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COMMENT

# Hypotensive effects of resistance training in treated hypertensive men: Is the systemic dynamic mode better than the isometric handgrip mode?

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Hypertension is a leading cause of cardiovascular disease, and nearly 1.39 billion people worldwide have been reported to be suffering from hypertension according to the data of 2010 [1]. Medical cost due to hypertension and related diseases are huge and becoming a great economic burden in many countries. Importantly, the number of hypertensive patients is progressively increasing due to many factors like aging, prevalent obesity, and an unhealthy lifestyle like physical inactivity [1]. Therefore, adequate treatment and prevention of hypertension is a crucial social issue all over the world.

Exercise is an essential non-pharmacological therapy for hypertension treatment. Dynamic aerobic exercise has been a first-line mode recommended in many guidelines, but recently, resistance training has been also considered. The American College of Cardiology (ACC)/American Heart Association (AHA) hypertension guidelines published in 2017 considered both dynamic and isometric resistance (especially handgrip) training in addition to aerobic exercise [2], while only dynamic resistance training was advised in the 2018 European Society of Cardiology (ESC)/European Society of Hypertension (ESH) guidelines [3]. Considering the diversity of patient characteristics and their surrounding situations, the greater the choice of an exercise mode, the better the individualised guidance. Moreover, hypotensive effects of exercise in a population with high-normal or normal blood pressure (BP) is also important if we consider the prevention of hypertension or management of high risk patients. The European Association of Preventive Cardiology (EAPC) and the ESC Council on Hypertension published a consensus document on personalised exercise prescription according to BP category [4]. The authors suggested that the first-line exercise therapies recommended for hypertensive patients, individuals with high-normal BP, and individuals with normal BP who expect BP reduction are aerobic exercise, dynamic resistance, and isometric resistance (especially handgrip) therapy, respectively. This document also presented some important comments, which should be further addressed. Particularly, there is less data available on hypotensive effects of isometric resistance training for all BP categories, and therefore, the hypotensive effects on a population with normal BP may be currently overestimated. No meta-analysis exists for the hypotensive effects of isometric resistance training in people with high-normal BP. Therefore, further research is required for isometric resistance training to precisely implement it in general practice. Furthermore, no study addressed the combined effects of dynamic resistance training and isometric resistance training.

In this article on Hypertension Research, Fecchio et al. addressed some of the issues that were not yet settled. For the first time, they compared the effects of dynamic resistance training (DRT), isometric handgrip training (IHT), and their combination on BP in treated hypertensive men [5]. Systemic haemodynamics, vascular function, and cardiovascular autonomic modulation were also examined as secondary outcomes. Sixty-two middle-aged men with treated hypertension were randomly allocated to four groups (DRT, IHT, CRT [DRT + IHT], and control [CON]). In all groups, each exercise was well guided according to established guidelines, and the interventions were administered three times per week for 10 weeks. As a result, net systolic blood pressure (SBP) reduction in the DRT, IHT, and CRT groups was −8 ($p < 0.05$), −5 (not significant), and −11 mmHg ($p < 0.05$), respectively, as compared with the

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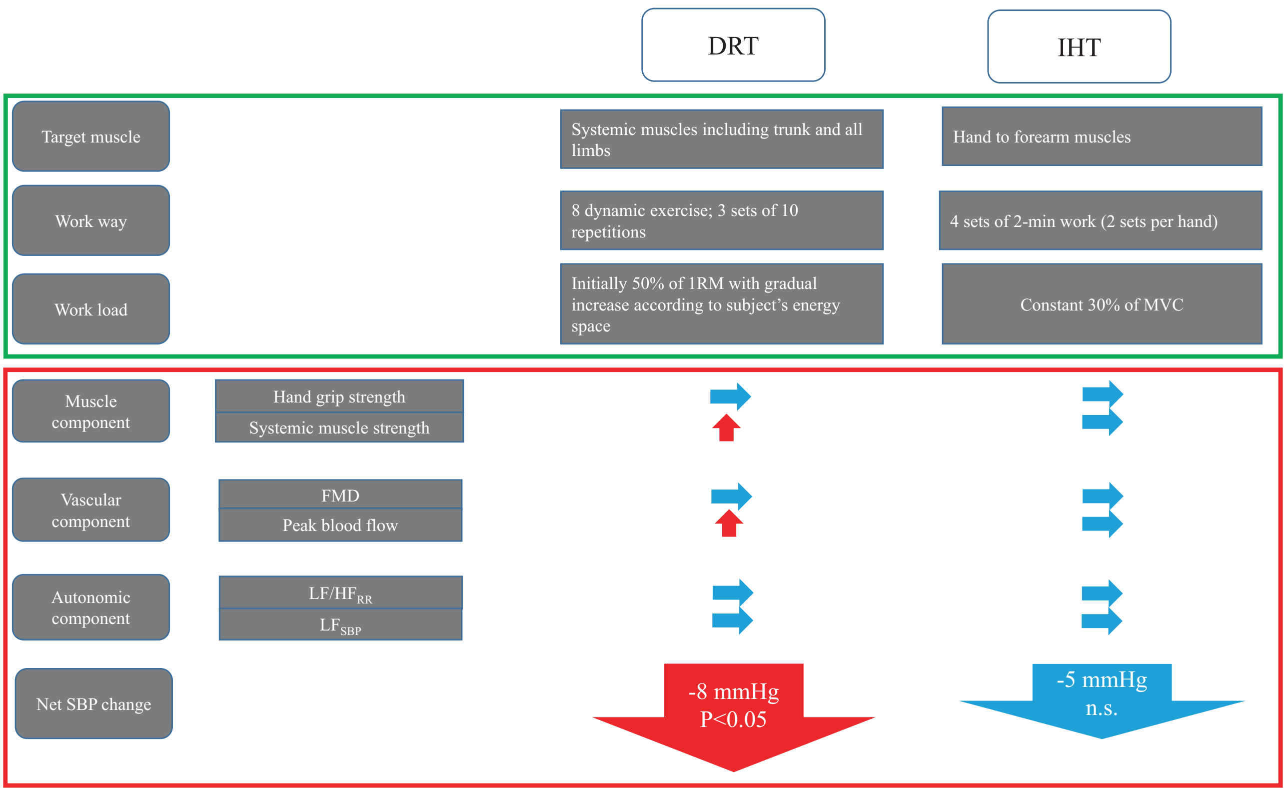


**Fig. 1** Comparison of the details of exercise mode and changes in several output measures between DRT and IHT groups. Details of exercise mode include target muscle, work way, and workload. Output measures include muscle strength, vascular, autonomic components, and net systolic blood pressure (SBP) change. In each component, red and blue arrows indicate significant and non-significant change, respectively

CON. Moreover, the net increase in peak blood flow during reactive hyperaemia, a marker of microvascular function, was +321 ($p < 0.05$), +110 (not significant), and +296 mL/min ($p < 0.05$), respectively. None of the other outcomes remained unchanged. The magnitude of the changes in SBP and peak blood flow during reactive hyperaemia did not differ significantly between the DRT and CRT groups.

This study provides a great amount of important clinical evidence. First, DRT may be a better exercise mode than IHT for middle-aged treated hypertensive men with high-normal BP, providing net SBP reduction of about −8 mmHg. This hypotensive effect is nearly equal to that reported after aerobic training and after administration of the main anti-hypertensive drug classes used in monotherapy. This BP reduction was associated with an improvement of microvascular function and was probably elicited by a reduction in peripheral resistance. This alteration would add further benefit to the prognosis, because impaired microvascular function, which is very common in hypertension, is known to be associated with an increased risk of cardiovascular events independent of BP. Moreover, there are some other benefits of DRT. First, DRT significantly increased the systemic muscle strength (Fig. 1). These changes would further improve metabolic and physical outcomes. We recently reported randomised control trials (RCTs) conducted in elderly treated hypertensive patients, which demonstrated that a 6-month, home-based dynamic resistance training significantly improved blood pressure and lipid profiles when compared with the control group [6]. Moreover, leg muscle strength and some physical functions were improved, and the risk of fall was decreased in the intervention group when compared with the control group. In a modern aging society like Japan, fracture due to fall is one of the major risks of disability [7]. In addition, the cause of fall is largely attributed to impaired leg physical function [8]. Therefore, DRT could be favourably recommended for elderly hypertensive patients, especially those with reduced muscle strength and function.

The SBP reduction of the IHT group was less than that of the DRT group and did not reach a statistically significant level. However, the net SBP reduction in the IHT group was −5 mmHg, indicating some degree of hypotensive response (Fig. 1) . The lower hypotensive effect of IHT when compared with DRT may be explained partly by the patients' baseline BP category, which was high-normal, for which DRT is the first-line choice as mentioned above [3]. However, there is another factor, which should be considered. Fig. 1 compared the details of exercise mode (green rectangle) and changes in several output measures (red rectangle) between DRT and IHT. Ten weeks of exercise significantly increased the general muscle strength in the DRT group but failed to increase handgrip strength in the IHT group. These data suggest that the workload of the related muscle was lower in the IHT than in the DRT groups. According to the current exercise guidelines, workload in the DRT group was adjusted after considering the subject's energy space, but there was no such adjustment in the IHT group (Fig. 1). Previous RCTs comparing hypotensive effects between different intensity groups of isometric resistance training have shown that the effect was consistently larger in higher-intensity groups than in lower-intensity groups [9]. Difference in muscle volume involved did not seem to matter, because isometric resistance training of the arm has been reported to show superior effects on SBP reduction compared to that of leg (−6.9 vs. −4.2 mmHg) [4]. Recently, Javidi et al. compared the hypotensive effects between groups performing isometric handgrip at 60% (IHG-60) and at 30% (IHG-30) of maximum voluntary contraction (MVC) [10]. The volume was equated between the exercise groups, with IHG-60 performing $8 \times 30$ s contractions and IHG-30 performing $4 \times 2$ min contractions/day. After eight weeks of intervention, systolic BP was significantly reduced for IHG-60 (−15.5 mmHg [−18.75, −7.25]) and IHG-30 (−5.0 mmHg [−7.5,−3.5]) groups, compared to the control group ($p < 0.01$). Compliance was >80% and no adverse events were reported in either group. Interestingly, the MVC of handgrip was significantly increased when compared with the pre-intervention conditions in both IHG-60 (11.8%, $p = 0.002$) and IHG-30 (13.6% $p = 0.001$) groups, and there were no significant changes in the control group. These data suggest that muscle adaptation and BP response are very variable, even at 30% of MVC. Consequently, sufficient handgrip load seems to be necessary for certain BP reductions. How then do we find the adequate handgrip load for individuals? Establishing personalised IHT therapy seems to be a crucial issue.

## Compliance with ethical standards

**Conflict of interest** The authors declare no competing interests.

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