circuit will work properly and initiates the data acquisition at any chosen point of the heart cycle. In reality, however, the heart rate does change slightly during data acquisition. When the R-wave is used to indicate the beginning of the heart cycle, the data collected will be synchronized with the beginning of each heart beat. On the other hand, if prefixed time delay circuit is employed using monostable univibrators, the heart will be at a slgihtly different stage of contraction when the data acquisition sequence begins. The end result is some loss of synchronization and blurring of temporal events due to overlapping between adjacent frames.

Tatarczuk and Flesh correctly point out that part of the diastole will be placed at the end of the image sequence when the framing process begins at the R-wave. The computer programs currently available to us use fixed time intervals for framing so that some of the frames in diastole toward the end of image sequence have fewer counts than the other frames. At present these frames have to be sacrificed or normalized before the heart motion can be displayed smoothly by the computer. This drawback may be partly overcome by modification of the framing algorithm and rejection of data from irregular heart beats.

Related to the topic is a recent paper by Bacharach et al. (*2*) who used both forward and backward analysis of R-wave synchronized data from a scintillation probe. By merging the first two-thirds of the forward time-activity curve with the late diastolic portion (or first third) of the backward curve, the merged curve would more closely approximate the ventricular volume changes throughout the entire heart cycle including atrial contractions and other events prior to the R-wave. The same principle can be applied to analysis of scintillation camera data from cardiac motion studies, although it would put considerable burden on the memory requirements and processing speed of the computer.

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Measurement of Regional Ventilation and Lung Perfusion with Xe-133

We were pleased to read the recent article by Wilson et al. (*1*), which showed that regional ventilation measured with Xe-133 during tidal breathing is more sensitive for the detection of abnormalities than is the method that requires a deep breath and subsequent breath-holding at total lung capacity (TLC). Their demonstration of this technique in patients with bullous disease is similar to our experience in patients with bronchial asthma (*2*).

We were curious, however, about the regional perfusion data for normal upright humans that showed a steady increase in perfusion index from top to bottom of the right lung but a decrease in perfusion index between the middle and lower portions of the left lung. In addition, the standard deviations for regional perfusion were very large. In ten normal upright humans studied recently in our laboratory, perfusion indices obtained during tidal breathing were 0.58 $\pm$ 0.11, 0.86 $\pm$ 0.08, 1.13 $\pm$ 0.07, and 1.35 $\pm$ 0.12 from top to bottom of the left lung. The right lung showed a similar distribution.

We have also measured regional perfusion during breath-holding at TLC and indexed this to regional volume at TLC. We found that at TLC the perfusion index is significantly lower in the upper zones compared to values obtained during tidal breathing. In addition, regional ventilation measured during deep breathing with subsequent breath-holding at TLC resulted in a significantly higher ventilation index in the upper zone compared to that obtained after inhalation of two or three tidal breaths of Xe-133. Consequently, ventilation-perfusion ratios at TLC were 2.01, 1.12, 0.84, and 0.81 in the four regions top to bottom, respectively. Although Wilson et al. (*1*) made the necessary measurements, this data was not included in their paper, and we wonder whether they also found higher ventilation-perfusion ratios in the upper zone at TLC compared to those obtained during tidal breathing.

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Reply

We were interested in the comments of Jones, Sproule, and Overton and appreciate the opportunity to see the results of their studies. The smaller standard deviations and failure to see a zone of decreased perfusion at the lung base suggest that the bottom scintillation probes used in their studies were not as low as in our study. Our top scintillation probe was centered on the second anterior rib and the center of the bottom probe was 17 cm lower. At this position it is surprising that our bottom probe did not detect more often the "zone 4" of decreased perfusion described in upright humans by Hughes et al. (*1*). They found the zone 4 to extend upward as far as 10 cm below the second rib when breathholding studies were done at functional residual capacity (FRC). When breath was held at total lung capacity, zone 4 extended upward from the base only to about 16 cm below the second rib. Our study suggests that a zone 4 exists at the base during normal tidal breathing at FRC but that it may not extend up as far as during breathholding studies at FRC, and therefore is not consistently detected. We have studied eight more normal upright subjects with the same technique and found a zone 4 of decreased perfusion at the left base only once, but it was present at the right base in three subjects. The means and standard deviations of perfusion indices for all 15 subjects are as follows: L_1 0.64 $\pm$ 0.22; L_2 0.91 $\pm$ 0.16; L_3 1.16 $\pm$ 0.26; L_4 1.04 $\pm$ 0.29; R_1 0.64 $\pm$ 0.31; R_2 0.98 $\pm$ 0.12; R_3 1.25 $\pm$ 0.22 and R_4 1.23 $\pm$ 0.28.

None of the potential explanations of this zone 4 decreased perfusion has been completely satisfactory, but in-