ACUTE CHANGES AFTER 30 MINUTE OF DYNAMIC EXERCISE IN ARTERIAL STIFFNESS AND PULSE WAVE VELOCITY OF HEALTHY YOUNG AND MIDDLE-AGED INDIVIDUALS

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ABSTRACT

The major non invasive evaluation of cardiovascular parameters include arterial stiffness index (ASI), ankle - brachial index (ABI), right and left brachial ankle pulse wave velocity (Right & left ba PWV), heart ankle pulse wave velocity (ha PWV), heart brachial pulse wave velocity (hb PWV) and carotid femoral pulse wave velocity (cf PWV), blood pressure (systolic, diastolic, pulse and mean) at four regions (right and left brachial and right and left ankle), respiratory rate (RR) and heart rate (HR) which have a prime role to diagnose the patients suffering from cardiovascular diseases. ASI of right and left brachial, ASI of right and left ankle and PWV at left ba PWV, right ba PWV, cf PWV, ha PWV, hb PWV and ha PWV were investigated before and after 30 min of acute dynamic exercise in young aged 20 + 2.4yrs and middle aged 40 + 1.5 yrs healthy male sedentary subjects to know the underlying mechanisms behind the advantages of taking regular dynamic exercise leading to alteration of cardiovascular mortality and morbidity and to assess endothelial dysfunction, elasticity and also autonomic adjustments as well as sympatho-vagal balance. ASI at all four regions were significantly reduced ($p<0.05$) after acute dynamic exercise in both the groups. HR, RR and blood pressure in mm Hg (SBP, DBP, PP and MABP) at four regions (right and left brachial, right and left ankle), were not much changed significantly ($P>0.05$) before and after acute dynamic exercise for 30 min in both the groups. The data suggested cardiac autonomic balance and vasodilatation of major arteries by reducing in arterial stiffness (ASI) as well as decrease in PWV in both young and middle aged individuals. The percentage change of arterial stiffness index at right & left brachial and right & left ankle was significant ($P<0.05$) in young adults as compared to middle aged subjects and which might be due to age related changes on elasticity of the arterial walls or endothelial dysfunction.

Key Words: arterial stiffness index, baroreflex, blood pressure, ankle-brachial index pulse wave velocity

INTRODUCTION

Regular dynamic physical exercise reduces cardiovascular morbidity and mortality. There may be multiple pathways involved including consistent physiological changes. All over the world scientists have studied the effect of regular dynamic exercise including Yoga and claimed that it increases longevity and provides healthy life.[1] But the underlying mechanism remains unclear. Aging is inevitable and no system is spared of its changes. Only cardiovascular system holds a key position in interpretation of age changes throughout the body. As the age advances cardiovascular regulatory mechanisms including baroreceptor reflex sensitivity/, autonomic responses, reduces their efficiency, elastic and non elastic fibers in the arteries giving the arterial walls strength and flexibility, are replaced by non elastic elements which decrease the elasticity of the arteries. So the arteries become stiffer, lose some of their ability to expand 1. This stiffness (ASI) leads to changes in cardiovascular dynamics and an increase in cardiovascular problems. The stiffer an artery the speedier the pulse wave generated by the heart travels, the higher the blood pressure and for a variety of reasons the harder the heart has to work.

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PWV was measured to assess arterial stiffness, is the speed of the blood pressure wave to travel a given distance between two sites of the arterial system (regional measurement) and is determined by the elasticity, wall thickness and blood density 2. Pulse-wave velocity correlates well with arterial distensibility and stiffness and is a useful non-invasive index to assess arteriosclerosis.

Arterial endothelial dysfunction is one of the key early events in atherogenesis, preceding structural atherosclerotic changes. This present study however was undertaken to ascertain whether acute dynamic exercise including yoga has any effect on arterial stiffness index as well as pulse wave velocity attributing on slowing the aging changes in cardiovascular system, considering the possibility of advocating this simple and easy technique for reducing the morbidity and mortality from cardiovascular diseases.

MATERIALS AND METHODS

The study protocol and informed consent were duly permitted by the Institutional Ethics Committee (IEC) of the Institute. Normal healthy subjects aged 20.11 + 0.12 yrs (young) and 40.21+ 2.11 yrs (middle aged healthy), having normal 3 ankle brachial index (>.9) were included in the study and performed in the department of Physiology,U.P.Rural Institute of Medical Sciences & Research, Saifai, Etawah, UttarPradesh State.. Participants of both the groups (N=17 (young) and N=17 (middle aged) after understanding the study protocol and procedures, gave their written informed consent for the study. Before the determination of PWV, recording of complete medical history including details of drug regimen and clinical examination was performed. Pulse wave velocity and arterial stiffness index were determined by Periscope (M/S Genesis Medical System, Hyderabad, India), as per description reported earlier 4, 5. Periscope is a PC based low cost instruments when used with a laptop, it can be carried to remote locations. It uses ECG as a marker. Periscope thus facilitates use in epidemiological studies which has been validated and has had good interday and inter observer reproducibility for various estimated central and peripheral arterial velocities. In brief, PWV was determined by a non-invasive pulse wave analyzing device. Participants were asked to refrain from smoking and drinking caffeine-containing beverages 12 h before the test. Procedure was performed always by the same operator in the morning hours between 8 and 10 a.m. 6 with subject resting in supine position at least for 10 min before the recording. Electrodes for electrocardiogram were placed in ventral surface of both wrists and medical side of ankles and BP cuffs were wrapped on both upper arm brachial artery and tibial artery above ankles. The cuffs were connected to a plethymographic sensor, which determines volume pulse form and an oscillometric pressure sensor, which measures blood pressure volume waveforms from the brachial and tibial arteries. All the pressure recordings were done for about 10 s and data were stored in the computer for analysis. Software was applied to calculate the following parameters from the waveforms which were stored in the computer for analysis like systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial blood pressure (MAP), pulse pressure (PP), heart rate (HR), heart brachial (hb) PWV, heart ankle (ha) PWV, brachial ankle (ba) PWV, carotid femoral (cf) PWV and right and left heart brachial pulse wave velocity (right hb PWV & left hb PWV) .

Dynamic exercise was performed for a period of 30 min by asking subjects to run followed by SURYA NAMASKAR. All were male, lifestyle was sedentary, undergoing a 30 min period of moderate dynamic exercise followed by a 30 min recovery period. Recording of all parameters using PERISCOPE 7,8 was done both before and just after recovery period of taking the acute dynamic exercise.

Statistical analysis: Data was expressed as mean + SD. Differences between the groups were evaluated by unpaired student 't' test and ANOVA. Probability values of P<0.05 were considered to indicate statistical significance.

RESULTS

1. ASI in left and right brachial(RB & LB) as well as in left and right ankle RA & LA), were significantly reduced (p<0.05) after acute dynamic exercise in both young adult (20 yrs) and middle aged (40 yrs) healthy subjects as compared to initial stage. Figure-1-4). The percentage change on ASI in 20 yrs young groups was significantly (P<0.05) lower than middle aged groups (Figure-11)
2. Heart rate was not significantly reduced (p>0.05) after acute dynamic exercise (end of recovery period) in both young adult (20 yrs) and middle aged (40 yrs) healthy subjects as compared to initial stage. The percentage change was not significant in both the groups (p>0.05) (Figure-5).
3. Systolic Blood pressure, Diastolic Blood Pressure, Pulse Pressure and Mean Pressure at four regions (RB and LB, RA and LA) were not altered significantly after dynamic exercise (end of recovery period) in both the groups when compared with initial stage (Table-1).
4. Pulse wave velocity such as right and left baPWV, haPWV, cfPWV & hb PWV were significantly reduced (p<0.05) after acute dynamic exercise (end of recovery period) in both young adult and middle aged healthy subjects as compared to initial stage (Fig. 6-10). The percentage change on ASI in young groups (20 yrs) was not significant (P<0.05) lower than middle aged groups.
5. There was no significant change (P>0.05) on ankle brachial index (> 0.9), body weight, RR, body temperature, room temperature, recorder.and recording apparatus (Table-1)

DISCUSSION

In our study blood pressure (SBP,DBP,PP,MABP) was not either increased or decreased at the end of recovery period (at the time of recording) in both the groups would be due to 1) more parasympathetic discharge than sympathetic, signifying no endothelial dysfunction 2) non alteration of baroreflex sensitivity 3) no extra accumulation of nitrous oxide (endothelial factors). 4) Abilities of arteries and arterioles to dilate fully in

Table-1: Body weight, height, ankle- brachial index (ABI) respiratory rate and blood pressure at four regions before taking acute dynamic exercise (Before) and after acute dynamic exercise (After) for 30 min with the recovery period of 30 min of all male subjects (middle aged and young).(Mean ± SD)

Groups (yrs)	Period	Body weight (kg)	Height (cm)	ABI (mm Hg)	Respiratory rate Cycles/min
40.21	Before	61.43±8.04	165.9±7.13	0.92±0.21	19.10±2.21
±2.11	After	60.87±8.04	165.9±7.13	0.90±0.11	19.12±2.11
20.11	Before	59.43±7.12	162.5±6.41	0.93±0.52	19.63±1.42
±0.12	After	58.78±8.04	159.5±6.41	0.91±0.42	20.63±1.31
Groups	Period	Blood	Pressure	at right	Brachial (mm Hg)
(yrs)		SBP	DBP	PP	MABP
40.21	Before	128.12±8.97	79.21±3.22	38.11±2.12	95.21±5.11
±2.11	After	129.02±8.11	78.31±4.11	37.31±1.42	94.31±4.76
20.11	Before	127.11±6.91	78.21±3.22	38.41±2.12	95.31±5.11
±0.12	After	130.02±5.12	79.01±3.18	39.35±5.41	96.31±4.16
Groups	Period	Blood	Pressure	at left	brachial (mm Hg)
(yrs)		SBP	DBP	PP	MABP
40.21	Before	129.11±8.07	78.11±2.21	39.17±3.11	94.21±4.11
±2.11	After	127.52±6.11	79.01±4.11	38.31±4.42	97.31±3.71
20.11	Before	128.81±6.91	79.21±3.22	38.11±2.12	95.21±5.11
±0.12	After	129.02±3.12	80.01±8.18	39.39±4.41	94.31±4.06
Groups	Period	Blood	Pressure	at right	ankle (mm Hg)
(yrs)		SBP	DBP	PP	MABP
40.21	Before	148.12±8.97	89.21±3.22	38.11±2.12	103.21±5.11
±2.11	After	149.22±8.11	88.31±5.11	39.31±1.42	101.31±4.16
20.11	Before	148.11±6.94	79.81±3.22	37.11±3.12	99.11±4.11
±0.12	After	150.02±8.12	79.01±3.18	39.35±5.41	98.31±5.16
Groups	Period	Blood	Pressure	at right	ankle (mm Hg)
(yrs)		SBP	DBP	PP	MABP
40.21	Before	148.12±8.97	89.21.±3.22	38.11±2.12	103.21±5.11
±2.11	After	149.02±8.11	88.41±5.11	39.21±1.42	101.11±4.16
20.11	Before	148.11±6.94	79.81±3.22	37.11±3.12	99.11±4.11
±0.12	After	150.02±8.12	79.41±3.18	39.35±5.41	98.31±5.16

response to an appropriate stimulus. Arterial stiffness is reduced significantly; even more reduction found in healthy young individuals when compared to middle aged would be due to age related changes of endothelium. PWV is reduced due to decrease in arterial stiffness reconfirm vasodilatation of the arteries which could correlate with our earlier studies. Tissue perfusion is increased, would be an important to improve vascular functions in both the groups. These results suggested that young and middle aged people are also able to reduce arterial stiffness and to prevent the lifestyle related diseases by doing dynamic physical exercise.

It is already suggested that the cardiovascular changes associated with exercise are set in motion by central command, in which cerebral regions concerned with volition induce parallel activation of motor and cardiovascular centers 9. In this study also we observed similar changes which was noted earlier. Recent evidence shows that these involuntary muscle contraction-induced heart rate increases are elicited by small muscle afferents that are sensitive to distortion or stretch of muscles called tentanoreceptors or mechanoreceptor, 10, and effect is an inhibition of cardiac vagal tone. Muscles also contain metabolically sensitive afferents that are excited, provide a major driving force to sympathetic activity 11&12. On the cessation of high physical activity, heart rate, respiratory rate and blood pressure decreases rapidly. Therefore, cardiac parasympathetic reactivation is the principal determinant of the immediate fall in HR, RR and BP.

The exact mechanism behind improvement of cardiovascular system by following dynamic exercise and Yoga yearns for an extensive research. But present studies indicate that acute dynamic regular exercise may be an effective adjunct in managing good health, should be made part of the standard treatment regime. Overall, this study found that regular dynamic exercise has a positive effect on arterial stiffness as well as pulse wave velocity which are an important to reduce mortality and morbidity.

Figure-1 : ASI in left brachial before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean + SD, P<0.05 (*) when compared.

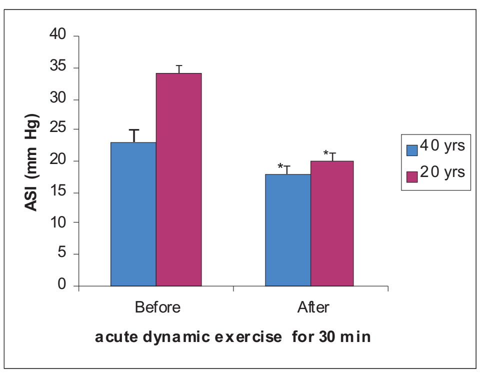


Figure-2 : ASI in right brachial before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean + SD, P< 0.05 (*) when compared.

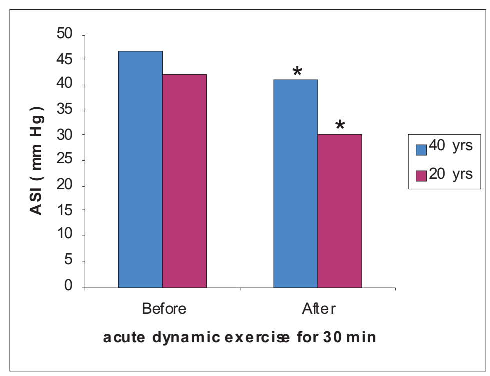


Figure-3 : ASI in left ankle before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean + SD, P< 0.05 (*) when compared.

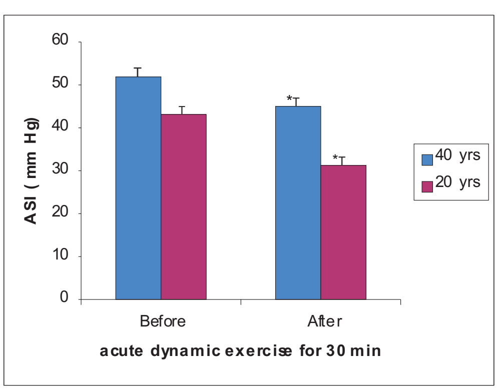


Figure-4 : ASI in right ankle before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean + SD, P<0.05 (*) when compared.

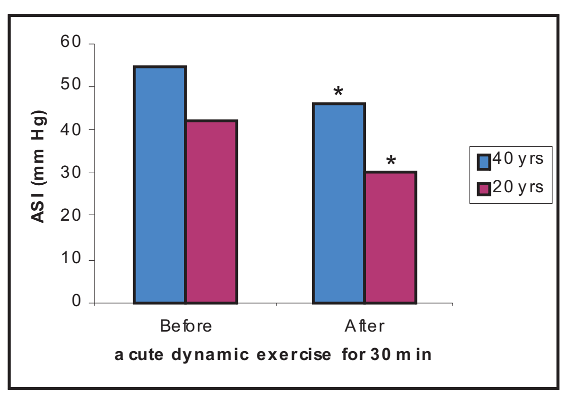


Figure-5 : HR before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean ± SD, P>0.05 when compared.

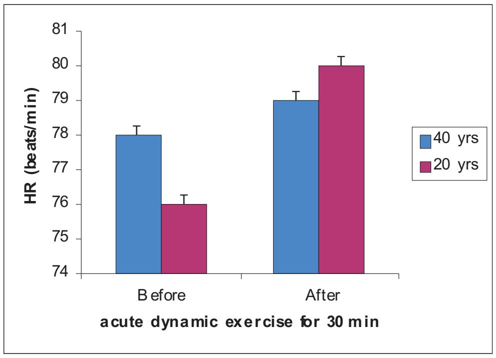


Figure-6 : Right brachial ankle pulse wave velocity before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects. Mean ± SD, P<0.05 (*) when compared.

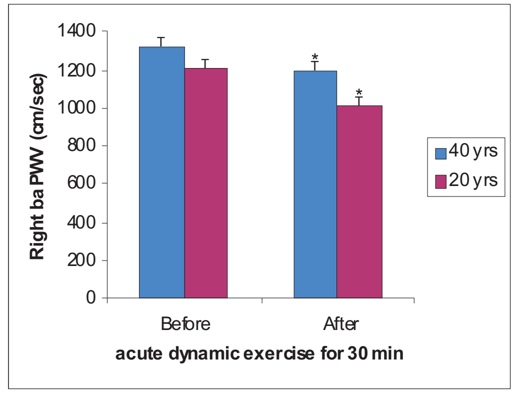


Figure-7 : Left brachial ankle pulse wave velocity before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects, Mean ± SD, P<0.05(*) when compared.

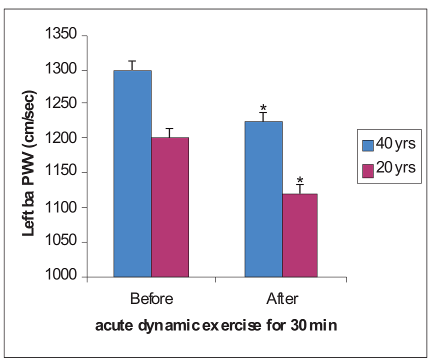


Figure-8 : Carotid femoral pulse wave velocity before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects. Mean±SD, P<0.05 (*) when compared

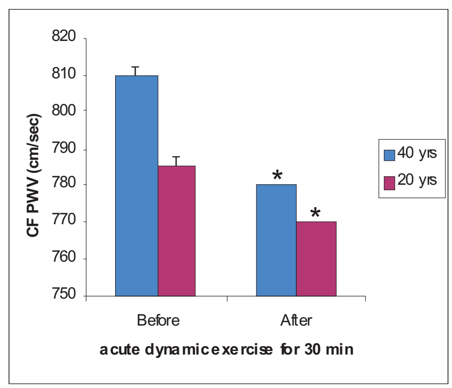


Figure-9 : Heart ankle pulse wave velocity before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects. Mean ± SD, P<0.05 (*) when compared.

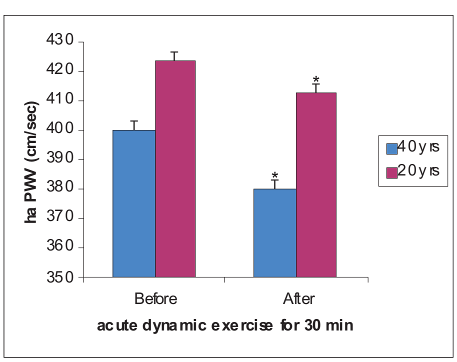


Figure-10 : Heart brachial pulse wave velocity before and after acute dynamic exercise in young adult (20 yrs) and middle aged (40 yrs) healthy subjects. Mean ± SD, P<0.05 (*) when compared.

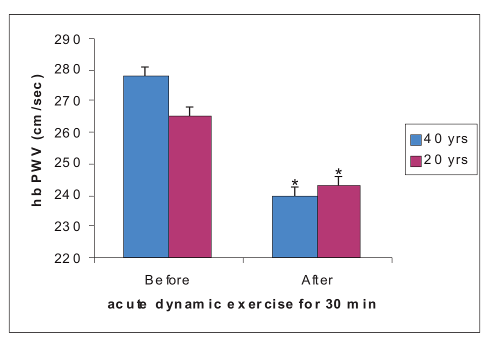
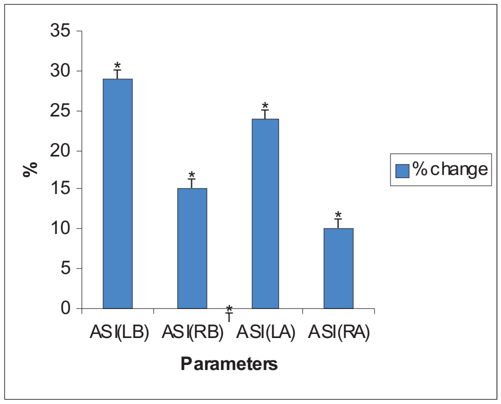


Figure-11 : Percentage change in arterial stiffness index (right and left brachial, right and left ankle) in 20 yrs healthy subjects when compared with 40 yrs middle aged subjects. Mean ± SD, * P<0.05(when compared with middle aged group).



REFERENCES

1. Bharshankar J R., Bharshankar R N , Vijaykumar N, Deshpande, S, Kaore B, Gosavi GB. Effect of Yoga on cardiovascular system in subjects above 40 yrs.. Ind J Physiol Pharmacol. 2003; 47(2):202-206.

2. McEniery C M, Wilkinson IB, Avolio AP. Age, Hypertension and arterial function. Clinical and Experimental Pharmacology and Physiology. 2007; 34: 665-671.

3. Doobay AV; Anand SS. Sensitivity and specificity of the ankle brachial index to predict future cardiovascular outcomes: A systemic review. Arteriosclerosis, Thrombosis, and Vascular Biology. 2005; 25: 1463-1469.

4. Bhunia S. Can physical exercise, control on diet and naturopathic treatment prevent early development of diabetes mellitus? Ind J Physiol Pharmacol. 2010,; 54(1): 92-94.

5. Bhunia S. Tripathy N. A Comparative Analysis of Non-invasive Cardiovascular Functions in Proficient and Non-proficient Healthy Subjects. International Journal of Physiology. 2013; 1(2):22-26.

6. Panza JA, Epstein SE, Quyyurni AA. Circadian variation in vascular tone and its relation to alpha sympathetic vasoconstrictor activity. N Engl J Med. 1991; 325: 986-990.

7. Sridhar Y, Naidu MUR, Usharani P, Raju YSN . Non-invasive evaluation of arterial stiffness in patients with increased risk of cardiovascular morbidity: A cross-sectional study. Ind J Pharmacol. December 2007; 39 (6): 294-298.

8. Rao Naidu MU,Reddy MB, Yashmaina S, Patnaik AN, Usha PR. Validity and reproducibility of arterial pulse wave velocity measurement using new device with oscillometrictechnique: A pilot study. BioMedical Engineering online. 2005;4: 49-62..

9. Coote JH. Recovery of heart rate following intense dynamic exercise. Experimental Physiology. 2010; 95(3): 431-440.

10. Gladwell VF, Fletcher J, Patel N, Elvidge LJ, Lloyd D, Chowdhary S & Coote JH. The influence of small fibre muscle mechanoreceptors on the cardiac vagus in humans. J Physiol. 2005; 567: 713-721.

11. Fisher JP, Young CN & Fadel PJ. Effect of muscle metaboreflex activation on carotid-cardiac baroreflex function in humans. Am J Physiol Heart Circ Physiol 2008: H2296-H2304.

12. Okamoto T. Effect of periodic Physical Exercise on Pulse Wave Velocity in Female College Students. Health Evaluation and Promotion. 2004; 31(4): 577-581.