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CORRESPONDENCE

Central and peripheral blood pressure response to a single bout of an exercise session in patients with resistant hypertension

Fernando Ribeiro[1] · Nádia Almeida[2] · Raquel Ferreira[3] · Nórton Oliveira[4] · José Oliveira[4] · Alberto J. Alves[5] · José Mesquita-Bastos[2,3]

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Resistant hypertension (RH) is an important public health issue that increases the risk of cardiovascular events, chronic kidney disease, and death, as well as the burden of disease [1]. Currently, the available treatment options to lower blood pressure in patients with RH, namely, antihypertensive drugs and renal sympathetic denervation, have shown limited success [1, 2]. Exercise training has been suggested as a promising therapy, as it has been shown to decrease both acute [3] and chronic [4] blood pressure in RH patients. However, evidence is lacking regarding how the central and peripheral blood pressures in these patients respond to acute aerobic exercise. Thus, this study analyzed the effects of a single session of light-intensity aerobic exercise on the central and peripheral blood pressure and the carotid-femoral pulse wave velocity (cf-PWV) in RH patients.

Nineteen patients (nine women and ten men) were enrolled. To be admitted, patients were required to be between 45 and 75 years of age, have RH for more than 3 years and have regular and unchanged medication use in the previous 6 months; RH was defined as systolic blood pressure (SBP) ≥140 mmHg, despite treatment with ≥3 optimally dosed antihypertensive medications of different classes, including a diuretic, or the need for four or more drugs to achieve an SBP ≤140 mmHg [5]. The exclusion criteria were heart failure, any previous cardiovascular event, peripheral artery disease, renal failure, chronic obstructive pulmonary disease, insulin-dependent diabetes, and regular participation in exercise training programs. The hospital ethics committee approved the study. Participants provided written informed consent, and all procedures were conducted according to the Declaration of Helsinki.

Determination of the cf-PWV and pulse wave analysis of the right radial artery was performed after a 10-min rest period after the exercise session using applanation tonometry (SphygmoCor, AtCor Medical, Australia) according to international guidelines [6]. Changes in central and brachial blood pressure and cf-PWV were recorded in response to a 10-min session of walking on a treadmill at 3 km/h. The speed and duration of walking were set to reproduce a real-life situation such as dog walking or picking up children from school. Paired *t*-tests were used to compare mean differences between variables and the magnitude of changes between central and peripheral pressures. The effect size for within-group comparisons was calculated using the Cohen *d* coefficient.

Overall, patients were middle aged (58.7 ± 9.0 years) and mostly overweight/obese (weight: 84.4 ± 9.5 kg; height: 166.6 ± 7.4 cm; body mass index: 30.5 ± 3.7 kg/m^2). The number of medications used for blood pressure control ranged from three to eight pharmacological agents (mean 4.7 ± 1.9) and included diuretics (71.5%), angiotensin-converting enzyme inhibitors/angiotensin receptor antagonists (42.75%), calcium channel blockers (66.5%), beta-blockers (61.75%), central inhibitors (33.25%), and vasodilators (9.5%). Both the central (150.5 ± 22.8 to 156.6 ± 21.1 mmHg, $p = 0.023$; Cohen's $d = 0.278$) and peripheral (163.1 ± 21.7 to 173.4 ± 21.2 mmHg; $p = 0.002$; Cohen's $d = 0.478$) SBP were increased immediately after exercise, but the magnitude of the increase was significantly lower

✉ Fernando Ribeiro
fernando.ribeiro@ua.pt

1 School of Health Sciences and Institute of Biomedicine – iBiMED, University of Aveiro, Aveiro, Portugal

2 School of Health Sciences, University of Aveiro, Aveiro, Portugal

3 Cardiology Department, Hospital Center of Baixo Vouga, EPE, Aveiro, Portugal

4 Research Center in Physical Activity, Health and Leisure, Faculty of Sport, University of Porto, Porto, Portugal

5 Research Centre in Sports Sciences, Health and Human Development, CIDESD, University Institute of Maia, ISMAI, Maia, Portugal

for the central pressure (6.1 ± 10.7 versus 10.3 ± 12.7 mmHg, $p = 0.002$; Cohen's $d = 0.354$). The central pulse pressure results also showed lower values than the peripheral pressure (15.4 ± 11.8 versus 20.2 ± 15.1 mmHg, $p = 0.001$; Cohen's $d = 0.354$). Both the central (89.9 ± 15.3 to 80.6 ± 15.3 mmHg; $p = 0.005$, Cohen's $d = 0.608$) and peripheral (89.7 ± 13.8 to 78.7 ± 15.2 mmHg, $p < 0.001$; Cohen's $d = 0.763$) diastolic pressure decreased similarly after exercise. The augmentation pressure increased (18.1 ± 10.2 to 21.9 ± 10.8 mmHg, $p = 0.004$; Cohen's $d = 0.366$), but neither the augmentation pressure index at 75 beats/min (24.9 ± 9.7 to 27.1 ± 7.5%, $p = 0.319$; Cohen's $d = 0.133$) nor the cf-PWV (8.4 ± 1.1 to 8.8 ± 1.4 m/s, $p = 0.103$; Cohen's $d = 0.313$) changed in response to exercise.

These results are similar to those reported in previous studies of healthy young subjects [7–9]. A previous study [8] in young healthy male subjects, i.e., subjects with better central arterial compliance than older healthy men [10], showed that a daily living task, such as walking while carrying a load on the upper limbs (aerobic exercise accompanied by upper limb isometric contraction), increased the augmentation index at 75 beats/min, central pulse pressure, and peripheral and central systolic pressure. Additionally, a recent systematic review of 43 studies assessing the effect of acute aerobic exercise on arterial stiffness in healthy subjects concluded that arterial stiffness of the peripheral arteries in the central and upper body is increased only immediately postexercise (0–5 min)[9]. The acute increases in blood pressure and derived measures of central pressure induced by the walking session were similar to those observed in previous studies; hence, the afterload was not substantially increased in these patients. Indeed, the increase in the workload posed on the left ventricle during walking was relatively low in a group of patients with elevated afterload at rest. However, it is important to highlight the numerous benefits of physical activity and exercise training in hypertensive patients, including the improvement of antioxidant defenses and the reduction of disease severity [11].

Future work should address whether this acute response is similar in RH patients with increased inflammatory status and vascular dysfunction, as a previous study showed that even in normotensive subjects with an exaggerated blood pressure, responses to exercise could be observed in those with lower nitric oxide bioavailability and higher C-reactive protein levels [12].

Our primary new finding is that light-intensity aerobic exercise (walking) does not elicit an abnormal or exaggerated increase in the central pressure or PWV of RH patients. The central blood pressure response, which is a better index of cardiac load than the peripheral blood pressure, to a single session of exercise was lower than the peripheral response in RH patients. Therefore, healthcare providers should consider, whenever possible, the inclusion of physical activity and evidence-based exercise programs as part of the comprehensive management of RH.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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