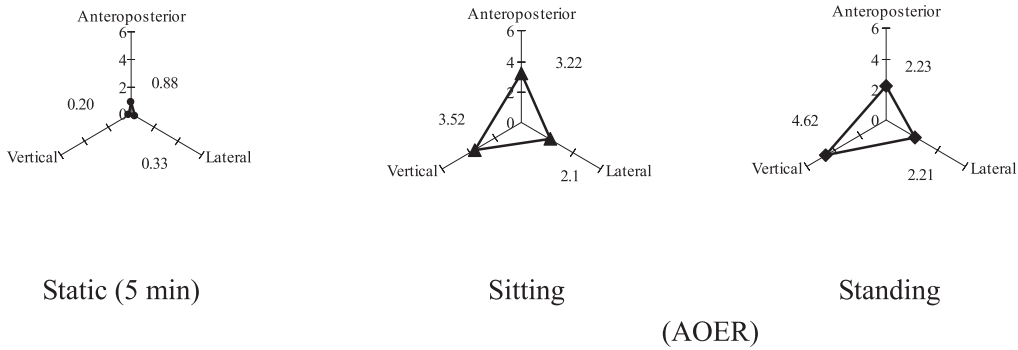


Figure 2. Ranges of postural sway in each axis in AOER
 Ranges (centimeters) of COM displacements at static, sitting and standing position for 5 minutes : AOER showed wide ranges of COM displacements than static.

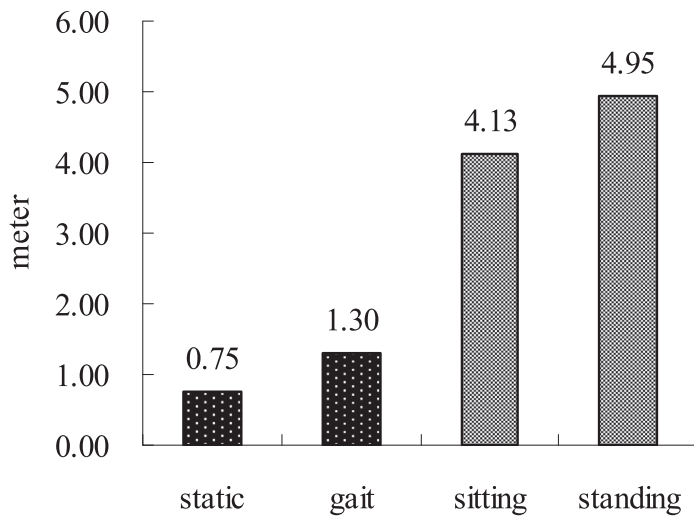


Figure 3. Total distance of LNG LNG trajectories during Static (for one minute), gait (five meters), sitting and standing positions of the exercise, the exercises were necessary for the longer distances of LNG compared with other motions.

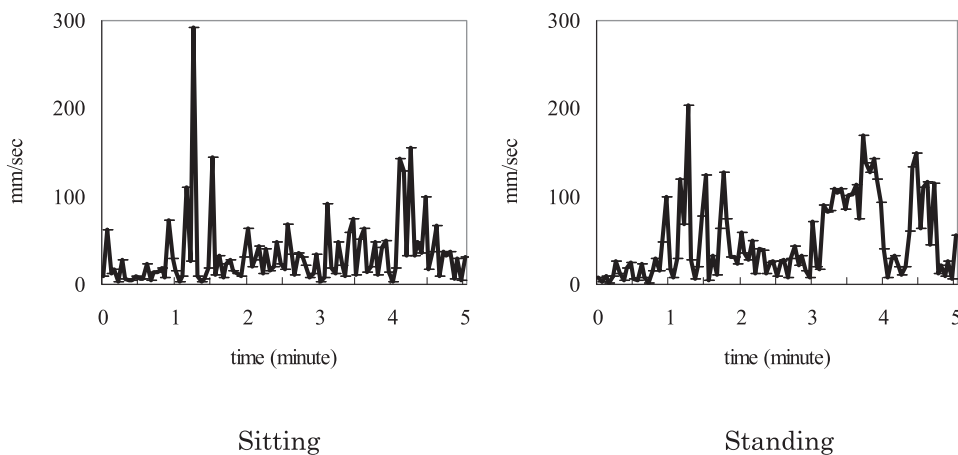


Figure 4. Velocity of COM amplitudes
 AOER did not have the fixed speed for 5 minutes, represented the necessity to adjust the complicated movements.

DISCUSSION

Subjects had impressions to be easy and fun, felt warmed up after AOER. People who did not know this exercise could do for the first time. The AOER had configurations for range of motion exercises or muscular conditioning such as joint motions of shoulder, elbow, wrist fingers, hip, knees and ankle. These various kinds of movements might necessitate the wide ranges of COM displacements in AOER. The total lengths of COM were correspondence to approximately fifteen or twenty meters of walking distance (Fig. 5). People who could not walk might make use of these exercises in substitution for walking. The movements of postural sway in AOER covered other values of COM displacements, which suggested the new style of training for balance performances in the rehabilitation. The reinforcements of balance abilities had possibilities to decrease the opportunities of falling. The results of this study proved to have expectancies with the efficacy of these exercises for the aged and impaired who could stand or not. An aerobic dance trial for elderly women improved on functional fitness components except for control/coordination, including cardiorespiratory endurance, strength endurance, body agility, flexibility, body fat and balance after 12 weeks (8). Dance based aerobic exercise designed for older women may improved selected components of balance and locomotion/agility attenuating the risk of falling (9). The AOER also had one of the aspects for balance function like aerobic dance. Cultural aspects including the background music or traditional bon festival dance are also contributed

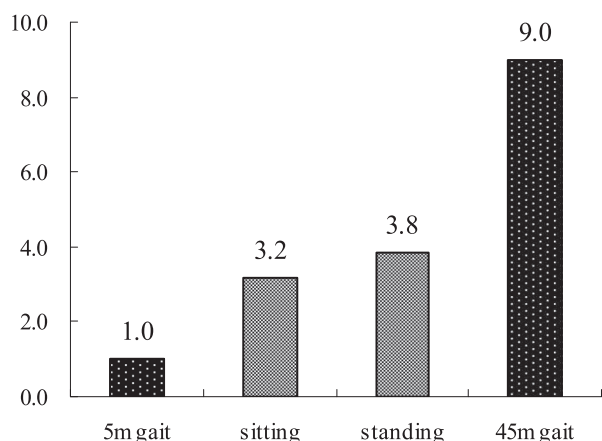


Figure 5. LNG ratio correspondence to walking distance
LNGs were rerun by the value of 5 meters walking for LNGs ratio. 45 meters walking which Barthel Index (10) required for independence in activities of daily living.

to induce the motivations of participation for the physical exercise as collecting strategies in familiar with people in Tokushima Prefecture. The exercise model had an opportunity to keep the aging or the impaired from activities limitation in the medical and welfare facilities.

The aging in Tokushima prefecture caused to increase the number of withdrawal or bedridden at home or facilities in the future (3). The popularization for AOER expected for such aging people had a chance to develop their participating restriction in the society. Currently, public relation was spreading over the areas of Tokushima by local TV and rehabilitation hospital as a new trial of health promoting and worth living. This study had small number and no references of gender and age differences over the data. We need to verify these points and prove the availabilities of AOER for the patients with aging, stroke and musculoskeletal disorders in future study.

CONCLUSION

The AOER had efficacies of reinforcement for balance abilities at all directions and corresponded to the several meters of walking distance, therefore, it expected the substitution for walking training with prevention of fall, bed ridden and participating restriction for old people. This exercise could be health promotion in Tokushima because of popularity in original 'Awa Odori'.

ACKNOWLEDGEMENTS

The authors are deeply indebted to Toshio Tanaka and Eiji Tamura for offering the document, the staff of rehabilitation at Tokushima University Hospital for collecting data and to Shinjiro Takata, Michiharu Kashihara, Natsuo Yasui, for academic writing.

REFERENCES

1. Tatuoka Y: Awa-Odori as a metonymy of Tokushima, Japan. Geographic report of department literature of Kanazawa University 10 : 87-100, 2002 (in Japanese)
2. Tanaka T : Health promotion by Awa odori exercise taking 'Awa odori'. Japanese Journal of Physical Fitness and Sports Medicine 57(6) : 858, 2008 (in Japanese)

3. Takata S, Okawa Y, Yasui N : The actual condition survey for the aged with disuse syndrome and development of physical therapy to improve the life function. JST N20080499 : 17-20, 2007 (in Japanese)
4. Noma Y : Contribution of the Department of Laboratory Medicine for the Protection and the Treatment of Diabetes Mellitus in Tokushima Prefecture. Rinsyo Byori 54(9) : 973-9, 2006 (in Japanese)
5. Fabunmi AA, Gbiri CA : Relationship between balance performance in the elderly and some anthropometric variables. Afr J Med Med Sci 37(4) : 321-326, 2008
6. Hughes MA, Duncan PW, Rose DK, Chandler JM, Studenski SA : The relationship of postural sway to sensorimotor function, functional performance and disability in the elderly. Arch Phys Med Rehabil 77(6) : 567-572, 1996
7. Raymakers JA, Samson MM, Verhaar HJ : The assessment of body sway and the choice of the stability parameter(s). Gait posture 21(1) : 48-58, 2005
8. Hopkins DR, Murrah B, Hoeger WW, Rhodes RC : Effects of low-impact aerobic dance on the functional fitness of elderly women. Gerontologist 30(2) : 189-192, 1990
9. Shigematsu R, Chang M, Yabushita N, Nakagaichi M, Nho H, Tanaka K : Dance-based aerobic exercise may improve indices of falling risk in older women. Age Ageing 31(4) : 261-266, 2002
10. Mahoney FI, Barthel DW : Functional Evaluation : The Barthel Index. Md State Med J 14 : 61-65, 1965