

Effect of Aerobic Exercise Training on the Internal Carotid Artery Blood Flow in Post Menopausal Women

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ABSTRACT

Background: The incidence of heart disease increases as women approach menopause, reports have suggested that regular exercise decrease these risks. **Objective:** This study was undertaken to assess the effect of aerobic exercise training on the internal carotid artery blood flow after menopause. **Method:** A total of twenty normotensive, healthy post menopausal women were participated in an aerobic exercise training program for 4 weeks. The maximum systolic velocity, end diastolic velocity, resistance index (RI) and pulsatility index (PI) of the internal carotid artery were assessed by color Doppler ultrasound before and after 4 weeks of exercise. **Results:** The internal carotid artery end diastolic velocity increased significantly and its maximum systolic velocity decreased significantly after 4 weeks of exercise training program. A significant reduction in internal carotid artery RI and PI were observed in all women participating in exercise training program, these reductions with respect to the pre training values were 10.34 and 11.34% respectively after 4 weeks of exercise training. **Conclusion:** After 4 weeks of aerobic training program, exercise appears to induce an increase in the internal carotid artery blood flow corresponding with a reduction in its RI and PI in post menopausal women which could be considered as a protective measure for reducing cardiovascular disease in post menopausal women.

Key words: Menopause, carotid artery, pulsatility index, resistance index, end diastolic velocity, maximum systolic velocity, exercise.

INTRODUCTION

Cardiovascular disease is currently the leading cause of death in both men and women and accounts for 52% of all deaths in women⁸. Its incidence increases significantly after menopause and is related to the low estrogen levels typical of this period of life²⁰. In addition, after the onset of menopause, there is an increase in total plasma cholesterol and low density lipoprotein cholesterol, higher levels of triglycerides and very low density lipoprotein cholesterol and

generally lower levels of high density lipoprotein cholesterol which could be thought to the increased incidence of cardiovascular disease in women at this period². Also, inactivity is recognized as contributing factor for increasing incidence of morbidity and mortality due to cardiovascular disease, diabetes mellitus and hypertension. The physiological changes associated with physical inactivity include an increase in the percentage of fat and glucose intolerance, hyperlipidemia and an increase in peripheral resistance, resulting in hypertension²².

Signorelli et al., (2001)²⁸ reported a direct relationship between lipid profile and increase in the carotid wall intima thickness in post menopausal women which may underlie as one of the cause for cardiovascular disease.

Many studies have demonstrated that estrogen replacement therapy reduces the incidence of arterial disease, ischemic heart disease and cerebrovascular events after menopause^{25, 26} and has a beneficial effect on lipid profile⁵. These effects reduced the incidence of cardiovascular disease¹⁰.

Kallikazaros et al., (2001)¹¹ reported that acute conjugated estrogen administration induced an improvement in carotid artery elasticity and a significant reduction in its PI in normotensive post menopausal women. In addition, estrogen have demonstrated to have a vasodilatory effect in arteries, this effect is mediated by a reduction in carotid artery PI¹⁰.

Numerous studies have demonstrated that exercise reduces the morbidity and mortality of cardiovascular disease^{3, 22}, also, it reduced the risk of illness¹⁸, improve health and ultimately enhance quality of life²³.

Regular aerobic exercise training has been shown to confer a 10% - 30% improvement in Vo_{2max} in healthy persons¹⁵. However, this improvement appears to result from peripheral adaptation, such as a large arteriovenous oxygen difference rather than from improvement in central adaptation which commonly associated with men⁹.

Also, exercise improves the cardiorespiratory endurance in women²⁷. Pre and post menopausal women responded to training with similar improvement. In addition, exercise training can favorably alter lipid and lipoprotein profiles in post menopausal women^{4, 19}.

As mentioned above exercise has a positive effect on the cardiopulmonary functions in post menopausal women.

However, there have been no studies on the effect of exercise on the carotid artery blood flow in post menopausal women. Therefore we designed this study to assess the effects of an aerobic exercise training program on the carotid artery blood flow in post menopausal women.

SUBJECTS, MATERIALS AND METHODS

Subjects

Twenty normotensive, healthy sedentary post menopausal women, ages from 44 to 49 years participated in this study from the outpatient clinic of Gynecology at EL- Hosan University Hospital. Their body mass index did not exceed 27kg/m^2 and had menopause for at least one year.

Women with known cardiovascular, pulmonary, musculoskeletal disorders and inability to participate in exercise training program were excluded from this study.

None of women had taken any hormonal replacement therapy in the previous 6 months and all through this study. Blood lipid levels and blood pressure were in the normal range for all women.

Instruments

- 1- Electronic bicycle ergometer (ECD ergometer E405) was used for performing exercise training program.
- 2- Color Doppler ultrasound machine (Sony Au 530, Serial No. 2663) with a linear 5MHz probe was used for measuring the carotid artery blood flow.

Procedures

I- Evaluative procedures

Initially each woman was subjected to a careful history taking including personal and medical history. Then weight and height were

taken to calculate the body mass index by dividing weight (Kg)/ height (m^2).

After that each woman rested for 10 minutes in supine position with the head turned slightly to the left before starting the investigation of the carotid artery. The common carotid arteries and the proximal parts of the internal and external carotid arteries were identified. Maximum systolic velocity, end diastolic velocity, RI and PI were the mean of 3 consecutive recordings from the internal carotid artery. Also, carotid artery RI must be <0.6 and $PI < 1$ to confirm that woman was normotensive¹ and the measurement of all women was done by the same physician. Carotid artery blood flow was evaluated before and after 4 weeks of exercise training program.

II- Aerobic exercise training program

The training program consisted of exercise training on bicycle ergometer 3 days a week; each session was for 30 minutes.

The exercise session consisted of five minute warm up in the form of pedaling at 60 revolution per minute without load and 20 minutes of active pedaling in which the woman cycled at a target heart rate calculated from the Karvonen equation¹³, the heart rate corresponding to 50% of the heart rate reserve

(maximal heart rate minus resting heart rate) + resting heart rate during the first 2 weeks and progress to 65% of heart rate reserve during the subsequent weeks and ended by five minutes of cool down in form of pedaling without load.

III- Statistical analysis

The data was collected and fed into

carried to compare between before and after the end of the exercise training program (4 weeks), at a level of significance $P < 0.05$.

RESULTS

The women participated in this study had a mean age of (47.07 \pm 3.61 years), height (156.34 \pm 12.86cm), weight (68.7 \pm 7.2Kg), body mass index (25.2 \pm 3.7kg/ m^2) and time since menopause (22.41 \pm 4.5months).

The maximum systolic velocity and end diastolic velocity in the internal carotid artery was presented in table (1) which showed a statistically significant decrease ($P < 0.05$) in the maximum systolic velocity as well as a significant increase ($P < 0.04$) in end diastolic velocity between before and after 4 weeks of exercise training.

Table (1): Maximum systolic and end diastolic velocities in the internal carotid artery.

Variables	Pre training	Post exercise training	% of change	T value	Level of significance
Maximum systolic velocity	0.48 \pm 0.08	0.45 \pm 0.08	↓ 6.25%	2.10	$P < 0.05$
End diastolic velocity	0.15 \pm 0.02	0.17 \pm 0.02	↑ 13.33%	2.17	$P < 0.04$

Values of evaluating the internal carotid artery RI were presented in table (2) and figure (1). Before training, the mean value of the internal carotid artery RI was 0.58 \pm 0.05, while

after 4 weeks of exercise training it was 0.52 \pm 0.06. The mean reduction with respect to pre training values was 10.34% after 4 weeks of exercise training program. Internal carotid

artery RI showed a significant decrease with respect to pre training value ($t=2.89$, $P<0.012$).

Also, there was a positive correlation between the size of reduction and pre training value of internal carotid artery RI ($r=0.71$,

$P<0.05$), in other words, the higher the pre training values of internal carotid artery RI, the greater was its reduction after 4 weeks of exercise training program.

Table (2): Mean and SD of the internal carotid artery RI for all women.

Timing of evaluation	Internal carotid artery RI			
		%of change	T value	Level of significance
Pre training	0.58 0.05	↓ 10.34%	2.89	$P<0.012$
Post training (4 weeks)	0.52 0.06			

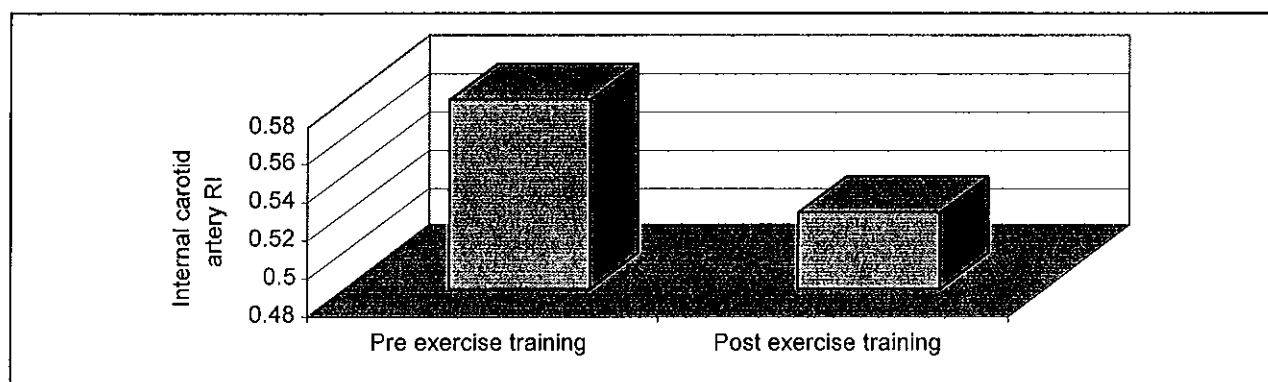


Fig. (1): Effect of exercise training program on the internal carotid artery RI.

Values of the internal carotid artery PI were presented in table (3) and figure (2). Before training, the mean value of the carotid artery PI was 0.97 0.12, while after 4 weeks of exercise training it was 0.86 0.9. The mean reduction with respect to pre training values was 11.34% after 4 weeks of exercise training program. Internal carotid artery PI showed a

significant decrease with respect to pre training value ($t=2.66$, $P<0.019$).

Also, there was a positive correlation between the size of reduction and pre training values of internal carotid artery PI ($r=0.65$, $P<0.05$), in other words, the higher the pre training values of internal carotid artery PI, the greater was its reduction after 4 weeks of exercise training program.

Table (3): Mean and SD of the internal carotid artery PI for all women.

Timing of evaluation	Internal carotid artery PI			
		%of change	T value	Level of significance
Pre training	0.97 0.12	↓ 11.34%	2.66	$P<0.019$
Post training (4 weeks)	0.86 0.9			

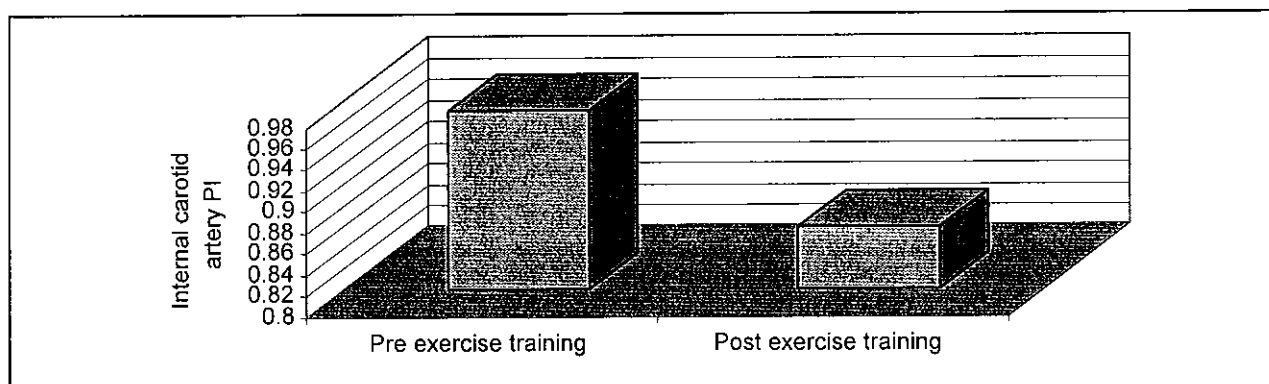


Fig. (2): Effect of exercise training program on the internal carotid artery PI.

DISCUSSION

Exercise has become a vital part of women's lives. After menopause, it has a minimal risk of disease for women when it is performed on a regular basis^{3,12}.

Exercise is associated with fewer symptoms and discomfort later in post menopausal period. The lack of evidence for harmful effects of exercise in post menopausal women indicates that exercise during this period is safe and prevent many diseases⁷.

The present results of the internal carotid artery showed a significant decrease in the maximum systolic velocity, RI and PI corresponding with a significant increase in the end diastolic velocity after exercise training in normotensive healthy post menopausal women that could not be correlated or contradicted with any previous studies as there is no published study in this area. But, exercise induced a 11.34% reduction in the internal carotid artery PI respectively after 4 weeks of training which is similar to the percentage of reduction (10- 15%) reported with estrogen therapy in post menopausal women^{5,10,26}.

Also, exercise induced a significant increase in the end diastolic velocity and decrease in the maximum systolic velocity in the internal carotid artery in post menopausal women which confirmed by the report of George and Goldberg, (2001)⁷ on which they mentioned that one of the benefits of moderate exercise in geriatric women was the increased of the blood flow in various body tissues and relaxation of the smooth muscle cells of the blood vessels such as the coronary arteries; due to an increase in the cross sectional area of the normal arteries as a result of increasing the release of endothelial dependent relaxing factor which causes arterial relaxation and prevents platelet and leukocyte adhesion to the endothelial surface²⁴.

In this study, we chose to investigate the internal carotid artery, a major artery that could be representative of vascular resistance in general. The increase in arterial PI occurring in women after menopause seems to be due to reduced vascular compliance and increased vascular resistance²⁰. The reduction after exercise could be attributed to a marked diminishes in the peripheral vascular resistance and reduction in systolic blood pressure as mentioned by Kisner and Colby¹⁴.

The cardiovascular effects of exercise have been described in many clinical and preclinical studies^{16,17}. The beneficial effects include reduction of coronary artery intima thickness¹⁷, increased nitric oxide production by endothelium and inhibition of smooth muscle activity⁷.

The present results suggest that exercise can represent the same results like hormonal replacement therapy in producing direct vasodilating effect on the arterial tree, which could be explained by the study of Yousef in (1995)³⁰ who found that aerobic exercise at 60% of the VO_{2max} for 6 months could increase secretion of the sex hormone from the supra adrenal gland by percentage equal 16.12.

However, the overall effect of exercise on cardiovascular risk in women may be different, because exercise is associated with changes in high density lipoprotein levels²¹ and a reduction in levels of risk factors such as tissue plasminogen activator²⁹. In addition, many studies have shown that aerobic exercise induced an increase in catecholamine stimulated lipolysis in isolated adipocytes in both cross sectional²¹ and longitudinal designs⁶.

Also, women recruited in this study were relatively young post menopausal women, thus the finding of a positive effect of exercise on the internal carotid artery could be confirmed by the study of Kallikazaras et al., (2001)¹¹ who reported that if the age of women and time since menopause was high, so the improvement in carotid distensibility decreased in such cases.

As a conclusion, the present study demonstrates that 4 weeks of aerobic exercise training is associated with a significant increase in the velocity of the blood flow with a reduction in internal carotid artery RI and PI in post menopausal women which could be considered a mechanism by which exercise

could potentially reduce the incidence of cardiovascular disease.

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الملخص العربي

تأثير التمرينات الهوائية على معدل سريان الدم في الشريان السباتي الداخلي لدى السيدات بعد انقطاع الدورة الشهرية

يزداد معدل أمراض القلب لدى السيدات بعد انقطاع الدورة الشهرية وقد وجد أن التمرينات تقلل من هذه المضاعفات. تهدف هذه الدراسة إلى تقييم تأثير برنامج التمرينات الهوائية على معدل سريان الدم في الشريان السباتي الداخلي لدى السيدات بعد انقطاع الدورة الشهرية. وقد أجريت هذه الدراسة على ٢٠ سيدة سليمة صحياً بعد انقطاع الدورة الشهرية شاركن في برنامج التمرينات الهوائية لمدة ٤ أسابيع وقد تم تقييم الحالات عن طريق قياس معدل سريان الدم (سرعة الانسداد وسرعة الانقباض) ونسبة المقاومة ونسبة النبض في الشريان السباتي الداخلي باستخدام جهاز الدوبلر الملون قبل وبعد ٤ أسابيع من التمرينات. أثبتت النتائج أن التمرينات الهوائية لها تأثير إيجابي على زيادة معدل سريان الدم في الشريان السباتي الداخلي وذلك عن طريق تأثيرها الإيجابي على زيادة أدنى سرعة انبساط ونقص أقصى سرعة انقباض وكذلك نسبتاً المقاومة و النبض لدى السيدات بعد ٤ أسابيع من التمرينات . وعليه يمكن استنتاج أن ٤ أسابيع من التمرينات الهوائية تساعد على زيادة سرعة سريان الدم في الشريان السباتي الداخلي و هو ما يمكن اعتباره طريقة وقائية لتقليل معدل حدوث أمراض القلب لدى السيدات بعد انقطاع الدورة الشهرية. الكلمات الدالة: التمرينات الهوائية- سريان الدم في الشريان السباتي الداخلي- انقطاع الدورة الشهرية.