T-wave subtleties in screened athletes: sharpening the lead or whittling the pencil away?

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This editorial refers to ‘Electrocardiographic anterior T-wave inversion in athletes of different ethnicities: differential diagnosis between athlete’s heart and cardiomyopathy’, by C. Calore et al. on page 2515.

The merits of screening young athletes for cardiovascular abnormalities remain controversial. Corrado et al. provided the most robust contribution to the debate with a study of >62 000 young athletes drawn from nearly 3 million inhabitants in the Italian region of Veneto and included histopathological confirmation of all sudden cardiac death (SCD) cases. Following the implementation of systematic pre-participation screening inclusive of a 12-lead ECG, SCD rates amongst athletes were observed to fall progressively from 4.2 to 0.9 per 100 000 person-years.¹ Opponents of screening have noted the uncharacteristically high baseline SCD incidence and have suggested that the subsequent fall to approximate that described in unscreened athletic populations may reflect a statistical ‘regression to the mean’.² The other major critique of ECG screening is the relatively high number of athletes needing to be excluded from sport potentially to save one life. In the Veneto experience, 9% of athletes were referred for further evaluation and 2% were ultimately excluded from sports participation, equating to ~60 and 2000 exclusions for each expected case of life-threatening cardiomyopathy and SCD case, respectively.³ Thus there has been a concerted effort to reduce this ‘false-positive’ rate. As depicted in Figure 1, the European guidelines of 2010 distinguished common benign ECG patterns from uncommon changes requiring further evaluation for the possibility of underlying pathology,⁴ and subsequent refinements have led to progressively fewer athletes being classified as abnormal.⁵–⁷ It may be optimistic to expect that these more stringent ECG criteria identify just as many at-risk athletes (maintained sensitivity) whilst vastly reducing the number of healthy athletes who are misclassified (improved specificity). Whilst recent studies suggest that few patients with cardiomyopathies are missed with increasingly stringent ECG criteria,⁷ we are unlikely to be able to prospectively test newer approaches to ECG interpretation in an appropriately massive population to determine whether they actually save lives. Hence we search for an ideal screening methodology without a definitive means of validation.

The prevalence of T-wave inversion in leads V1–V3 increases with exercise-induced cardiac remodelling⁸ and may be identified in up to 28% of endurance athletes.⁹ This creates a considerable potential overlap with cardiomyopathies such as arrhythmogenic right ventricular cardiomyopathy (ARVC) and, to a lesser extent, hypertrophic cardiomyopathy (HCM) in which T-wave inversion in V1–V3 may be observed in ~50% and 2% of affected individuals, respectively. Furthermore, deep T-wave inversion has been clearly associated with an increased risk of clinical events, even in ostensibly healthy athletes.¹⁰,¹¹ In the current issue of the journal, the most influential investigators in the field of athletic screening have sought to improve the specificity of ECG interpretation in athletes by refining the classification of T-wave inversion in the precordial leads.¹² Calore et al. combine cohorts from Padova, Rome, and London to enable a comparison between athletes, ARVC patients, and HCM patients selected for the presence of T-wave inversion in at least two contiguous anterior leads, and conclude that the presence of J-point elevation and T-wave inversion limited to the anterior leads (i.e. not extending beyond V4) accurately identifies athletes and excludes patients with cardiomyopathy. This would be a simple and precise means of avoiding unnecessary testing in more than half of athletes with anterior T-wave inversion whilst losing no sensitivity for identifying those at risk of SCD. However, a number of important caveats need to be considered. First, anterior J-point elevation is identified as the single most predictive measure on the ECG and was present in 64% (80%) of the athletes and only 1 (2%) of the subjects with cardiomyopathy, implying that J-point elevation is an acquired feature associated with athletic conditioning. However, J-point elevation has been demonstrated to be more prevalent in populations of younger age and non-Caucasian ethnicity,¹³,¹⁴ thus potentially explaining some of the observed differences in J-point prevalence between the younger athletic cohort of predominant Afro-Caribbean ethnicity and the older, predominantly Caucasian cardiomyopathy patients. Furthermore, recent studies suggest that anterior J-point

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elevation is present in up to 23% of patients with ARVC,\textsuperscript{15,16} and therefore some caution should be exercised before accepting that J-point elevation is an accurate means of excluding significant pathology. The negative predictive value of T-wave inversion confined to V1–V4 also needs interrogation. Calore \textit{et al}. restrict their analysis to athletes and patients with T-wave inversion in two consecutive anterior leads but then conclude that only extensive T-wave inversion (beyond V4) suggests pathology. However, multiple studies, including data from the authors themselves, demonstrate that T-wave inversion is confined to the anterior leads in more than half of ARVC patients.\textsuperscript{15,16} Further investigations will be required to determine this disparity between the prevalence of T-wave inversion and J-point elevation in historical ARVC cohorts as compared with that presented here by Calore \textit{et al}.\textsuperscript{12}

Significant barriers to the clinical acceptance of the refinements to T-wave interpretation remain. Not least is the fact that J-point elevation can be subtle, and evidence suggests that the reproducibility of ECG interpretation in athletes is poorer than we would like.\textsuperscript{17,18} For example, interobserver agreement on the presence or absence of T-wave inversion can be as low as 17%,\textsuperscript{18} which provides some reason to be pessimistic about the real-world predictive value of J-point assessment. It is clear that false positives represent ‘a thorn in the side’ of athlete screening programmes. However, one might argue that if we decide that T-wave inversion V1–V4 with J-point elevation can be ignored then we are left to ask which specific ECG features were responsible for saving lives in the landmark Veneto experience? We congratulate and thank the authors for this important contribution to the literature and for decades of groundbreaking research in the field. We also believe that further investigation is needed to confirm the value of this new strategy of ECG interpretation before it is rolled out as a clinical tool.

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References
Surgical exploration of the submerged part of the iceberg

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A 75-year-old man was admitted to our department with a severe condition and a large tumefaction at the level of the xiphoid region (Panel A). Seven years earlier he underwent a coronary artery bypass for left anterior descending artery revascularization using the left internal thoracic artery without closure of the pericardium. During the months before his admission, the patient became increasingly dyspnoeic and bedridden. Magnetic resonance imaging (MRI) showed a pericardial collection connected to a large sub-cutaneous cavity with a tract leading to the skin (Panel B). Surgical exploration revealed thick and brown fluid contained in a sub-cutaneous cavity (Panel C) communicating with the pericardium through a fistula in the lower part of the sternum (Panel D, see Supplementary material online, Video S1).

We performed partial pericardectomy with large excision of the fistula tract. Staphylococcus aureus was isolated from pericardial fluid. Surgical management allowed a rapid haemodynamic improvement with the disappearance of cardiac tamponade signs. Unfortunately, the patient died on Day 6 from refractory septic shock despite aggressive antibiotic treatment. Pericardial-cutaneous fistula is a rare complication of cardiac surgery. Its development can be very insidious.

Panel A: The big swelling of the lower third of the scar sternotomy. Panel B: magnetic resonance imaging showing the pericardial collection connected to a large sub-cutaneous cavity. Panel C: The large thick and brown sub-cutaneous effusion. Panel D: The pericardial-cutaneous fistula through the sternum.

Supplementary material is available at European Heart Journal online.