Aortic Root Size in Elite Athletes
When No Change Matters

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It is known that sport-specific remodeling of the heart may occur with exercise. Although some overlap exists, exercise activity can be segregated into 2 forms: isotonic exercise (endurance training) and isometric exercise (strength training), with defining hemodynamic differences. Increased cardiac output leads to a volume challenge that occurs with isotonic exercise that affects all 4 heart chambers and may cause an increase in left ventricular (LV) mass, biventricular chamber dilation, biatrial enlargement, and enhanced diastolic function. Conversely, isometric exercise (strength training) will increase the peripheral vascular resistance and cause a pressure load on the heart. This results in concentric LV hypertrophy and reduction in LV diastolic function. Although an athlete may have expertise in one particular sport, usually elite athletes train with combined isotonic and isometric components (weight training, plyometrics, speed drills, running, etc.) and may not fit into one specific category of training.

See Article by Boraita et al

There is limited data on the effect of exercise training on the aorta and whether aortic dilation occurs because of the hemodynamic effects of chronic exercise training. One could hypothesize that with isometric exercise, there is a transient increase in peripheral vascular resistance and systolic hypertension that leads to increased aortic wall tension and chronically may result in aortic dilation. A meta-analysis performed by Iskandar and Thompson showed minor enlargement associated with training in elite athletes at the level of the aortic valve annulus and the sinus of Valsalva compared with controls. The degree of enlargement at the aortic valve annulus was less than at the level of the sinuses suggesting that the fibrous skeleton of the heart may have a protective effect. Another study of 100 elite, strength-trained athletes showed that all levels of the ascending aorta were greater in size when compared with healthy, age- and height-matched controls. They also found that the duration of the high-intensity training to be the strongest predictor of aortic root enlargement. Similarly, in a study of 615 patients, D’Andrea et al found the body surface area (BSA), exercise type and duration, and LV circumferential end-systolic stress were independent predictors of the aortic root diameter at all levels. Although the aorta may be enlarged compared with controls, it is unclear how and if this minor aortic enlargement will affect the athlete clinically.

In this issue of Circulation: Cardiovascular Imaging, Boraita et al evaluated 3281 elite athletes and found that only 1.8% of the athletes had dilated aortas (>40 mm in men or 34 mm in women) and also found that age, LV mass, and BSA were the main predictors of aortic dimensions. These results are similar to the percent of athletes (elite and nonelite) who were found to have aortic dilation in the study by Pelliccia et al using similar cut-off values for aortic dilatation. These findings suggest that ascending aortic dilation in elite athletes is rare and if found on echocardiogram, work up of underlying aortopathy should be considered.

The inclusion of male and female athletes is important and allowed the authors to examine the effect of sex on cardiac dimensions in their populations. Similar cardiovascular adaptations to training occur in men and women; however, unique adaptations to exercise in women have been described. Both men and women demonstrate an increase in heart chamber sizes and muscle mass, and when adjusted for BSA, the findings are not as substantial in women when compared with men. In this study, 1242 female athletes were included, and after BSA adjustment, LV end-diastolic diameter and atrial size remained larger in women compared with men. Similar findings were seen, albeit on a smaller scale of female patients, in a longitudinal study published by Baggish et al. Sex differences were also seen in the aortic diameters that were adjusted for BSA. Larger aortic diameters were found at all levels of the aorta in men except at the sinotubular junction and the ascending aorta. These sex differences are intriguing and potentially implicate a hormonal effect on vascular remodeling in females. Further studies evaluating the hormonal effects on the aorta in elite female athletes would be an interesting future investigational study.

A few limitations should be considered in the study by Boraita et al including that it is a cross-sectional study that comes with its inherent limitations, including the inability to exclude the possibility that the findings are from innate changes that may have occurred without training. A longitudinal study design that assesses athletes before and after training would be more informative, however challenging with such a large cohort of patients. Given that echocardiographic imaging is mandatory in many European countries, a study examining serial changes in cardiac dimensions during the course of years in athletes would be truly original and helpful.
this study, the use of the term remodeling is in fact incorrect because of the absence of data supporting a change in dimensions over time.

There is an ongoing controversy about the technique used to measure aortic dimensions. The most recent echocardiogram guidelines recommend measuring the aortic annulus in mid systole, where all other ascending aorta measurements should be performed in end diastole.\(^5\) Also, measurements should be performed from leading edge-to-leading edge preferably using 2-dimensional echocardiography over M-mode imaging. Boraita et al\(^5\) studied patients over a long time period and inconsistency in the method of measurement may lead to variability in absolute measurements. The investigators in this study indexed their measurements to BSA. A recent investigation by Giraldeau et al\(^9\) compared indexing to BSA, with correction by lean body mass there were no significant sex differences noted.\(^9\)

It is known that race has an effect on the amount of cardiac remodeling that occurs with exercise and that black athletes have more LV hypertrophy than their white counterparts.\(^10,11\) In the study by Boraita et al\(^5\), blacks were excluded. Care should be taken to generalize the findings of this study, specifically the normal reference ranges of the aorta provided, to all athletes. Using the reference values for populations who were not studied may cause misdiagnosis of aortic disease that could limit exercise and affect the overall quality of life of the athlete.

The value of this article is that it adds to the abundant body of literature devoted to imaging the athlete’s heart. It supports the work of groups where large, heterogeneous groups of male and female athletes were assessed.\(^12\) Cardiac adaptations to training seem to primarily involve the atria and ventricles.\(^13\) Unlike the atria and ventricles, the occurrence of ascending aortic dilatation in elite athletes is rare and if found, work up of underlying aortopathy should be considered.

The data once again highlight the importance of using a consistent and structured approach to the assessment of the athlete’s heart. It is imperative that uniform approach be taken when interpreting echocardiographic data in athletes and clear normative, sex-specific indexed data should be readily available for reference. Such an approach will hopefully improve sensitivity and specificity of echocardiographic imaging.

**Disclosures**

None.

**References**


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