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Can Body Flexibility Predict Arterial Stiffening?

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Abstract

Arterial stiffness is a risk factor for cardiovascular disorders and mortality. Arterial stiffness increases progressively with aging. Although nobody can escape from age-related arterial stiffening, having a high-level of cardiorespiratory fitness delays age-related arterial stiffening. The primary components of physical fitness are muscular strength, cardiorespiratory fitness, and flexibility. Recent cross-sectional studies have shown that flexibility is associated with arterial stiffness, independent of muscular strength and cardiorespiratory fitness. In addition, using a 5-year longitudinal study, we found that a greater progression of age-related arterial stiffening was associated with poor flexibility in healthy adults. These cross-sectional and longitudinal studies suggest that flexibility can predict arterial stiffening. In this article, we review the recent studies regarding the relationship between arterial stiffness and flexibility.

Keywords: Arteriosclerosis; Blood pressure; Aging; Fitness; Prevention

Introduction

The sit-and-reach test is a basic physical fitness test to determine flexibility of the hamstrings, hips and lower back. The flexibility assessed by the sit-and-reach test is called trunk flexibility, which is generally used to assess overall body flexibility. Flexibility has traditionally been used as a determining factor to reduce the risk of injury and/or optimize functional movement in daily life. Recent studies have provided a new aspect of flexibility as physical fitness. The studies have demonstrated that arterial stiffening is associated with flexibility. For this reason, the relationship between arterial stiffness and flexibility has gained attention [1]. In this article, we review the recent studies regarding the relationship between arterial stiffness and flexibility.

Flexibility and Arterial Stiffness

Arterial stiffness is identified as an independent risk factor for cardiovascular disorders and mortality [2-5]. Prevention of arterial stiffening is an important issue. It is well known that higher levels of cardiorespiratory fitness attenuate age-related arterial stiffening [6,7]. The primary components of physical fitness are muscular strength, cardiorespiratory fitness, and flexibility. In 2009, we found that arterial stiffness is also associated with poor trunk flexibility in middle-aged and older adults, independent of muscular strength and cardiorespiratory fitness [8]. Following that, several studies have supported the finding that a less flexible body indicates greater arterial stiffening [9-11]. However, these studies all used a cross-sectional study design. Therefore, it would be interesting to determine if poor flexibility accelerates the progression of age-related arterial stiffening using a longitudinal study design.

Using a 5-year longitudinal study, we recently examined the association between progression of aortic stiffness (carotid-femoral pulse wave velocity; cfPWV) and trunk flexibility [12]. The annual rate of changes in cfPWV (mean ± standard error) were 14.41 ± 2.73, 9.79 ± 2.59, 2.62 ± 2.68 cm/sec/year for Low, Middle, High trunk flexibility, respectively. There was a significant association of the annual rate of changes in cfPWV to trunk flexibility levels (Table 1).

	Trunk flexibility levels			P for trend
	Low	Middle	High	
N (men/women)	99 (23/76)	104 (30/74)	102 (27/75)	
Annual rate of changes in cfPWV, cm/sec/year (Crude)	15.55 ± 2.88*	8.17 ± 2.81	3.17 ± 2.84	0.01
Annual rate of changes in cfPWV, cm/sec/year (Adjusted model)	14.41 ± 2.73*	9.79 ± 2.59	2.62 ± 2.68	0.011

Table 1: The annual rate of changes in aortic stiffness assessed by cfPWV according to trunk flexibility levels [12]. Values are mean ± standard error. [Adjusted model is adjusted for baseline age, sex, weight, body fat, heart rate, systolic blood pressure, carotid-femoral pulse wave velocity (cfPWV), moderate and vigorous physical activity times, and peak oxygen uptake. *P<0.05 *vs.* High]

Multiple regression analysis showed that the value of baseline sit-and-reach (β=-0.12) was independently correlated with the changes in cfPWV following adjustment for baseline age, sex, heart rate, body fat, cfPWV, and peak oxygen uptake. These results indicate that a greater progression of age-related arterial stiffening is associated with poor trunk flexibility, independent of cardiorespiratory fitness. These cross-sectional and longitudinal studies suggest that flexibility can be a predictor of arterial stiffening.

We previously proposed physiological mechanisms to explain the relationship between flexibility and arterial stiffness [1]. Functionally, sympathetic nerve activity and endothelial function modulate arterial vascular tone which determines arterial stiffness [13]. Habitual stretching exercises, which improve flexibility, may reduce sympathetic nerve activity [14]. Recently, Yamato et al. found that stretching stimulation locally reduced arterial stiffness [15]. The localized reduction of arterial stiffness may involve the release of vasodilator from the endothelium induced by mechanical stimulation of regional blood vessels [16,17]. Structurally, the muscles or connective tissues (e.g., elastin-collagen composition) may be determinant factors for both flexibility and arterial stiffness [13]. Age-related structural alterations in flexibility may correspond to age-related alterations in the arterial wall within the same individual. In this regard, the relationship between flexibility and arterial stiffness can be partly attributed to genetic factors [18,19]. Kikuchi et al. found that RR genotype of α-Actinin-3 R577X was associated with lower flexibility compared to RX and XX [20]. RR genotype was also associated with higher blood pressure [21] which is a strong determinant of arterial stiffness.

High blood pressure may also be associated with poor flexibility. Systolic blood pressure in a group with poor-flexibility was higher than in a high-flexibility group in middle-aged and older adults [8]. Komatsu et al. showed that flexibility was inversely correlated with central systolic blood pressure and pulse pressure in the elderly [10]. Hypertension is acknowledged as one of the greatest and most established risk factors for cardiovascular disease [22-24]. Unfortunately, only approximately 30-40% of patients currently taking antihypertensive drug treatments are controlling their blood pressure at less than 140/90 mmHg [25,26]. Thus, it has become crucial to explore alternative methods for hypertension treatment. Our hope is that studies regarding flexibility and blood pressure or arterial stiffness will contribute to further exploration of alternative methods to reduce hypertension [27,28,14].

Perspectives

Since an association between flexibility and arterial stiffness was found, the next logical question would be whether or not improving flexibility could modify arterial stiffening. We recently summarized findings regarding the effects of stretching or yoga on arterial stiffness [1]. Although some studies showed that stretching or yoga improved arterial stiffness, the findings are complicated. Therefore, more studies will be needed to reach a conclusion regarding the chronic effect of stretching exercise on arterial stiffness. Arterial stiffness is a risk factor for cardiovascular disorders and mortality [2-5]. It would be of interest to identify the relationship between flexibility, stretching training or yoga and cardiovascular disease.

Conclusion

Cross-sectional and longitudinal studies demonstrate that poor flexibility indicates greater arterial stiffening, suggesting that flexibility can be a predictor of arterial stiffening. Accordingly, there is a possibility that flexibility could be a novel indicator relating to cardiovascular disease, which can be easily evaluated in any area and over all ages.

Declaration of Interest

The authors declare that there is no conflict of interests regarding the publication of this article.

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