Isometric handgrip exercise: Advantages of the Zona Plus™

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Role of isometric handgrip exercise as a non-pharmacologic therapy for hypertension

Exercise is recommended as a core lifestyle modification for the prevention and management of primary hypertension. Historically, guidelines have advocated for the participation in aerobic dynamic exercise (Class I, Level of Evidence A), with dynamic resistance exercise serving an adjunct role (Class II/A, Level of Evidence B). A growing body of evidence advocates also a similar and complimentary role for isometric resistance exercise. As a result, a 2013 scientific statement on non-pharmacological approaches to lowering blood pressure from the American Heart Association included, for the first time, isometric handgrip exercise (Class IIB, Level of Evidence C) as a potential therapeutic strategy available to patients.

The efficacy of isometric exercise training to reduce resting blood pressure is substantiated by five meta-analyses, with the most recent demonstrating mean reductions in systolic and diastolic blood pressure of 7 mmHg and 4 mmHg, respectively. The data for these analyses stem from small, randomized-control, single-center studies investigating primarily isometric handgrip exercise. Thus, while the current level of evidence suggests that isometric handgrip exercise may represent a novel therapeutic lifestyle modification to manage and treat high blood pressure, evidence corroborating its efficacy to lower blood pressure in large-scale and clinically relevant populations is urgently needed.

Isometric contraction

An isometric (or static) contraction is defined as an increase in muscle tension without a corresponding change in muscle length. This is in contrast to a dynamic muscle contraction which involves both a change in muscle tension and length. Sustained isometric contractions can be associated with a unique pressor response activated by reduced intramuscular blood flow, particularly during moderate-high intensities. For a full review of the circulatory responses to isometric exercise see previous paper entitled “Isometric handgrip exercise: Cardiovascular responses and safety”.

Isometric handgrip protocol

In published research studies, the isometric exercise protocol most frequently employed consists of four 2-minute isometric contractions, performed unilaterally in alternating hands at 30% of maximal voluntary contraction, with each contraction separated by a 1-4 minute rest period (Figure 1). A full review of isometric exercise protocols has recently been summarized.

Mode of isometric exercise

To date, research has focused largely on the use of handgrip exercise to complete isometric training. However, it is also possible to target other muscle groups. A research group from the United Kingdom has demonstrated the effectiveness of bilateral leg isometric training to lower blood pressure using an isokinetic dynamometer. These findings corroborate the robust capacity of isometric exercise to lower blood pressure but have limited generalizability outside of the laboratory setting due to the need for technically-demanding, large (i.e. non-portable) and expensive ($>10,000 USD) equipment. Further reducing the practical significance of isometric leg training, a head-to-head trial with isometric handgrip noted similar reductions in blood pressure with both modalities. This suggests the blood pressure lowering actions are independent of the muscle mass involved, and reaffirms the real-world benefits of using handgrip as an easy, accessible, and portable training modality.

Figure 1. Schematic of common isometric handgrip protocol

Isometric handgrip devices

The majority of isometric handgrip training research has utilized a commercially-available, patented, digital handgrip dynamometer, the Zona Plus™ (Figure 2) or its predecessor the CardioGrip™ (Zona Health Inc, Boise, ID, USA). These digital devices are designed specifically for isometric handgrip exercise and are programmed to determine maximal voluntary contraction in each hand and to guide step-by-step the user through the isometric exercise protocol (Figure 1).

The success of the Zona Plus™ (and the CardioGrip™) to lower resting blood pressure has raised justifiably the question whether other devices could be used to replicate such results. A number of low-tech alternatives, including tennis balls or spring-loaded handgrips, have been proposed as substitutes. These devices (and many others) are indeed capable of being used to facilitate the completion of an isometric contraction, however, they possess one glaring deficit which reduces their practicality. That is, almost all of these low-tech alternatives do not provide real-time feedback to ensure the exercise intensity is sufficient to produce training adaptations (i.e. lower blood pressure) or not overly excessive, to produce large, potentially dangerous, acute cardiovascular responses. It is imperative that any device used for isometric handgrip training be capable of obtaining the maximal handgrip strength and providing real-time intensity feedback to ensure compliance with the established exercise protocol.

For example, in the only study to investigate the potential utility of such alternative devices, isometric handgrip training with spring-loaded handgrips was shown to reduce significantly resting
blood pressure. However, the investigators systematically tested the maximal handgrip strength of each participant and the force required to squeeze each handgrip device in a research laboratory setting to ensure completion of the 30% relative intensity. Such expertise and equipment is not commonly available to the broad population, limiting the applicability of such devices in a real-world setting. Additionally, in this study, the majority of isometric handgrip exercise sessions were completed in the laboratory under direct supervision to continuously monitor compliance with the protocol duration and intensity.

Advantages of the Zona Plus™

The Zona Plus™ device is designed specifically to complete isometric handgrip exercise training. Each exercise session is started by having the participant complete a maximal voluntary contraction in each hand, enabling the device to calculate the contraction force corresponding to a 30% relative intensity. This is an important detail as differences in maximal voluntary contraction can be observed between hands (i.e. dominant vs. non-dominant) and over time. For example they can be lower after a bout of fatiguing hand exercise (e.g. gardening) or increased following a strength building program. The built-in determination of maximum handgrip strength using a calibrated load sensor ensures the appropriate relative contraction intensity for each exercise session. This feature also means that the Zona Plus™ can be used properly by anyone, regardless of maximal voluntary strength. In contrast, a tennis ball or spring-loaded handgrip has a fixed force required to squeeze or deform the apparatus, and would be only applicable to participants with corresponding maximal strength measurements.

Next, the device provides real-time visual and auditory feedback to ensure the isometric contraction is maintained at the 30% relative intensity. At the same time, the LCD screen displays which hand the contraction is being completed in (as it is completed in an alternating fashion), and the time remaining in each contraction or rest period. At the end of the protocol a final compliance score is displayed on the screen to provide feedback on how well the 30% target was maintained. To assist with training, the device stores results over both the preceding 7 day and 12 week period. This information can similarly be viewed on a personal computer by uploading results from the device. Collectively, these features ensure the protocol is completed as prescribed, and allow individuals to track their progress.

Often overlooked, the ergonomical design accommodates different hand sizes and is made of soft rubber to provide comfort during each contraction.

Ensuring a minimal contraction intensity

Exercise, like a drug, is required in a minimal dose to produce training adaptations. Current data demonstrate that isometric training at a relative contraction intensity of 8% maximal voluntary contraction is not sufficient to lower blood pressure, highlighting a minimal intensity threshold needed to elicit chronic adaptations. To maximize the hypotensive effects of isometric handgrip training it is therefore important to determine ones compliance with the protocols contraction intensity.

The Zona Plus™ directly tests maximal voluntary contraction and provides real-time feedback on contraction intensity to ensure every isometric handgrip contraction is completed and maintained at 30% of maximal handgrip strength. In contrast, most individuals do not have a method to test their maximal handgrip strength, and a tennis ball or spring-loaded handgrip provides little feedback on maintaining an appropriate stimulus.

Preventing exaggerated cardiovascular responses

It is well known that sustained moderate- and high-intensity isometric contractions can be associated with large, potentially dangerous, increases in blood pressure. This pressor response would increase cardiac afterload and subsequently myocardial oxygen demand and workload. At the same time elevated vascular pressure may increase the risk of aneurysm or hemorrhage. The safety of such intense isometric exercise, particularly in clinical populations, has not been established.

In contrast, accumulating evidence demonstrates that low intensity isometric contractions produce only modest cardiovascular responses which are similar to those generated by dynamic aerobic exercise. Thus, an important component of any isometric handgrip exercise protocol, particularly one to be deployed in a clinical population such as hypertension, is the use of low intensity isometric contractions.

As mentioned, the Zona Plus™ mitigates the risk of excessive increases in blood pressure by ensuring that all contractions are completed at 30% of maximal voluntary contraction, thus reducing the risk of an acute cardiovascular event during the exercise. It also visually reminds participants to complete the isometric contractions in alternating hands, limiting the progression of muscle fatigue, a driver for powerful pressor responses. Overall, such information is difficult to attain using non-feedback devices, and as a consequence participants do not...
know if they are completing sufficient yet safe isometric handgrip contractions.

Broad application for the general population
The lifetime risk of developing hypertension is upwards of 90%, and thus impacts people across a wide range of ages and physical abilities. In the elderly population, a cohort already established to have difficulty adhering to drug therapies, facilitation of isometric handgrip training requires a mode of exercise that is simple, easy to follow, and portable. The Zona Plus™ incorporates each of these requirements in one device.

The proposed low-tech alternative devices do not provide maximal strength measurements, step-by-step instructions, a method to monitor the contraction and rest periods, or feedback on protocol compliance. Failure to comply with the established intensity and protocol durations may limit the benefit and safety of such isometric handgrip exercise.

Conclusion
The current level of evidence suggests a beneficial role of isometric exercise training in lowering blood pressure. The majority of such research stems from studies utilizing isometric handgrip exercise. The use of this mode permits a highly portable method of training and is facilitated by a commercially-available digital handgrip dynamometer, the Zona Plus™. It is conceivable that alternative devices or objects, such as tennis balls or spring-loaded handgrip are capable of replicating such isometric contractions but applications are limited in the general population due to inadequate feedback and control. Without such information, it is difficult to ensure each isometric contraction in completed at the 30% relative intensity. This could be problematic as isometric contractions at low intensities are ineffective, while those at high intensities can produce excessive cardiovascular responses. Furthermore, many of these alternative devices also have practical issues relating to their design and form which makes it difficult to maintain a prolonged isometric contraction. The Zona Plus™ device addresses each of these concerns and remains the only practical option for prescription of isometric handgrip exercise to the general population.

Disclaimer
The information contained in this article is intended solely to provide general guidance on the topic. It is recommended that all patients seek appropriate medical approval before commencing an exercise training program.

References


