decreasing the arterial pressure and coronary blood flow.

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References

The authors reply:

To the Editor:

We appreciate the opportunity of responding to some of the questions raised by Dr. Han in his letter. Dr. Han makes a very important point when he emphasizes that his own observations (demonstrating that slower heart rates during experimental acute myocardial infarction increase the incidence of ventricular premature beats) were made mainly within the first 1–3 min of onset of acute coronary occlusion. We certainly do not question the importance of these results, given this time frame and the fact that open-chest anesthetized dogs were used with the attendant increase in circulating catecholamines, faster control heart rates, etc. However, it is questionable how relevant the data are to the problem we were mainly concerned with; i.e., the advisability of giving atropine to the patient with bradycardia and acute myocardial infarction. In this circumstance, practical considerations make it virtually impossible for any therapeutic intervention to be applied for the first few minutes after onset of infarction. It therefore seems to us that this important clinical question relates not so much to the first 3 min of the onset of myocardial infarction but to the effects of increasing heart rate on the incidence of ventricular premature contractions and ventricular fibrillation over the course of the first 1–3 hours after onset of acute infarction.

Dr. Han is not entirely accurate in suggesting that the time course of onset of ventricular arrhythmias after coronary occlusion between his and Dr. Scherlag's studies1, 2 was very different. Moreover, although interpretation of Dr. Scherlag's paper is complicated when evaluating the results following the very fast-paced heart rates, Dr. Han neglects to mention another phase of the study in which these investigators reported that ventricular slowing produced by vagal stimulation caused disappearance of ventricular ectopic beats in all instances. Nevertheless, interpretative difficulties do remain since this study was not specifically designed to answer the question we were interested in exploring. We therefore investigated the effects of atropine (using a randomized study design) on ventricular arrhythmias over the first few hours of acute coronary occlusion in the closed-chest conscious dog. This model was chosen so that the relative arrhythmic potential of a physiologic range of heart rate could be evaluated. We found that the incidence of serious ventricular arrhythmias was directly related to the spontaneous heart rate; i.e., slower heart rates (< 60 beats/min) were accompanied by a lower incidence of ventricular ectopic activity and ventricular fibrillation. Moreover, we found that when compared to a saline-treated control group the incidence of ventricular arrhythmias and ventricular fibrillation was higher in dogs whose baseline heart rates were increased from a mean of 88–107 beats/min by an infusion of atropine.

A second aspect of the problem raised in Dr. Han's letter is the influence of heart rate on electrophysiologic parameters that may influence the incidence of ventricular arrhythmias. Dr. Han and his co-workers demonstrated that both ischemia and bradycardia independently increase the disparity of the length of ventricular refractory periods (thereby favoring development of reentrant arrhythmias) and decrease ventricular fibrillation thresholds. While we do not question these experimental results, we do wonder whether some of the conclusions derived from these results are entirely valid. For example, several authors have interpreted these data as supporting the hypothesis that increasing the heart rate of a patient with an acute myocardial infarction who has bradycardia will diminish the risk of arrhythmic death. Although this may be true, it appeared somewhat tenuous to us to extrapolate data obtained in the absence of ischemia to the ischemic situation since, to our knowledge, Dr. Han has never published studies showing that a slower heart rate during acute myocardial infarction leads to deleterious electrophysiologic effects (with the exception of a figure illustrating temporal dispersion data obtained from only a single dog).

Our own skepticism originated from the finding that increasing heart rate, even from rates as slow as 30–40/min, increased the degree of ischemic injury in the closed-chest conscious dog, a result which suggested to us that altering heart rate might have very different electrophysiologic effects in the presence of ischemia. When this hypothesis was tested, we indeed

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found that the results in the absence of ischemia were opposite to those found during ischemia. Thus, increasing heart rate during ischemia increased the dispersion of recovery of refractory periods and decreased fibrillation threshold. More recently, we demonstrated that when heart rate was increased from 50–60 to 90 beats/min by lowering the intensity of vagal stimulation, ventricular fibrillation threshold during ischemia consistently decreased; the mean decrease was 37%. In addition, over this same heart rate range, disparity of recovery of refractory periods increased in half of the animals tested. Thus, our results clearly indicate that during acute coronary occlusion in the dog, increasing heart rate within a range similar to that present during acute myocardial infarction in man causes electrophysiologic effects that would favor development of reentrant arrhythmias and increase the heart’s vulnerability to ventricular fibrillation.

We would certainly agree with Dr. Han that atropine and cardiac pacing have a definite place in the management of bradycardia in the setting of a coronary care unit, but we would add the proviso that these interventions are clearly indicated only when severe bradycardia is complicated by excessive hypotension or excessive ventricular ectopic activity. The point we wish to emphasize is that we do not know the precise definitions of “severe” or “excessive,” nor what the limits of safety are when heart rate is increased, since our own studies would indicate that relatively modest increases in heart rate may produce deleterious effects. Nor do we know whether increasing modest levels of hypotension by increasing heart rate is truly beneficial. For example, although hypotension has been shown experimentally to increase the degree of ischemic injury produced by coronary occlusion, patients with acute myocardial infarction observed in a coronary care unit who had hypotension unassociated with clinical evidence of vasoconstriction or impaired regional perfusion were reported not to have a significantly higher mortality than patients without hypotension. It therefore is not clear whether under these circumstances the net effect on ischemic injury of modest increases in pressure at the expense of an increased heart rate diminishes or augments the degree of ischemic injury.

In conclusion, our own orientation toward this very important question is that the role of atropine in the treatment of bradycardia in acute myocardial infarction is uncertain, insofar as the specific situations in which atropine may result in a net beneficial effect; and those in which it may result in a net deleterious effect still must be defined.

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Echocardiographic Pattern of Right Ventricular Diastolic Volume Overload in Children

To the Editor:

This article (Circulation 46: 36, 1973) is quite good and does confirm previous observations having been made by echocardiography. I would like to comment on the three cases of right ventricular volume overload that had normal septal motion by echocardiography. Two of these are illustrated in the article. Case 13 was illustrated as having normal septal motion and is a case of anomalous pulmonary venous connection. The echocardiogram illustrated is taken from low in the left ventricle near the apex, and there is no evidence of the mitral valve being present. Past experience with scanning techniques involving a strip chart recorder rather than Polaroid films has shown that in people with atrial septal defects with abnormal septal motion as you scan near the apex you tend to get a normal septal motion. I feel strongly that in order to make the diagnosis of abnormal septal motion you must

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