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Effects of 8-week Rehabilitation Exercise on Vascular Health

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ABSTRACT

The purpose of this study was to investigate the effect of 8-week rehabilitation exercise on active vascular health and ultimately propose an effective rehabilitation program applying various stretching methods. The research targets were females who visited hospital due to chronic diseases or metabolic syndrome; and were divided into two groups, participants of rehabilitation exercises, and non-participants of rehabilitation exercises. 10 people were included in each group. The subjects were restricted to participate in other exercise programs during the exercise period. The 8-week exercise program was designed to measure the ankle brachial index (ABI) and the cardio-ankle vascular index (CAVI) using active stretching and passive stretching. In the data processing, descriptive statistics were presented for each measurement item and a 2-way RGRM ANOVA was conducted to examine the interaction effects between groups. The results have shown significant interaction effects in ankle brachial index (ABI) and the cardio-ankle vascular index (CAVI). Therefore, the eight-week rehabilitation campaign has shown to have a positive effect on vascular health and is believed to be an effective preventive measure to reduce the incidence and risk of cardiovascular disease. Also, this rehabilitation program is thought to help prevent cardiovascular disease if it is provided to more elderly people since which does not require special places or specialized equipment.

Keywords: *Rehabilitation Exercise, Cardio-Ankle Vascular Index (CAVI), Ankle Brachial Index (ABI), Stretching Exercise, Vascular Health*

Introduction

According to the report published by National Statistical Office (NSO) in 2014, the main cause of death in elderly women (over 65) was circulatory system diseases[1]. When compared to the fact that the main cause of death of men is cancer, it seems obvious that the women in their 60s or 70s have more relation with circulatory diseases than men. Cardiovascular disease is the most frequent manifestation of cardiovascular disease, and 80% of the causes are thought to be arterial dysfunction. It is considered as an element which brings high risk of death[2].

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This change in cardiovascular aging is due to the loss of elasticity and stiffness of the pulsatile arteries, resulting in a loss of blood vessel expansion and a burden on the heart. It therefore causes cardiac hypertrophy and cardiac function, resulting in reduced cardiac output – which ultimately skyrockets the probability of heart function failure[3].

The decrease of the arterial compliance- which is - The increase of arterial stiffness interferes with blood pressure or blood flow - can increase blood pressure, bring left ventricular hypertrophy, cause ischemic disease in the coronary artery, and decrease arterial baroreflex sensitivity[4].

Various methods such as medication therapy, diet control, and exercise are being explored to alleviate arteriosclerosis and maintain proper arterial rigidity(Cardio Ankle Vascular Index, CAVI) and angle brachial index (ABI).

Since exercise (body activity) is considered as a means of minimizing physiological disorders caused

by aging and preventing chronic diseases or disorders, it is also thought as a method which efforts to increase expectations of positive life to achieve successful aging[5]. Exercise for the treatment and prevention of diseases is called therapeutic exercise or rehabilitative exercise[6], and is constantly emerging as a countermeasure against diseases and injuries in the elder. Plus, the rehabilitative exercise which was conducted in conjunction with medical teams for injury or disease treatment has also proved and demonstrated its efficiency as well[7]. In this context, exercise rehabilitation programs for the elderly can reduce stress by improving physical health, giving confidence in physical strength and providing an opportunity to enjoy life by enhancing social activities and cooperation. Research in developed countries has shown that sports activities can effectively prevent problems and reduce diseases among older people, and aerobics, swimming, jogging and other sports activities can effectively relieve stress in the general public[8].

Stretching, which is part of the dual rehabilitation exercise program, is a temple exercise that expands muscles, tendons, ligaments, and around joints. It not only improves the range of operation of joints and posture imbalance, but also prevents musculoskeletal damage, and is also effective in balancing the pelvis by relaxing the tense muscles around the pelvis and spine[9]. Stretching exercises are also simple to perform, by expanding and contracting muscles, and can be performed anywhere, reducing muscle and musculoskeletal adhesion as well as increasing joint flexibility and blood circulation[10]. Stretching exercise is one of the therapeutic interventions to improve the operability of connective tissue, such as muscles, and to increase the range of joint operation. Depending on how the exercise is performed, there are passive or active methods, but regardless of the method of stretching exercise performed, the most important thing is to relax the contracted muscles and increase the connective tissues' flexibility as much as possible[11].

The purpose of this study was to investigate the effect of 8-week rehabilitation exercise on the vascular health of active elderly women with active stretching and passive stretching, and to propose an effective rehabilitation exercise program for stretching.

Materials snd Method

Subject of Study: This study was conducted with the consent of participating in rehabilitation exercise for women who visited the hospital due to metabolic syndrome and chronic diseases. The subjects were 10 rehabilitation exercise group(RG) and 10 non - participation group(CG) and they were restricted to participate in other exercise programs during the exercise period. Other daily activities were instructed to live the same as before the experiment, and explained that if you feel any abnormality during the experiment, you can withdraw from this experiment immediately<Table 1>.

Table 1: Physical Characteristic of Subjects (M ± SD)

Group	N	Age (yr)	Height (cm)	Weight (kg)	Fat (%)
RG	10	69.33 ± **2.54**	153.42 ± **3.51**	62.13 ± **4.29**	29.12 ± **4.03**
CG	10	70.20 ± **2.06**	154.17 ± **2.76**	62.97 ± **4.23**	29.30 ± **3.70**

Exercise Program: The exercise program of this study was applied in parallel with active stretching and passive stretching. Stretching can help relieve pain in the long term through orthodontic correction and extension, and can improve physical activity by improving the range of motion of the joints. First, active stretching was performed in a way that the subject could proceed alone while watching the leader, and passive stretching was performed by artificially stretching the range of motion of the subject's joint by the assistant. The exercise program consisted of 30 minutes of active stretching for 30 minutes and passive stretching for 60 minutes, three times a week for 8 weeks. Specific exercise programs are shown in <Table 2>.

Table 2: Exercise Program

Division	Intensity	Main Stretching
Periods (8week)	RPE (Borg scale) <=11	Cervical rolling, cervical joint release, cervical trapezius stretching, cervical side bending stretching, cervical rotation, erector spinae stretching, mobilization, traction modify, scapula medial STR, scapula dislocation, shoulder full extension, trunk rotation stretching, thoracic mobilization, hamstring stretching, hip joint traction stretching, quadriceps stretching, psoas stretching

Measurement Method and Equipment: The vascular health according to the rehabilitation exercise was measured before and 8 weeks after exercise program using Vascular Screening Device (VeSera VS-2000, Japan). The measurement items were 4 diastolic blood pressure (both arms and legs), atherosclerosis (CABI), and arterial stenosis (ABI).

Data Analysis: The data analysis of this study presented descriptive statistics for each measurement item and 2-way RGRM ANOVA was performed to examine the interaction effect between groups. The significance level was analyzed based on a = .05.

Result

Cardio Ankle Vascular Index (CAVI): After an 8-week rehabilitation exercise with RG and CG, ANOVA showed that R-CAVI had an interaction effect(p=.035) between the two groups. Also, L-CAVI was also found to have interactive effects(p=.04)<Table 3>.

Ankle Brachial Index (ABI): After an 8-week rehabilitation exercise with RG and CG, ANOVA showed that R-ABI had an interaction effect(p=.045) between the two groups. Also, L-ABI was also found to have interactive effects(p=.049) <Table 4>.

Table 3: CAVI ANOVA

Factor	Group	Pre	Post	P
R-CAVI	RG	10.10 ± 1.01	9.20 ± 1.03	Group*period: .035 Group: .547, Period: .02
	CG	9.89 ± .98	9.99 ± 1.10	
L-CAVI	RG	9.28 ± .89	8.92 ± 1.02	Group*period: .04 Group: .486, Period: .035
	CG	9.45 ± .94	9.55 ± .88	

Table 4: ABI ANOVA

Factor	Group	Pre	Post	P
R-ABI	RG	1.75 ± .13	1.25 ± .11	Group*period: .045 Group: .423, Period: .024
	CG	1.98 ± .50	1.99 ± .64	
L-ABI	RG	1.48 ± .15	1.02 ± .13	Group*period: .049 Group: .436, Period: .027
	CG	1.42 ± .21	1.52 ± .32	

Discussion

The purpose of this study was to compare and analyze the differences of vascular health changes through the 8 - week rehabilitation exercise program which included active stretching and passive stretching in the elderly women who visited the hospital due to metabolic syndrome and chronic diseases. The results of this study are as follows.

The Cardio ankle vascular index(CAVI) is an index that reflects the loss of elasticity of the arterial blood vessels and is an independent predictor of the incidence and mortality of cardiovascular disease[12]. The central aorta is more easily stiffened by aging, menopause, smoking, metabolic syndrome, and lack of exercise due to lower percentage of muscles and a high proportion of elastic fibers[13]. Increased CAVI can lead to elevated central blood pressure, and can result in increased cardiovascular risk by overloading the left ventricle[14]. ABI is an indicator of atherosclerotic change and is used to diagnose peripheral arterial diseases[15]. It also can be used to assess blood flow to the ankles and play a role as a marker for vascular diseases[16].

In a previous study on vascular health changes through exercise in the elderly, Madden et al[17] conducted a three-month median-high-intensity aerobic exercise on hypertensive elderly people. The results showed that it decreased the pulse wave velocity of radius and aorta femoralis. Miura et al[18] reported that at least two times of exercise can give positive effect on improving arterial stiffness. A study by Jung et al[19] found that 12 weeks of physical dance movements for senior citizens had a positive effect on improving arterial hardness and vascular function. According to study of Thetiwuthikiat et al[20], there was no change in ABI after eight-week of arm-swinging exercise were conducted on men and women over the age of 50, while there was a significant decrease in cardio-ankle vascular index(CAVI).

However, it is necessary to conduct further studies about long-term results of arm-swings exercise to improve arteriosclerosis.

Regarding the previous studies about the change in vascular health through stretching exercises, Logan et al[21] reported that a 30-minute video demo of full-body stretching exercises in healthy women resulted in a decrease in carotid-femoral pulse wave velocity(cf-PWV). Also, Hota et al[22] suggested that stretching exercises in patients with acute myocardial infarction could significantly increase the reactive hyperemia peripheral arterial tonometry(RH-PAT) and improve intravascular function and peripheral circulation. The study by Nishiwaki et al[23] showed that the four-week of stretching exercises in middle-aged men resulted in a decrease in both brachial-ankle pulse wave velocity(ba-PWV) and CAVI. However, according to Wong & Figueroa[24], eight-weeks of stretching exercises in obese women after menopause did not show changes of arteriosclerosis. These contrasting studies could have excuse for the fact that vascular adaptation by stretching can vary depending on the characteristics of participants such as age, gender, history, type of exercise program, intensity, duration, frequency, and momentum [23].

In this study, eight-week of rehabilitation program using active –passive stretching exercise resulted in reduction of the degree of arterial rigidity and arterial stenosis, with statistically significant differences. It would be attributed to the improvement in the functional ability of vasodilation and also vascular epithelial cell itself by supporting endothelial progenitor cells involved in the hormone secretion and inflammatory response, owing to the stretching exercises [25].

Therefore, it is supposed that rehabilitation program using active –passive stretching exercise is the way to not only reduce but also prevent the incidence of aging-induced cardiovascular diseases by improving vascular function. However, further additional studies with larger subjects, various physiological factors, and various stretching exercise programs should be performed to establish a clear effectiveness.

Conclusion

The purpose of this study was to investigate the effect of rehabilitation exercise on vascular health for 8 weeks. The rehabilitation exercise group and the control group were divided into two groups.

After the rehabilitation exercise group and the control group applied the rehabilitation exercise for 8 weeks, the R-CAVI showed an interaction effect between the two groups. Also, L-CAVI was also found to have interactive effects.

After the rehabilitation exercise, R-ABI showed an interaction effect between the two groups. In addition, L-ABI also has an interaction effect.

And a statistically significant decrease in arterial stiffness and stenosis after the rehabilitation exercise. In addition, aerobic exercise is recommended as a method of reducing arteriosclerosis, but stretching based on rehabilitation exercise in this study also showed a significant effect on decrease of atherosclerosis.

In the follow-up study, it is necessary to increase the number of subjects to be interested in the validity of the study. In addition, it is thought that various approaches are needed to further refine the program, intensity, time, and frequency of rehabilitation exercise.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. National Statistical Office. Cause of death in 2014 (deaths by sex and age), mortality statistics, Press release, 2016.
2. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Makuc DM, Marcus GM, Marelli A, Matchar DB, Moy CS, Mozaffarian D, Mussolino ME, Nichol G, Paynter NP, Soliman EZ, Sorlie PD, Sotoodehnia N, Turan TN, Virani SS, Wong ND, Woo D, Turner MB; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2012 update a report from the American Heart Association. Circulation, 2012;125(1):188-197.
3. Sattelmair JR, Pertman JH, Forman DE. Effects of physical activity on cardiovascular and

noncardiovascular outcomes in older adults. Clinics in geriatric medicine, 2009;25(4):677-702.

4. Yasuda T, Fukumura K, Uchida Y, Koshi H, Iida H, Masamune K, Yamasoba T, Sato Y, Nakajima T. Effects of Low-Load, Elastic Band Resistance Training Combined With Blood Flow Restriction on Muscle Size and Arterial Stiffness in Older Adults. The Journals of gerontology. Series A, Biological sciences and medical sciences, 2015; 70(8):950-958.
5. Zajko WC, Schwingel A, Park CH. Successful Aging: The role of physical activity. American Journal of Lifestyle Medicine, 2009; 3(1):20–28.
6. Kottke FJ, Lehman JF. Krusen's Handbook of Physical Medicine and Rehabilitation. Philadelphia, WB Saunders, 1990.
7. Eun JW. The reorganization of participation constraint factors on rehabilitation exercise of middle and elderly people. Korean Journal of Adapted Physical Activity, 2016;24(2): 77-87.
8. Judge JO, Lindsey C, Underwood M, Winsemius D. Balance improvements in older women: Effects of exercise training. Physical Therapy, 1993; 73(4): 254–262.
9. Kim BY, Eom WS. The Effects of lumbar stretching on the degree of scoliosis and flexibility in elementary school students. The Journal of Korea Elementary Education, 2012; 23(4):157-166.
10. Rejeski WJ, Mihalko SL. Physical activity and quality of life in older adults. The Journals of Gerontology, Series A, Biological science and Medical Science, 2001; 56(2): 23-35.
11. Kisner C, Colby L. Therapeutic exercise: Foundations and techniques (4thed), Philadelphia: FA Davis, 2002.
12. Hwang MH, Yoo JK, Kim HK, Hwang CL, Mackay K, Hemstreet O, Christou DD. Validity and reliability of aortic pulse wave velocity and augmentation index determined by the new cuff-based SphygmoCor Xcel. Journal of Human Hypertension, 2014; 28(8): 475–481.
13. London GM, Pannier B. Arterial functions: How to interpret the complex physiology. Nephrology Dialysis Transplantation, 2010;25(12):3815–3823.
14. Park SH, Yoon ES, Jung SJ, Jae SY. Association between muscular strength and arterial stiffness in healthy adults. Exercise Science, 2011;20(3): 273-282.
15. Potier L, Khalil A, Mohammedi K, Roussel R. Use and Utility of Ankle Brachial Index in Patients with Diabetes. European Journal of Vascular and Endovascular Surgery, 2011; 41(1): 110–116.
16. Jelinek HF, Austin M. The ankle–brachial index in clinical decision making. The Foot, 2006; 16(3): 153–157.
17. Madden K, Lockhart C, Cuff D, Potter T, Meneilly G. Short-term aerobic exercise reduces arterial stiffness in older adults with type 2 diabetes, hypertension, and hypercholesterolemia. Diabetes Care, 2009; 32(8): 1531–1535.
18. Miura H, Nakagawa E, Takahashi Y. Influence of group training frequency on arterial stiffness in elderly women. European Journal of Applied Physiology, 2008; 104(6): 1039-1044.
19. Jung SJ, Yoon ES, Son TY, Jae SY. Effects of recreational dance exercise on cardiovascular risk factors, vascular structure and function in older women. Exercise Science, 2011; 20(1): 35-46.
20. Thitiwuthikiat P, Imerbtham T, Weeraphan O, Siriwittayawan, D. Improvement of Cardio-Ankle Vascular Index by Arm-Swing Exercise in Older Adults. Songklanagarind Medical Journal, 2018; 36(1): 53-60.
21. Logan JG, Kim SS, Lee MJ, Byon HD, Yeo SA. Effects of Static Stretching Exercise on Lumbar Flexibility and Central Arterial Stiffness. Journal of Cardiovascular Nursing, 2018; 33(4): 322–328.
22. Hotta K, Kamiya K, Shimizu R, Yokoyama M, Nakamura-Ogura M, Tabata M, Kamekawa D, Akiyama A, Kato M, Noda C, Matsunaga A, Masuda T. Stretching exercises enhance vascular endothelial function and improve peripheral circulation in patients with acute myocardial infarction. International Heart Journal, 2013; 54(2):59-63.
23. Nishiwaki M, Yonemura H, Kurobe K, Matsumoto N. Four weeks of regular static stretching reduces arterial stiffness in middle-aged men. Springerplus, 2015; 4(1): 555.

24. Wong A, Figueroa A. Eight weeks of stretching training reduces aortic wave reflection magnitude and blood pressure in obese postmenopausal women. Journal of Human Hypertension, 2014; 28(4): 246–250.

25. Laufs U, Werner N, Link A, Endres M, Wassmann S, Jürgens K, Miche E, Böhm M, Nickenig G. (2004). Physical training increases endothelial progenitor cells, inhibits neointima formation, and enhances angiogenesis. Circulation, 2004; 109(2): 220-226.