Atrial Fibrillation In Athletes: The Role Of Exercise

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Abstract
There is growing evidence that atrial fibrillation (AF) is prevalent in athletes and even in individuals participating in intense long term exercise at a non-competitive level. Several causes have been described for these phenomena including atrial remodeling, atrial fibrosis, inflammation, autonomic activation, body fluid changes and changes in blood volume and pressure. This article reviews the epidemiology, pathophysiological mechanisms and management options of AF in regards to exercise.

Introduction
Atrial fibrillation (AF) is the most common cardiac arrhythmia seen in clinical practice and is more prevalent in older patients (>5% in age >65 years and about 8% with age >80 years of age).¹² AF is uncommon in young patients with a reported prevalence of 0.5% in <40 years of age.² The most common traditional risk factors associated with AF include hypertension, age, diabetes, structural heart disease and hyperthyroidism.³ Historically AF when associated in young patients without the typical cardiovascular risk factors was called “lone AF”.¹ Recently, studies have demonstrated other minor risk factors like medications, sleep apnea, alcohol, esophagitis, genetics and exercise to be associated with AF and the term “lone AF” may be a misnomer.³ There is significant evidence that regular exercise has cardiovascular benefits.⁴ However, certain studies recently have demonstrated an increased prevalence of AF in athletes than rest of the population.⁵⁻¹⁰ Additionally, there have been conflicting reports on the risk of AF with regular physical exercise in subjects participating at a non-competitive level.¹¹⁻¹⁶ The exact mechanism for this phenomenon is unclear and may be different in athletes and subjects participating in regular exercise at a non-competitive level.¹⁷ In this review we discuss the magnitude of the problem, mechanisms involved, and management strategies of AF in this special population.

Epidemiology
Athletes and AF
Studies have shown that AF is the most common arrhythmia in the athletic population with a reported prevalence from as low as 0.2% to as high as 63% in various studies.¹⁸,¹⁹,²⁰ This variability in prevalence is attributed to differences in the subjects’ age, associated comorbidities, sports practices involved and duration of training. A study by Baldesberger et al in 62 former Swiss professional cyclists who participated at least once in Tour de Suisse were matched against 62 male golfers reported higher incidence of AF in these professional cyclists (p=0.028).⁵ Another study by Pelliccia et al reported very low prevalence of AF (0.3%) in 1777 young (mean age of 24 ± 6 years) competitive athletes.¹⁹ Another case control study compared questionnaires obtained from 300 top-ranked middle aged (mean age 47.5 years) orienteers and 495 healthy controls. The study reported that orienteers experienced more episodes of AF (0.3%) in 1777 young (mean age of 24 ± 6 years) competitive athletes.¹⁹ Another case control study compared questionnaires obtained from 300 top-ranked middle aged (mean age 47.5 years) orienteers and 495 healthy controls. The study reported that orienteers experienced more episodes of AF than controls (5.3% vs 0.9%; p=0.012).⁸ Age played an important role in the cause of AF in athletes according to one study which reported that adrenergically induced AF was more common in younger athletes while vagal AF was more common in older athletes.²¹ A metaanalysis by Abdulla et al including 655 athletes reported that the risk of AF was 5.29 times higher (95% CI 3.57-7.85, P=0.0001) than matched controls.²²

Exercise and AF
Studies on AF with regular exercise have reported conflicting results.¹¹⁻¹⁶ Aizer et al reported that subjects who participated in exercise 5-7 times a week had a significant risk (RR 1.53, 95% CI 1.12 - 2.09, p <0.01) of developing AF at 3-year follow-up compared to controls.¹¹ Another study reported that sports practices >1500
hours, the odds of developing AF were 2.87 times (95% CI: 1.2-6.91) higher. Higher accumulated physical activity was also associated with risk of AF. Physical activity between 2078-9318 hours was 5.6 (1.59–19.75, p=0.0075) times more likely to develop AF while activity >9319 hours was 15.1 (3.75-217.56, p=0.0001) times more likely. Higher prevalence of AF (12.8%) was found in a study including 149 healthy, long term trained cross country skiers. A lower exercise heart rate on a moderate work load was reported to be a predictor of AF in a study including 2014 healthy Norwegian men. According to the study men who had a heart rate <100 beats per minute with a moderate workload of 100W had 1.60-fold AF risk (95% confidence interval, 1.11-2.26) compared with men an exercise heart rate of ≥100 beats per minute. However, this study has its own limitations as bradycardia may not truly be a surrogate of exercise capacity. Some studies failed to show an increased risk of AF with exercise. Mozaffarian et al. in a prospective cohort study of 5,446 patients reported that light to moderate physical activities, particularly leisure-time activity and walking (600 kcal/week), were associated with significantly lower AF incidence. Another metaanalysis by Olfman et al including 95,526 subjects reported a non-significant risk of AF 1.08 (0.97-1.21) among regular exercises than compared to those who don’t. However, the analysis included several studies with wide variation in sample size, baseline characteristics and how physical activity was defined. Similarly, no evidence was found between routine physical activity during work hours and AF according to the Danish Diet, Cancer, and Health Study including 19,593 men and 18,807 women with a mean age of 56 years.27

Pathophysiology Of Atrial Fibrillation In Athletees And Exercise

The mechanism of AF in athletes or even intense exercise is presumed to be multifactorial with a complex interplay between autonomic activation, cardiac adaptation such as atrial remodeling and fibrosis, inflammation, electrolyte abnormalities, neurohormonal imbalance, changes in pH and alterations in blood volume and pressure (Fig. 1).

Autonomic Activation With Physical Activity

There have been several studies on the role of autonomic activation in AF. It is well known that increased vagal tone, resting bradycardia and even lower exercise heart rates noted in subjects involved in regular sports practices are at an increased risk of AF. According to one study, vagal AF is a more common form of AF in athletes. Swanson et al in an interesting review hypothesized that regular exercises can induce esophageal acid reflex which may induce AF and other cardiac dysrhythmias. Wilhelm et al in non-elite athletes reported that life vagal tone was higher in subjects with a life time training hours of >4500 hours vs those <1500 hours (47 ± 16 ms vs 34 ± 13 ms, p=0.002). Studies have shown that increased vagal tone shortens and increases the dispersion of the atrial refractory period, creating a reentry pathway that may be responsible for the development of AF. Guasch et al reported that increased vagal tone and autonomic changes may cause AF with chronic endurance exercise in rat models. In that study rats underwent programmed stimulation with daily 1 hour treadmill training for 8 and 16 weeks along with 4 and 8 weeks of exercise cessation. Vagal tone increased at 16 weeks in rats and normalized within 4 weeks of detraining. Exercising rats showed a significant downregulation of IKACH-inhibiting RGS proteins at 16 weeks with no change in cardiac adrenergic, cholinergic receptors and IKACH-subunit gene expression.

On the other hand intense short term physical exertion can activate the sympathetic system which may also shorten the atrial action potential which may cause increased automaticity and microreentry and in turn increase the risk of AF. However, this phenomenon is more likely in a diseased atrium.27

Cardiac Adaptation With Physical Activity

The heart undergoes several physiological changes with respect to physical activity including increased left atrial size, left ventricular mass, atrial pressure, and volume changes which may all reduce atrial refractory period, increase dispersion, and lead to the development of a microreentry pathway. Atrial remodeling and LA enlargement has been described to be more common in athletes and subjects who participate in long term training. Atrial remodeling and LA enlargement in Wistar rats significantly increased fibrosis marker expression in atria and ventricle when compared to control group. Furthermore, the fibrotic changes caused by programmed exercise were reversed after an 8-week exercise cessation. Further evidence regarding exercise induced atrial fibrosis comes from a study by Lindsey et al including 45 veteran athletes. The study showed an increase in three collagen markers—plasma Plasma carboxyterminal propeptide of collagen type I (PICP) (259 vs 166 microg/l, p<0.001), carboxyterminal telopeptide of collagen type I (CITP) (5.4 vs 2.9 microg/l, p<0.001), and tissue inhibitor of matrix metalloproteinase type I (TIMP) (350 vs 253 ng/ml, p= 0.01). Another study involving stimulated rat models reported a 34% increase in LA diameter which failed to recover on detraining. However, further studies are required to validate the role of fibrosis with exercise.

![Mechanism of Atrial fibrillation with exercise](Image)
Inflammation

The role of inflammation on exercise induced AF is speculative and controversial with no data on the relationship between intensity, type and duration of exercise with risk of AF. Several studies have shown that exercise may induce activation of IL-6, TNF-Alpha and IL-1 beta which in turn may induce and maintain AF.38 Also there are some studies demonstrating that elevated CRP is observed in AF and elevated CRP was positively related to left atrial size.39,40 Studies have demonstrated that moderate endurance training may reduce inflammatory markers, while high-intensity training may transiently produce a sustained systemic inflammatory response and elevated CRP levels.38-40 Swanson et al hypothesized that overtraining may induce chronic systemic inflammation which may induce high CRP levels which may lead to atrial changes and development of AF and may be effectively treated with a trial of anti-inflammatory medications.41

Management Of Af In Athletes

AF continues to remain as the most prevalent arrhythmia in subjects who participate in regular exercise and the general population. However, there are some characteristics unique to AF associated with exercise. AF induced in athletes is usually vagal mediated and presents usually at nights or following meals. It is paroxysmal, highly symptomatic with an estimated prevalence of 0.2–60% depending on the type, duration, intensity and associated comorbidities.6 AF induced by physical exertion is usually self-limited and well tolerated. However, AF in athletes has a variable progression rate to persistent AF with about 17% to 43%.21,23

There is very little evidence that restriction of physical activity reduces AF in athletes or individuals actively participating in sports related practices. Furlanello et al reported good response to sports abstinence in elite athletes.11 Experimental evidence in Wistar rats demonstrates that fibrotic changes induced at 16 weeks by programmed exercise schedule were reversed after an 8-week exercise cessation.28 According to the recent position statement by European Society of Cardiology intensity of physical activity had a U-shaped response for exercise with AF development. Further studies are necessary to estimate the intensity, duration, frequency and type of exercise or physical activity that increases the risk of AF. Until then the recommendation is to decrease exercise intensity in subjects who develop AF.

References: