situations resembling most electrophysiological studies. One other factor in favour of subpectoral automatic cardioverter/defibrillator implantation under local anaesthesia is the reduced complexity of the implant procedure, whereby the procedure-related risk for the patients is reduced, since the complication rate during a pacemaker-like approach of automatic cardioverter/defibrillator implantation\(^5\) is lower than that with transvenous automatic cardioverter/defibrillator implantation, with the need to create an abdominal pocket and with the necessity of general anaesthesia (complication rate between 2.9%\(^{[1]}\) and 6%\(^{[2]}\)). Furthermore, the time interval from the automatic cardioverter/defibrillator implantation to the patient's discharge from hospital is reduced\(^6\), resulting in lower costs for treatment.

Thus, the pacemaker-like automatic cardioverter/defibrillator implantation mode is a very promising approach in the treatment of malignant ventricular arrhythmias. However, it has to be considered that the groups\(^4\)\(^\text{-}^\text{5}\) who have reported their excellent results included highly trained electrophysiologists who were also experienced in pacemaker implantation.

Implantation of an automatic cardioverter/defibrillator improves the survival of patients at risk of sudden cardiac death, even if the arrhythmia cannot be induced whilst they are taking drugs\(^6\). If the further experience of other groups confirms the feasibility and safety of this pacemaker-like implantation approach, we may see an expansion of the indication for automatic cardioverter/defibrillator implantation in patients who are at risk of sudden cardiac death without previous serial drug testing.

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References

Progress in exercise electrocardiography

See page 699 for the article to which this Editorial refers

For over 50 years, evaluation of the electrocardiographic ST segment response to exercise performed on stairs, bicycle or treadmill has been the most widely used laboratory method for the evaluation of ischaemic heart disease. The test is now applied for the identification of coronary disease in general populations, for the assessment of the anatomical and functional severity of established disease, for the evaluation of effort tolerance, for serial evaluation following therapeutic intervention and for the prediction of cardiovascular risk in selected populations.

However, the traditional exercise test has important and well recognized limitations. When an abnormal electrocardiographic response is defined by an empirically derived criterion of 0.1 mV of horizontal or down-sloping ST depression, test sensitivity for the detection of coronary disease is generally low, particularly in patients with only modestly severe obstruction, even though test specificity is quite high when patients with otherwise clinically recognized hypertensive, valvular and myopathic disease are excluded. As an inevitable mathematical consequence of these test performance characteristics, positive predictive value of the standard exercise test is poor in populations with a low prevalence of disease. The accuracy of standard test criteria is also suboptimal for the assessment of disease severity and for risk stratification in both symptomatic and asymptomatic populations.
Acceptance of these long-established limitations has reduced enthusiasm for, and slowed progress toward, test improvement. In contrast to the interest in developing quantitative imaging methods for the identification and assessment of coronary disease, such as perfusion, scanning, radionuclide cineangiography and echocardiography, it is fairly commonly believed that the simple exercise electrocardiogram in incapable of better performance. This perception is erroneous, and it has become a critical problem in the further development of exercise electrocardiography. Indeed, it often seems as if the prevalent purpose of the traditional exercise test were to provide the old method against which nearly all newer techniques can be shown to excel, from detection of ischaemia by ambulatory monitoring to positron emission tomography.

Despite these perceptions, the exercise test is not static in performance or fixed in mid-century technology, and it is capable of evolution and progress. Improvements in exercise electrocardiography require development and testing of new highly specific criteria with greater sensitivity than occurs from simple visual estimation of the magnitude of ST depression alone. Much of the diagnostic and prognostic information in the exercise test remains to be discovered and utilized, and there is little reason to believe that this cannot happen. Examples of newer approaches include physiological methods that attempt to normalize the amount of ST depression induced by ischaemia for the corresponding underlying cardiac work during effort, such as the treadmill exercise score and the ST segment/heart rate slope and index\(^1\). New markers of effort-induced ischaemia have been found in other repolarization measurements, including QT dispersion\(^2\), and methodology is now available to permit the identification of other subtle manifestations of electrophysiological inhomogeneity during exercise, such as T-wave alternans\(^3\). Other new approaches focus on the effects of exercise-induced ischaemia on electrocardiographic depolarization, including measurement of QRS duration\(^4\) and QRS amplitudes, such as the report by van Campen \textit{et al.}\(^5\) in this issue.

This interesting and timely study builds on recent observations by Michaelides \textit{et al.}\(^6\) that a QRS score, derived entirely from the exercise-induced changes in R wave amplitude in aVF and V5 minus the corresponding changes in Q waves and S waves, provides a useful continuous variable that can distinguish patients with coronary disease from normal subjects. In addition, performance of the QRS score is shown to be superior to that of individual measures such as R wave alone and also to have greater sensitivity for the detection of disease than do standard criteria based on ST segment depression alone, at test partition values with comparable specificity. Interestingly, combined criteria based on both the QRS score and ST segment measurements are also noted to have additional value for predicting the presence and absence of coronary obstruction. In this population, the QRS score could be related to the extent of ischaemia as quantified by thallium imaging, and it also became less abnormal when the severity of exercise-induced ischaemia was reduced in individuals treated with beta-blocking drugs.

As the QRS score is examined further in other populations, the pathophysiological basis for these observations must be clarified. Might there be an interactive effect of intraventricular conduction velocity and amplitude that explains these data? Might this reflect spatial or non-spatial consequences of myocardial ischaemia that could be modelled by solid-angle theory? It is unlikely that these findings are adequately explained by the Brody effect, particularly in view of the evident contribution of the Q waves and S waves, but might there be effects of changing volume and heart rate during effort that could lead to these QRS differences? Could this be related to a physiologically based change in electrical axis throughout exercise? In this context, it is reassuring that the authors note no explanation for the different QRS scores in the importantly different peak exercise workloads, with inherently different peak heart rates and volume changes, achieved by normal subjects and by patients with coronary disease. This needs to be examined in additional detail. As seen in controversy regarding the value of the QT interval for the identification of ischaemia\(^2\), it is critical to confirm that performance of the QRS score is not predominantly due to non-linear behaviour of the QRS complex throughout exercise, in which higher normal values of the QRS score occur only at the highest heart rates, which, in turn, can be reached only by normal subjects.

At present, the QRS score appears to be a promising new way of detecting ischaemia during exercise testing. It illustrates just one of several current directions in which the exercise electrocardiogram continues to evolve beyond its original roots in ST segment depression. How can this method, and other new methods with similar promise, best contribute to progress in exercise electrocardiography? Each of these methods separately can contribute to a revised perception of the test as a fundamentally sound clinical investigation. The exercise test is better than we generally think, particularly when used in a logical clinical strategy of diagnosis and evaluation. Beyond issues of perception, new criteria based on different aspects of the electrocardiographic signal
during exercise should be complementary. These features can be rapidly examined by computer in multiple leads. Is it not time for these new depolarization and repolarization manifestations of effort-related ischaemia to be combined and workload-adjusted in physiologically sound diagnostic algorithms that might enhance the performance and the usefulness of this simple and accessible method?

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References


