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**EDITORIAL**

# The super healthy atrial fibrillation conundrum

**Øyvind H. Lie[1,2] and Kristina H. Haugaa[1,2]***

[1]ProCardio Center for Innovation, Department of Cardiology, Oslo University Hospital, Rikshopitalet, PO Box 4950 Nydalen, NO-0424 Oslo, Norway; and [2]Institute for Clinical Medicine, University of Oslo, Oslo, Norway

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**This editorial refers to 'Differing mechanisms of atrial fibrillation in athletes and non-athletes: alterations in atrial structure and function' S.J. Trivedi by *et al.*, pp. 1374–1383.**

It is well established that physical exercise promotes good health. However, a vast number of reports have linked longstanding athletic activity to increased risk of atrial fibrillation. Is atrial fibrillation in an athlete a prognostic marker of adverse health outcomes, or is it a sport-related injury more like osteoarthritis of the knee? Is the arrhythmia a sign of cardiac vulnerability and longstanding stress, a matter of cardiac size and fibrosis, or just an annoying thorn in an athlete's side? While atrial fibrillation is firmly linked to adverse prognosis in many patient populations, nothing is firmly known of the association between incident atrial fibrillation and unfavourable health outcomes in athletes.

Seemingly healthy athletic individuals frequently present to cardiology clinics with suspected or confirmed atrial fibrillation, and their suffering may be substantial. We also encounter athletes who are only symptomatic during high-intensity exercise who seek help to uphold their maximal performance. The clinical management of such individuals is challenging and relies mostly on data gathered in non-athletic populations. Athletes with atrial fibrillation are commonly treated with invasive ablation procedures due to either a reluctancy to use antiarrhythmic medication or an unwillingness to comply with watchful reduction in exercise intensity. However, there are sparse data suggesting the superiority of invasive treatment and certainly no sham-controlled trials validifying ablation therapy. The ethical aspects of referring to an otherwise healthy athlete for invasive procedures that may or may not permanently or temporarily enable him or her to perform sports are challenging. Insights to clinical associations and possible mechanisms are therefore more than welcome in this complex field.

Trivedi and the distinguished and experienced group of authors provide data on the functional and structural cardiac characteristics of athletes and non-athletes with and without atrial fibrillation using comprehensive echocardiographic exams.[1] Such comparisons of the phenotypes of athletes and non-athletes with atrial fibrillation are valuable. Not surprisingly, they found that individuals with atrial fibrillation had larger left atria than individuals without atrial fibrillation. More interestingly, left atrial stiffness seemed to be a marker of atrial fibrillation only in non-athletes which may suggest different mechanisms of atrial fibrillation in the athletic and non-athletic populations. The most prominent observation was the differences in the ratio between left atrial volume and left ventricular volume. The authors showed that the athletes, even those with atrial fibrillation, had balanced enlargement of all cardiac chambers. This stands in contrast to the well-known clinical finding of atrial fibrillation in patients with diastolic dysfunction, small left ventricular cavities, and dilated left atria. This interesting observation may be valuable in differentiating athletic from maladaptive left atrial enlargement in the future.

Atrial fibrillation in an athlete seems to behave differently than atrial fibrillation in a patient population with structural or functional heart diseases. Further insight into any arrhythmogenic mechanistic differences between athletic atrial fibrillation and atrial fibrillation of other aetiologies may yield insight to potentially different treatment targets. Much is unknown of arrhythmia mechanics in athletes.[2] It seems reasonable to speculate that different arrhythmia mechanisms may be encountered in atrial fibrillation with high and normal left atrial stiffness. Athletes may present altered autonomic tone and more vagally induced atrial fibrillation,[2] but there also seems to be various arrhythmogenic mechanisms of atrial fibrillation within the group of athletes. Some athletes report arrhythmia triggering at high-intensity physical activity, while other athletes report events during a pronounced vagal activity such as after meals or during sleep. Pronounced vagal tonus is a hallmark of the athlete's heart, and increased tonus shortens a atrial refractory time and may thus facilitate re-entry cycle formation in individuals with appropriate substrates.[3] The present study fits well with this notion, as the parasympathetic modulator may be disproportionate in athletes enabling arrhythmia to initiate with less pronounced substrate indicated by left atrial stiffness. Whether atrial stiffness implicates more atrial scarring providing the arrhythmia substrate by electrical and structural remodelling is unknown. The raised hypothesis of an acquired

* Corresponding author. Tel: +4723071393; Fax: +4723073530. E-mail: Kristina.Haugaa@medisin.uio.no

atrial myopathy as an arrhythmic substrate must be explored in future studies.

Arrhythmogenic cardiomyopathy with defective cardiac desmosomes may provide a good model for cardiac adaptation to exercise exposure. We have previously observed that higher exercise intensity, conferring greater wall stress, rather than longer exercise duration was associated with ventricular arrhythmias.[4] The athletic cardiac remodelling has traditionally been considered a compensatory state of volume overloading with pressure loading only during bursts of exercise, whereas the atrial dilatation of diastolic dysfunction is mediated by chronic pressure overload. The maladaptive atrial remodelling of high left ventricular filling pressures may promote stretch-induced sarcoplasmic reticulum calcium leak which has been causatively associated with atrial fibrillation in an experimental setting.[5] Whether this implicates different arrhythmia mechanisms in athletic atrial fibrillation is unknown, but it may support the proposed differences.

The authors have previously reported on the possible existence of exercise-induced arrhythmogenic cardiomyopathy, a ventricular myopathy acquired by high doses of repetitive stress,[6] and although somewhat controversial, such patients are occasionally encountered in the clinical practice. The present study implicates an acquired atrial myopathy that shares certain traits with its ventricular counterpart. However, more questions are raised. Why do some individuals have an atrial predilection while others exhibit ventricular arrhythmias? Is genetic vulnerability involved? Are the two phenomena intertwined, i.e., do these patients with a possible exercise-induced atrial myopathy have a higher risk of subsequent ventricular arrhythmia if the exercise habits are upheld? Much is still to be learned.

Comparing the cardiac phenotypes of athletes and non-athletes is incredibly challenging, especially in terms of scientific confounding. To elucidate differences in cardiac function and structure, we sometimes must compare apples to oranges. Specifically, individuals with atrial fibrillation in the present study use more cardiac medication than those without. This may affect the assessed echocardiographic parameters. Left ventricular functional parameters may be altered by beta-blockers, and left atrial function relates closely to left ventricular longitudinal shortening. The present data do not allow for statistical adjustment and subgroup sensitivity analyses that could provide a glimpse into any signal behind this confounding. The reality is that such issues are difficult to overcome, and the scientific results must rather be interpreted in their context.

The present findings thus provide a possible link between the structural and functional cardiac imaging of athletes and the electrophysiological uncertainties of arrhythmias in athletes. The study highlights different atrial remodelling phenotypes in these populations, and as such, they pave the way for further research into prognostic and therapeutic measures. The results should be replicated in a separate cohort and must be interpreted in the sobering context of the unknown prognostic importance of atrial fibrillation in athletes. This accomplished research group sits at the front line of the athlete's heart research, and we anticipate further enlightening reports from them.

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