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Does combining elastic and weight resistance acutely protect against the impairment of flow-mediated dilatation in untrained men?

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Abstract *Background:* The evidence that the combination of elastic and weight resistance training acutely affects or improves resultant responses to conduit artery function is anecdotal. The aim of this study was to examine brachial artery flow-mediated vasodilation (FMD) before and after acute exercise when performed at 3 conditions of resistance.
Methods: Fourteen healthy, untrained (inactive) male participants (Mean age ± SD: 20.6 ± 0.5 years) completed 3 sets of 15 repetitions of the single-arm curl exercise. Testing was executed on 3 separate days as follows: day 1 with a dumbbell alone (DA), day 2 with elastic tubing alone (EA), and day 3 with a dumbbell with elastic tubing (DWE). Testing was executed in random order. Within the DWE condition, the resistance provided by the elastic tubing was equivalent to 20% of the subjects' 15 repetition maximum (RM). A one-way repeated measures analysis of variance was employed to evaluate different loading conditions on FMD.
Results: The results demonstrated that FMD was significantly greater during DWE than during EA, DA, and at baseline FMD ($p < 0.05$). Moreover, brachial FMD improved from baseline in the DWE condition (to 21.5 ± 7.3%; $p < 0.05$) but not significantly in the EA condition (to 14.3 ± 4.4%; $p \geq 0.05$), and actually decreased significantly in the DA condition (to 8.3 ± 3.1%; $p < 0.05$).
Conclusion: DWE exhibits notable efficacy for improving endothelial function in inactive men during the single arm curl exercise.

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Introduction

Dysfunction of the vascular endothelium can lead to cardiovascular disease, which is a primary cause of death. Consequently, proper function of the vascular endothelium is of particular importance for the maintenance of vascular health. The function of the vascular endothelium can be evaluated by flow-mediated dilatation (FMD), which is a non-invasive, and the most popular, method to assess endothelial function. The extent of FMD is a reflection of nitric oxide (NO)-dependent endothelial vasodilation in response to a brief ischemic stimulus.[1,2]

Several studies have demonstrated that FMD can decrease immediately after acute resistance exercise, particularly when researchers focused on inactive individuals.[3–5] Varady et al.[4] found that FMD was impaired after subjects achieved near-maximal exertion during three sets of 8—12 repetitions each of leg press exercises. Jurva et al.[3] and Phillips et al.[5] also reported a reduction in FMD after leg press exercises of 2—3 sets of 6—8 repetitions each to near maximal exertion in sedentary individuals. This is because traditional resistance training can induce high blood pressure,[6] with high levels of blood pressure being associated with the impairment of FMD.[7,8]

In practice, an individual's familiarity with free-weight exercises (e.g., dumbbell, barbell) correlates to their ability to generate torque/force during the initial of range of motion and the subsequent decrease in such force near the end.[9] Therefore, it is possible that this observed elevation of blood pressure might be consistent with increased torque/force during the initial phase of the training. To address this shortcoming while maintaining the muscle strength developed during traditional training, the muscular force generated by contraction should be distributed throughout the range of motion.

Combining elastic tubing with free-weight resistance (CEF) is one type of variable resistance training that provides optimal muscle load throughout the range of motion, since, at the lower part of the concentric phase, the greatest external load is provided by the free weight. However, during the upper part of the concentric phase, elastic tubing provides resistance and muscle overload by the increased stretch of the elastic tubing.[10] The CEF method consists of a lower external load of free-weight resistance training as compared to the routine free-weight program, while this method is compensated by the addition of an external force from the elastic tubing.[11] Therefore, to decrease the level of blood pressure, a decrease in force during the first phase of resistance training might be considered. Accordingly, CEF may represent one interesting strategy to decrease the negative effects on FMD.

To the best of our knowledge, no study has examined effects of combining elastic tubing and free weight resistance on FMD in untrained (inactive) male subjects. Therefore, we sought to identify whether dumbbell alone (DA), elastic tubing alone (EA), or a dumbbell with elastic tubing (DWE) is the most effective for improving FMD in untrained male participants. Therefore, the aim of the present study was to examine the acute effects of DWE, performed using different types of external load, on FMD. We hypothesized that DWE would protect against or improve FMD and provide greater FMD than that observed with exercise using DA or EA.

Materials and methods

Participants

Fifteen untrained male participants were recruited from Srinakharinwirot University, Nakhon Nayok, Thailand. The inclusion criteria were as follows: healthy men, a baseline body mass index (BMI) of 18.5—24.9 kg/m^2, waist circumference less than 102 cm, and no history of participation in an exercise program involving at least 30 min of moderate-intensity exercise on at least 3 days per week over the course of 6 months preceding this study. Participants were excluded if they had sustained any recent injuries, or had a history of cardiovascular disease, cerebrovascular diseases, hypertension, or diabetes mellitus. Participants who smoked were also excluded. Only men were recruited for this study in order to exclude the confounding effects of the menstrual cycle on FMD.[12] Participant characteristics are reported in Table 1. This study was approved by the Ethics Committee of Srinakharinwirot University (No. SWUEC/E-113/2560), Thailand, and is in accordance with guidelines set forth by the Declaration of Helsinki. All participants provided written informed consent after the exercise protocol and all experimental procedures in this study were explained to their satisfaction.

Experimental design

This research was designed to evaluate the acute effects on FMD of the single arm curl (SAC) exercise using a crossover design under 3 different conditions. In the first condition, the subjects performed SAC with the dumbbell alone (DA), in the second condition, the subjects performed SAC with elastic tubing alone (EA), and in the third condition, the exercise was performed with a dumbbell with elastic tubing together (DWE). Each condition was separated by 72 h to eliminate the acute effects on FMD. The order of the testing conditions was determined using a 3 × 3 Latin square design.

In the current study, participants were asked to visit the laboratory on 5 separate occasions. On day 1 (the first day, Monday), the consents were obtained after the testing

Table 1 Baseline characteristics of participants (N = 14).

Characteristics	Mean ± SD
Age (y)	20.6 ± 0.5
Body mass (kg)	69.0 ± 5.4
Height (cm)	172.4 ± 4.1
Body mass index (kg/m^2)	23.2 ± 1.6
Body fat (%)	14.2 ± 1.6
Heart rate at rest (bpm)	76.5 ± 7.7
Systolic blood pressure (mmHg)	119.9 ± 8.0
Diastolic blood pressure (mmHg)	76.1 ± 6.7
Mean arterial pressure (mmHg)	90.7 ± 5.3