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Triad and true? Examining the role of the ECG in evaluating young athletes with COVID-19

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When the global sporting world was paused by the onset of the pandemic in 2020, among the initial concerns in planning for the resumption of competition was the degree of cardiac involvement that would be seen in athletes with SARS-CoV-2 infection. Expert consensus rapidly evolved into the recommendation that athletes who had moderate or severe initial SARS-CoV-2 infection should undergo screening prior to their return-to-play [1]. One screening strategy that emerged was "triad" testing, which consisted of a 12-lead ECG, serum troponin I measurement (preferably high-sensitivity troponin), and a transthoracic echocardiogram (TTE) [1]. The purpose of this strategy was to identify patients who might have cardiac involvement, such as myocarditis and pericarditis, that would increase the risk of worsening disease or sudden cardiac death during competitive exercise.

Indeed, this triad testing strategy has thus far appeared to be effective in aiding the safe return-to-play at all sporting levels, even amid recurrent waves of COVID-19 spread. While only 0.6% of US professional athletes with prior COVID-19 were found to have inflammatory heart disease on cardiac magnetic resonance imaging (CMR) [2], with this testing strategy, there have been no known episodes of sudden cardiac death in these leagues.

Given the potential consequence of sudden cardiac death during competition, the key feature of an effective screening strategy for myocarditis in athletes' returning-to-play is a high sensitivity for detecting potential disease. Triad testing thus far appears to have achieved this goal. At this stage in the pandemic, however, it may be worth re-examining the components of triad testing, and in particular, the value each adds to screening in this context.

In this issue of the journal, Petek and colleagues provide insight into the prevalence of ECG abnormalities in young athletes with COVID-19 but without cardiac involvement. They evaluated data from the Outcomes Registry for Cardiac Conditions in Athletes (ORCCA), which included collegiate athletes in the United States with confirmed SARS-CoV-2 infection [3]. Importantly, they focused on athletes who: (1) did not have any SARS-CoV-2-related abnormalities on cardiac imaging (either TTE or CMR), and (2) had both pre- and peri-infection ECGs. Overall, 378 athletes (10% of the ORCCA cohort) met these criteria. Of the athletes who had a normal baseline ECG, only 4% (15/370) had a new abnormal finding on their SARS-CoV-2 infection ECG, which included T-wave inversions (6/15), ST-depressions (4/15), and bi-atrial enlargement (2/15). Interestingly, 50% of the athletes who had an abnormal baseline ECG had normalization of these findings on their SARS-CoV-2 infection ECG.

The study is an important addition to the growing literature of SARS-CoV-2 infection in athletes. In combination with previously published data from ORCCA demonstrating a 0.7% prevalence of SARS-CoV-2-related cardiac pathology in this population [4], it further highlights that SARS-CoV-2 uncommonly leads to electrical or structural cardiac abnormalities in young athletes. Additionally, ECG abnormalities without imaging abnormalities as this study shows appear to be of unclear significance, and the authors raise the important point that ECG changes may potentially reflect dynamic changes related to continued athletic training (or even nascent, unrelated cardiac pathology) rather than SARS-CoV-2-related injury. Indeed, the median elapsed time between baseline and infection ECG was 456 days, and the new bi-atrial enlargement seen in 2 of the athletes could very well be due to training.

A few key points of the study warrant emphasis. First, the International Criteria for ECG interpretation in athletes were used, and clinicians evaluating athletes in this context should have experience applying these criteria [5]. Secondly, it should be noted that the median time between SARS-CoV-2 diagnosis and the SARS-CoV-2 infection ECG in the study was 13 days, presumably outside the window of the acute illness in the vast majority of the athletes. A prior study of 30 healthy young adults with acute influenza infection found that while none had an abnormal TTE or elevations in biomarkers of myocardial injury, 53% had an abnormal ECG on study day 1, decreasing to 27% on study day 11 and to 23% on study day 28 [6]. None of these abnormalities were deemed to be clinically significant.

In light of these data, what is the utility of the ECG in screening for myocarditis and pericarditis in young athletes recovering from COVID-19? Prior to COVID-19, the use of 12-lead ECG alone to diagnose myocarditis had been established to have a low sensitivity, estimated at

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47%, and its specificity remains unknown [7]. The most common ECG abnormality in myocarditis is sinus tachycardia associated with non-specific T-wave changes [7], though these are common, non-specific findings seen in acute viral illnesses [6]. Estimates for the prevalence of ST segment elevations in acute myocarditis vary between 24 and 73% [7]. Further, the characteristic ECG patterns for acute pericarditis (e.g., diffuse ST segment elevation with PR depression) are similarly insensitive [8].

In a study of 789 professional athletes with COVID-19 from the National Basketball Association, Major League Baseball, Major League Soccer, National Football League, and National Hockey League, of the 30 athletes who had at least one abnormal triad test, 6 (20%) had an abnormal ECG. Of these 6, only 1 athlete had evidence of myocardial or pericardial involvement on CMR. Notably, this 1 athlete also had an abnormal TTE. Meanwhile, of the 4 other athletes who were found to have likely SARS-CoV-2 cardiac involvement, none had an abnormal ECG [2]. In the ORCCA registry, the value of the ECG in isolation remains less clear. While 21 patients underwent CMR for an indication of an abnormal ECG alone, 9 patients had an isolated abnormal ECG without undergoing further testing with CMR [4]. Only 1 of the 21 patients with SARS-CoV-2 involvement by CMR had an abnormal ECG.

Arguably one of the more important insights gleaned from the ORCCA registry is the value of assessing for cardiopulmonary symptoms during an athlete's return to exercise [9]. Of the 137 athletes who had cardiopulmonary symptoms on return to exercise, only 1 had an abnormal ECG. Meanwhile, 5 of these athletes were ultimately diagnosed with SARS-CoV-2-associated cardiac sequelae. Interestingly, of the athletes who specifically had chest pain upon return to exercise, 21% were found to have probable or definite SARS-CoV-2 cardiac involvement on CMR.

In summary, the role of the ECG in the triad testing of young athletes returning to play may serve more of a complementary role to the other components of the triad, as the value of isolated ECG abnormalities remains unclear. ECG abnormalities in combination with other testing abnormalities, and in particular the development of cardiopulmonary symptoms upon returning to exercise, should indeed warrant further evaluation for SARS-CoV-2 cardiac involvement. In these situations, the ECG abnormalities may aid in risk stratification, which may be particularly valuable in areas where CMR studies are not readily available. Yet as highlighted by this study by Petek and colleagues [3], the presence of ECG abnormalities alone may potentially reflect a normal dynamic range of a young athlete's ECG pattern, and as with all clinical tests, should not be interpreted in isolation.

References

[1] Kim JH, Levine BD, Phelan D, Emery MS, Martinez MW, Chung EH, et al. Coronavirus disease 2019 and the athletic heart: emerging perspectives on pathology, risks, and return to play. JAMA Cardiol [Internet]. 2020;6(2):219–27. [cited 2021 Jan 2];Available from. https://jamanetwork.com/journals/jamacardiology/fullarticle/2772399.

[2] Martinez MW, Tucker AM, Bloom OJ, Green G, DiFiori JP, Solomon G, et al. Prevalence of inflammatory heart disease among professional athletes with prior COVID-19 infection who received systematic return-to-play cardiac screening. JAMA Cardiol. 2021;6(7):745–52.

[3] Petek BJ, Moulson N, Baggish AL, Drezner JA, Harmon KG, Klein CF, et al. Electrocardiographic findings in young competitive athletes during acute SARS-CoV- 2 infection. J Electrocardiol. 2022;72:13–5.

[4] Moulson N, Petek BJ, Drezner JA, Harmon KG, Kliethermes SA, Patel MR, et al. SARS-CoV-2 cardiac involvement in young competitive athletes. Circulation. 2021;144(4):256–66. CIRCULATIONAHA.121.054824.

[5] Drezner JA, Sharma S, Baggish A, Papadakis M, Wilson MG, Prutkin JM, et al. International criteria for electrocardiographic interpretation in athletes: consensus statement. Br J Sports Med. 2017;51:704–31.

[6] Ison MG, Campbell V, Rembold C, Dent J, Hayden FG. Cardiac findings during uncomplicated acute influenza in ambulatory adults. Clin Infect Dis. 2005;40:415–22.

[7] Buttà C, Zappia L, Laterra G, Roberto M. Diagnostic and prognostic role of electrocardiogram in acute myocarditis: a comprehensive review. Ann Noninvasive Electrocardiol [Internet]. 2020;25:e12726 [cited 2022 Feb 18];25. Available from. https://onlinelibrary.wiley.com/doi/10.1111/anec.12726.

[8] Bruce MA, Spodick DH. Atypical electrocardiogram in acute pericarditis: characteristics and prevalence. J Electrocardiol. 1980;13:61–6.

[9] Petek BJ, Moulson N, Baggish AL, Kliethermes SA, Patel MR, Churchill TW, et al. Prevalence and clinical implications of persistent or exertional cardiopulmonary symptoms following SARS-CoV-2 infection in 3597 collegiate athletes: a study from the outcomes registry for cardiac conditions in athletes (ORCCA). Br J Sports Med. 2021. bjsports-2021-104644.