Letters to the Editor must not exceed 400 words in length and must be limited to three authors and five references. They should not have tables or figures and should relate solely to an article published in Circulation within the preceding 12 weeks. Authors of letters selected for publication will receive prepublication proofs, and authors of the article cited in the letter will be invited to reply. Replies must be signed by all authors listed in the original publication. Please submit three typewritten, double-spaced copies of the letter to Herbert L. Fred, MD, % the Circulation Editorial Office. Letters will not be returned.

T-Wave Shape in Clinical Research
To the Editor:

The editorial by Wilde and Roden1 in the December 5, 2000, issue of Circulation discussed how differences in electrocardiographic ST–T–wave patterns, together with other phenotypic differences, arise in genetically distinct forms of long-QT syndrome (LQTS).2 The authors observed how important these results can be for the investigation of the pathophysiology of ventricular repolarization. The T wave is the result of repolarization gradients across the ventricular myocardium. The LQTS ST–T–wave pattern study by Zhang et al.,2 to which the editorial referred, showed that broad-based T waves are characteristic for LQT1. The editorial also referred to the work of Yan and Antzelevitch,3 which suggested that currents flowing down transmural voltage gradients across the M-cell region might determine T-wave shape.

We would like to draw attention to our recent work on left ventricular repolarization,4 which showed that the dispersion of repolarization is one of the main determinants of T-wave shape. In particular, we demonstrated that an increase in the dispersion of repolarization causes broad-based and symmetrically shaped T waves. Zhang et al.,2 using a number of quantitative measures of repolarization, showed that genotype identification by ECG in LQTS is effective. However, they were not aware of the link we found between symmetry of the T waves, which is easily quantifiable using automatic techniques, and increased dispersion of repolarization.4 We believe it would be helpful to use this easy and additional measure of repolarization inhomogeneities in future studies.

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Response

In manifest cases of the congenital long-QT syndrome, ST–T–wave patterns show genotype-specific characteristics.1 The pathophysiological basis of these changes is debated, and available data are largely derived from in vitro models.2,3 In their letter to the editor, Drs di Bernardo and Murray add valuable modeled data on T-wave morphology to this discussion. Their computational model of repolarization predicts that T waves become more symmetrical as a result of increasing dispersion of regional cardiac repolarization.4 Broad symmetrical T waves are typically seen in LQT1 patients,1 and thus it is suggested that dispersion of repolarization in LQT1 is substantial. Indeed, quantitative analysis of T-wave shape, albeit not symmetry as such, is at present successfully being used to discriminate between LQT1 and LQT2.5

It is also suggested that this easy additional measure of repolarization inhomogeneity should be used in future studies. Both experimental1 and clinical data (A.A.M.W., unpublished data, 2001), however, suggest that dispersion of repolarization is larger in LQT2 patients than in LQT1 patients, yet LQT2 patients display T-wave morphologies that typically are not symmetrical but are characterized by low-amplitude, long-lasting, bifid T waves.1 In the modeling study by Drs di Bernardo and Murray, dispersion of repolarization was altered by increasing the time delay between the earliest and latest region to repolarize.4 In vivo, repolarization indeed differs among cardiac regions but also transmurally. Local increase in dispersion on the basis of the latter gradients and abnormal action potential waveforms, as a result of genetically altered membrane currents, will undoubtedly impact T-wave morphology. Thus, although we point to the modeling study as another important step in understanding the genesis of the surface ECG, symmetry obviously is not the only index of inhomogeneity in repolarization.

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