

# Your athlete-patient has a high coronary artery calcification score—‘Heart of Stone’. What should you advise? Is exercise safe?

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Coronary artery calcification (CAC) is a strong marker of subclinical coronary atherosclerosis and leading authorities recommend CAC scoring to help inform patient management decisions in cardiovascular disease (CVD) prevention.<sup>1,2</sup> This will result in an increasing number of athlete-patients with subclinical coronary atherosclerosis presenting to sport and exercise medicine physicians, raising questions about exercise recommendations in this subgroup. With a specific focus on the recent outcomes data of DeFina and colleagues<sup>3</sup> we extend our recent discussion of the topic<sup>2</sup> by focusing on how to manage athlete-patients with elevated CAC in the sport and exercise medicine setting.

## PHYSICAL ACTIVITY, CORONARY ARTERY CALCIUM AND CARDIOVASCULAR OUTCOMES—HIGHER PHYSICAL ACTIVITY PROTECTS AT EVERY LEVEL OF CAC

A breakthrough in reporting the association of CAC and mortality risk across different activity levels came from a recent study of 21 758 healthy male participants without prevalent CVD. Higher levels of leisure-time physical activity were associated with a lower risk of mortality at any given level of CAC.<sup>3</sup> The authors reported a higher risk metabolic profile (ie, higher baseline blood pressure, higher glucose concentrations and higher triglycerides) in the high volume exercise group with elevated CAC  $\geq 100$  AU compared with the high volume exercise group with CAC

$< 100$  AU.<sup>3</sup> Predating this observation, we reported that while training volume was not associated with impaired vascular function in marathon runners, higher blood glucose concentrations at baseline were associated with greater increases in carotid intima-media thickness over time.<sup>4</sup>

## EXERCISE RECOMMENDATIONS FOR ATHLETES WITH HIGH CAC

A zero CAC score denotes a very low risk profile, independent of the presence of traditional risk factors.<sup>1</sup> Conversely, the presence of CAC in athletes deserves a thoughtful cardiovascular risk assessment. As outlined above, athletes are not immune to modifiable and non-modifiable cardiovascular risk factors and despite high activity levels, often exhibit cardiometabolic risk factors. See our related discussion for more detail.<sup>2</sup> Note that exposure to risk factors at younger age may result in premature atherosclerotic plaque formation, an effect that may not be fully reversible by subsequent lifestyle changes. This raises the possibility of reverse causality in older athletes with elevated CAC—those older people with risk factors may start exercising because they are advised to by their physicians. The concept of cumulative burden as a major determinant of risk underpins the importance of taking into account lifetime exposure of risk factors.

General recommendations in athletes with CAC should promote healthy lifestyle choices like dietary patterns low in sugar, refined starches and trans fatty acids, and intermittent abstinence from nutrient exposure, avoiding cigarette smoke, regular circadian rhythms with a sleep duration of 6–8 hours per day and learning strategies to mitigate the physiological response to distress.<sup>5</sup> If appropriate, pharmacotherapy should be initiated in athlete-patients at high risk for adverse cardiovascular events according to guidelines.<sup>1</sup> Lipid modulating therapy with statins, despite the well-established effect on reducing cardiovascular end points,

has been linked to increased CAC progression.<sup>6</sup> One of the mechanisms underlying this observation may be that statin therapy promotes calcification of pre-existing plaque and might thus decrease the risk of acute plaque destabilisation.

## DOES EXERCISE STABILISE CORONARY ARTERY PLAQUES?

It is tempting to speculate that physical activity may operate through similar plaque stabilising mechanisms. Physical activity promotes a more benign plaque phenotype with a higher collagen and elastin content, increased fibrous cap thickness, decreased necrotic lipid core<sup>7</sup> and increased calcification.<sup>8</sup> This renders plaque less prone to acute destabilisation and the associated clinical sequelae of arterial occlusion and tissue infarction, and provides plausibility for why higher levels of both physical activity and cardiorespiratory fitness are inversely related to all-cause mortality and cardiovascular mortality.<sup>7,9</sup> As high level leisure-time physical activity is safe at every level of CAC<sup>3</sup> it should be advised in the asymptomatic patient with CAC. Importantly, if typical (ie, chest pain on exertion) or atypical (ie, exercise intolerance or reduced exercise capacity) symptoms occur that suggest flow-limiting stenosis, the patient requires further diagnostic workup and referral to a sports cardiologist (diagnostic algorithms are reviewed by Borjesson and colleagues).<sup>10</sup> Furthermore, athlete-patients with coronary artery disease (ie, CAC) who want to engage in competitive sports need to undergo individual evaluation by a sports cardiologist (reviewed by Borjesson and colleagues).<sup>10</sup>

## TAKE HOME MESSAGE

The presence of CAC is a strong predictor of CVD risk in the general population<sup>1</sup> and also in highly active individuals.<sup>3</sup> CAC in athletes is often associated with cardiovascular risk factors. These must be addressed by lifestyle modification and, if appropriate, pharmacotherapy. The collective evidence from analyses of plaque composition in athletes<sup>7,8</sup> and from recent clinical outcomes data<sup>3</sup> lends qualified support for the conclusion that—at any given level of CAC—long-term exposure to high leisure-time physical activity levels is safe, compatible with long-term health and confers prognostic benefit.<sup>2</sup> We promote the advice ‘Keep Exercising’ as an important health message, even in individuals with—as sports cardiologist Dr Aaron Baggish cleverly termed it—‘Hearts of Stone’.<sup>8</sup>

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**REFERENCES**

- 1 Grundy SM, Stone NJ, Bailey AL, *et al.* 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2019;73:3168–9.
- 2 Lechner K, Halle M, Scherr J, *et al.* Exercise recommendations in athletes with coronary artery calcification. *Eur J Prev Cardiol* 2019;204748731988170.
- 3 DeFina LF, Radford NB, Barlow CE, *et al.* Association of all-cause and cardiovascular mortality with high levels of physical activity and concurrent coronary artery calcification. *JAMA Cardiol* 2019;4:174.
- 4 Müller J, Dahm V, Lorenz ES, *et al.* Changes of intima-media thickness in marathon runners: a mid-term follow-up. *Eur J Prev Cardiol* 2017;24:1336–42.
- 5 Lechner K, von Schacky C, McKenzie AL, *et al.* Lifestyle factors and high-risk atherosclerosis: pathways and mechanisms beyond traditional risk factors. *Eur J Prev Cardiol* 2019;2047487319869400.
- 6 Henein M, Granåsen G, Wiklund U, *et al.* High dose and long-term statin therapy accelerate coronary artery calcification. *Int J Cardiol* 2015;184:581–6.
- 7 Fiuza-Luces C, Santos-Lozano A, Joyner M, *et al.* Exercise benefits in cardiovascular disease: beyond attenuation of traditional risk factors. *Nat Rev Cardiol* 2018;15:731–43.
- 8 Baggish AL, Levine BD. Coronary Artery Calcification Among Endurance Athletes: "Hearts of Stone". *Circulation* 2017;136:149–51.
- 9 Radford NB, DeFina LF, Leonard D, *et al.* Cardiorespiratory fitness, coronary artery calcium, and cardiovascular disease events in a cohort of generally healthy middle-age men: results from the Cooper center longitudinal study. *Circulation* 2018;137:1888–95.
- 10 Borjesson M, Dellborg M, Niebauer J, *et al.* Recommendations for participation in leisure time or competitive sports in athletes-patients with coronary artery disease: a position statement from the sports cardiology section of the European association of preventive cardiology (EAPC). *Eur Heart J* 2019;40:13–18.