Artery Research (2016) 13, 6–16

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/artres

Acute changes in arterial stiffness following exercise in healthy Caucasians and South Asians

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Received 29 May 2015; received in revised form 11 November 2015; accepted 16 November 2015
Available online 13 December 2015

KEYWORDS
Arterial stiffness;
Pulse wave analysis;
Exercise capacity;
Acute exercise;
Applanation tonometry;
Cardiovascular risk

Abstract *Background:* Arterial stiffness and exercise capacity are independent predictors of cardiovascular diseases. This study aims to establish the acute changes in arterial stiffness using applanation tonometry following sub-maximal exercise in Caucasians and South Asians. This study also aims to establish the relationship between exercise capacity and arterial stiffness.
Methods: In total, 69 participants including 37 Caucasians and 32 South Asians were assessed for arterial stiffness non-invasively using SpygmoCor (SCOR-PVx, Version 8.0, AtCor Medical Inc North America, USA) before and after an exercise test using the Bruce protocol on a treadmill and by measuring aerobic capacity using a metabolic analyser (Medical Graphics, Cardio Control, Minnesota, USA).
Results: Significant increases in arterial stiffness variables were observed including augmentation pressure, subendocardial viability ratio, ejection duration, pulse pressure, augmentation index and mean arterial pressure following exercise in both ethnic groups ($P < 0.05$). There were no significant differences in these increases between the ethnic groups ($p > 0.05$). There was no change in pulse wave velocity ($p > 0.05$). Exercise capacity was inversely related to arterial stiffness ($P < 0.05$).
Conclusion: There are no differences in arterial stiffness at the baseline and following acute exercise between Caucasians and South Asians. There was significant increase in arterial stiffness following exercise in both groups. Exercise capacity is inversely related to arterial stiffness. The results suggest that non invasive arterial stiffness could be used as a tool to measure acute changes following exercise.

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http://dx.doi.org/10.1016/j.artres.2015.11.002

Introduction

Changes in arterial distensibility occur with aging and arterial stiffness increases. These biophysical signs are elevated in cardiovascular conditions such as diabetes and hypertension.[1,2] Measurement of central aortic pressures has an important clinical value in the early diagnosis of cardiovascular risk. Central aortic pressures are often different from peripheral pressures and they have more diagnostic value than peripheral pressures because they are pathophysiologically more relevant.[3] Recently a 'Generalized Transfer Function' (GTF) technique has been developed and widely used to measure the central aortic pressures non-invasively using peripheral pulse wave analysis. Different types of equipment are available on the market to measure arterial stiffness using pulse wave analysis non-invasively. There are some differences between the measured values from those different systems,[4] yet non-invasive measurements provide important diagnostic and prognostic values. Studies show that non invasive assessment of pulse wave and arterial stiffness can be an independent predictor for cardiovascular mortality in healthy people.[5,6]

The SphygmoCor is one of the recently developed, computerized, portable and simple to use devices to assess pulse waveforms, and one of the common systems in use for measuring arterial stiffness.[7] It uses an arterial applanation tonometer for recording pressure waveforms. The advantage of this technique is the ease of performing applanation tonometry at the artery sites. Arterial stiffness varies with age, sex and ethnicity.[8,9] However, the non-invasive arterial stiffness measures are less frequently studied and reference values are not established for South Asian populations such as in India.

Measurement of exercise capacity using metabolic analysers is a standard method to predict or diagnose cardiovascular disease. Exercise capacity is inversely related to arterial stiffness in healthy people as well as those with cardiovascular conditions.[10,11] For example pulse wave velocity, one of the arterial stiffness variables derived from pulse wave analysis, has been shown to have an inverse correlation with exercise capacity in people with coronary artery disease.[12]

Ethnic differences in exercise capacity have been observed and well established.[13] However, the ethnic differences in the relationship between exercise capacity and arterial stiffness have been studied infrequently, especially between Caucasians and South Asians. The changes in arterial distensibility immediately following exercise may have important clinical importance. However, these are scarcely reported using maximum oxygen uptake (VO_2) and non-invasive carotid-radial pulse wave analysis.

The current study was carried out to explore the hypothesized acute changes in arterial stiffness using applanation tonometry following sub-maximal exercise in Caucasians and South Asians. This study also aims to find the relationships between exercise capacity and arterial stiffness. We hypothesized that there would be significant changes in arterial stiffness immediately after sub-maximal exercise and there would be significant relationships between exercise capacity variables using metabolic analysis and arterial stiffness variables using pulse wave analysis. It was also expected that there would be a significant difference between Caucasians and South Asians in exercise capacity and changes in arterial stiffness following acute exercise.

Methods

Following institutional ethical approval, the study was advertised to staff and students of a University through posters on notice boards and through emails. Sixty nine volunteers aged 20—63 (mean 33.09 $\pm$ 11.94) participated following written informed consent. Healthy Caucasians (37) and South Asians (32) were included. Subjects were excluded who had known cardiovascular conditions and any orthopaedic conditions which could limit exercise testing on treadmill.

Participants who showed interest were given a detailed information sheet with the entire requirement to be undertaken before the study. Participants were asked (i) not to smoke or have caffeinated drinks for 3 h before the study, (ii) not to drink alcohol or participate in unusually heavy activity for a day before the test. They were also advised not to take heavy meals immediately before the test. Upon arrival, the participants were measured for weight using a floor scale (Seca model 761, Vogel ad Halke, Germany) and height using a free standing stadiometer (Leicester Height Measure, Invicta Plastics, Oadby, Leicester, UK). The treadmill exercise testing was explained to the participants and a familiarisation session on treadmill walking was performed if necessary. They then sat in a chair and rested for 10 min. During this time they completed a Physical Activity Readiness Questionnaire (PARQ), a detailed demographic information sheet and the consent forms.

Measurement of arterial stiffness

Local blood pressures were assessed using a conventional measurement of the ipsilateral brachial artery blood pressure according to the recommendations of the European Society of Hypertension[14] using a validated oscillometric device (BP-300, Kernel Intl Ltd). The mean of three brachial blood pressure values was used for the auto-calibration in the measurement of arterial stiffness. Arterial stiffness was assessed with a SphygmoCor system (SCOR-PVx, Version 8.0, AtCor Medical Inc North America, USA). The SphygmoCor is one of the recently developed computerized portable and simple to use devices to assess pulse waveforms and one of the common systems in use for measuring arterial stiffness. It uses an arterial applanation tonometer for recording pressure waveforms that includes pulse wave velocity (PWV), pulse pressure (PP), augmentation pressure (Aug. P), augmentation index (AIx), augmentation index corrected for heart rate at 75 bpm (AIx@HR75), subendocardial viability ratio (SEVR) and ejection duration. An electrocardiogram (ECG) recording during measurements is used for synchronization of carotid and radial pulse wave times and heart rate (HR).

The measurements were taken under optimal conditions for applanation as advocated by Rietzschel et al.[15] The flat