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Central blood pressure is associated with trunk flexibility in older adults

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Abstract *Background:* Increase in central blood pressure is more predictive of future cardiovascular disease than increased brachial blood pressure. Arterial stiffness causes an early return of the reflected pressure wave to the aorta, with subsequently augmented central systolic pressure. It has been reported that arterial stiffness is associated with poor trunk flexibility; however, the effect of flexibility fitness on central blood pressure remains unclear. The purpose of the present study was to examine the relationship between trunk flexibility and central blood pressure using a cross-sectional design.
Methods: A total of 198 middle-aged (50–64 years) and older (65–75 years) adults participated in this study. We measured central blood pressure, carotid-femoral pulse wave velocity (cfPWV), and sit-and-reach flexibility as an index of body trunk flexibility. Study subjects were divided into either poor- or high-flexibility fitness group for each age category.
Results: Among middle-aged subjects, there were no significant differences in any hemodynamic parameters between the two groups. Among older subjects, the central systolic blood pressure and central pulse pressure in the high-flexibility group were lower than that in the poor-flexibility group. cfPWV was also lower in older subjects with high flexibility than those with poor flexibility. Furthermore, sit-and-reach flexibility was significantly correlated with central systolic blood pressure and central pulse pressure.
Conclusion: We demonstrated that trunk flexibility is correlated to central systolic blood pressure and pulse pressure in the elderly.

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Introduction

Increased blood pressure and arterial stiffness are independent risk factors for cardiovascular disease, morbidity, and mortality.[1,2] Central aortic blood pressure is a better predictor of cardiovascular outcomes than brachial blood pressure.[3] Central blood pressure is composed of an incident wave and reflected waves.[4] As arterial stiffness increases, the transmission velocity of the reflected wave increases and the pressure overlap of the reflected and incident waves is augmented during late systole. Hence, an increase in the pulsatile component of central aortic pressure, mainly because of an elevated systolic peak pressure and augmentation pressure, is considered to more accurately indicate left ventricular afterload, carotid intima—media thickness, and peripheral organ damage.[5,6] It has been reported that central systolic blood pressure and pulse pressure increase with advancing age as well as arterial stiffness.[7] Furthermore, pulsation of central blood pressure represented a greater indicator of cardiovascular and cerebrovascular risk than pulse wave velocity. In addition, Roman et al. documented that, after adjusted with taking of antihypertensive medication, only central pulse pressure remained as an independent predictor of cardiovascular outcome.[3] Xu et al. reported that central pulse pressure was a stronger correlate of the cerebral flow pulsatility of middle cerebral artery than aortic pulse wave velocity.[8] Therefore, the management of age-related increase in central blood pressure may be of great pathophysiological importance.

Central blood pressure is often treated by non-pharmacological therapy. Our group demonstrated that central blood pressure decreased after life-style modification (exercise and diet) concurrently with a reduction in arterial stiffness in overweight and obese men.[9,10] Laskey et al. reported that a 20-week exercise rehabilitation program decreased central systolic pressure in patients with coronary heart disease.[11] These studies imply that higher levels of physical fitness appear to prevent arterial deterioration. Furthermore, trunk flexibility, which is one of the physical fitness parameters, is associated with pulse wave velocity in the elderly.[12] Taken together, it is possible that poor flexibility-related arterial stiffening induces increase in central blood pressure. However, the effect of trunk flexibility on central blood pressure in middle-aged and older individuals has not yet been examined. Therefore, the purpose of this study was to examine the relationship between trunk flexibility, central blood pressure and arterial stiffness in middle-aged and older individual.

Methods

Subjects

A total of 198 adults (39 men and 159 women), middle-aged (50—64 years) and older (more than 65 years) adults participated in this study. None of the subjects had smoking habits or received cardiovascular-acting medication or hormone replacement therapy. We excluded subjects with abnormal blood chemistries, history of angina, arrhythmia, heart failure, stroke, cardiovascular and cerebrovascular disease, and diabetes mellitus. All potential risks associated with the study were explained to the subjects, and written informed consent with regard to participation in the study was provided by all participants. All procedures were reviewed and approved by the ethical committee of the University of Tsukuba.

Procedures

All experiments were conducted in the morning after a 12-h overnight fast. Subjects abstained from alcohol and caffeine for at least 12 h and did not exercise for at least 24 h before beginning the experiment so as to avoid the potential acute effects of exercise. Measurements were performed in a quiet, temperature-controlled (24—26 °C) room. We measured central blood pressure, arterial stiffness, and flexibility. To assess the effects of flexibility on central blood pressure, the subjects were furthermore divided into a poor- or a high-flexibility group on the basis of the median value of a sit-and-reach test.

Measurements

Blood pressure

Arterial pulse waves of the left radial artery were measured non-invasively by an automated tonometric system (HEM-9000 AI, Omron Healthcare, Kyoto, Japan), with the study individuals in a seated position. The wave was calibrated to simultaneously measure brachial blood pressure in the right brachium with an oscillometric device. Late systolic blood pressure in the radial artery was used as an estimate of the central systolic blood pressure.[13] Central pulse pressure was calculated from central systolic blood pressure and brachial diastolic blood pressure (central pulse pressure = central systolic blood pressure − brachial diastolic blood pressure).[9]

Pulse wave velocity

Carotid-femoral pulse wave velocity (cfPWV) was measured as an indicator of arterial stiffness by a semi-automated vascular testing system, as similar to our previous report.[14] Briefly, carotid and femoral pressure waves were obtained by two applanation tonometry sensors incorporating an array of 15 transducers (Form PWV/ABI, Colin Medical Technology, Komaki, Japan). The distance between the left common carotid and femoral arterial recording sites divided by the transit time enabled the calculation of cfPWV.

Flexibility

Flexibility was measured by a sit-and-reach test using a flexibility-testing device (Yagami Inc., Nagoya, Japan). Subjects were seated on the floor, with the hip, back, and occipital region of the head touching the wall and with legs held straight by the tester. They put both hands on the device with their arms held straight, and the device was set to zero. Participants were then asked to slowly bend forward and reach as far forward as possible. The best bout of two trials was recorded.[15] The subjects were divided into either poor- or high flexibility group on the basis of the median value of a sit-and-reach value in each age category and each sex.