crossclamping and then fully already after release of the crossclamp. This may have negatively influenced the number of detected MES and TEE-detected air emboli in the control group.

6. The authors claim that ''their results are similar, if not better, to those described with carbon dioxide insufflation'' and refer to a study by us.[2] We find this comparison inappropriate. Continuous carbon dioxide insufflaton of the open cardiothoracic cavity during open cardiac surgery with an effective device creates a local atmosphere of 100% carbon dioxide,[3,4] whereby only carbon dioxide and not air can enter the heart and the vessels directly. Thus, any gaseous microemboli detected with TEE or TCD during and after CPB must contain carbon dioxide and not air, unless air is introduced indirectly via cannulas. As expected, we found that the TEE-detected microemboli were fewer and disappeared much quicker in our treatment group receiving carbon dioxide.[2] In contrast, the new surgical de-airing technique[1] did not eliminate the risk of air embolism, inasmuch as air emboli were still present in the left side of the heart and MES containing air still occurred. Furthermore, our study[2] randomized patients, all 6 surgeons were blinded to TEE findings, the apex of the heart was not cannulated, and we did not have exclusion criteria.

In conclusion, if proven able to reduce air embolization in a correctly performed randomized trial, the described technique[1] may be a complement to de-airing with carbon dioxide only, if air has been introduced into the left heart and the great vessel directly, by use of an inappropriate carbon dioxide insufflation technique, or indirectly, through cannulas.

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Reply to the Editor:

We thank Peter Svenarud and his colleagues for their valuable comments and questions about our article in the *Journal*.[1] We will try to answer their queries in the order of their appearance in their letter to the Editor.

In our prospective controlled study, the de-airing was performed in both groups under intraoperative transesophageal echocardiographic (TEE) control. When air bubbles ceased to appear in the left side of the heart, the de-airing was stopped and the de-airing time noted. During this period, microembolic signals (MES) were also recorded by transcranial echo-Doppler (TCED) on line in both groups. The surgeon obviously could not influence these data in favor of one or the other group. Subsequent analysis of the data showed that, in addition to the significantly longer de-airing time ($P < .001$), the number of MES recorded were also significantly higher in the control group ($P < .002$). We also found a good correlation existing between the TEE and TCED measured air emboli in both groups (during the first 10 minutes after weaning patients from cardiopulmonary bypass), so a bias in favor of the technique proposed by us is unlikely.

The clinical study under discussion is the second in a series of studies under way. Patient inclusion and exclusion criteria were purposely kept strict to allow us to draw definite conclusions from the small number of patients included in the study. It is, however, too early to predict the real limitations to the de-airing technique proposed by us.

Our study has focused on two end points: (1) ''the de-airing time'' based on the cessation of air emboli on intraoperative TEE and (2) the ''residual microemboli'' during the first 10 minutes after termination of cardiopulmonary bypass as assessed by intraoperative TEE and TCED. In addition, the number of MES as recorded by online TCED during the ''de-airing time'' itself were also analyzed. During the de-airing period itself, assessment of the magnitude of the air emboli on TEE is not only difficult but also fraught with numerous errors. Moreover, a major amount of these emboli are being evacuated by the left ventricular vent. That is why TCED data alone were considered for assessing the magnitude of systemic air emboli in both groups during the de-airing period itself.

In the control group, the aortic root was de-aired by filling it passively with blood from the left ventricle before final closure of the aortotomy. Thereafter, the left side of the heart was manually de-aired through the left ventricular apical vent under continued passive filling of the lungs with blood and full ventilation of lungs with 100% oxygen. The aortic clamp was released first thereafter. In the study group, on the other hand, the aortic root was de-aired by filling it passively with blood by release of the aortic clamp under low systemic blood pressure over a short period of time before final closure of the aortotomy. The aortic clamp was released

thereafter and the left side of the heart de-aired through the left ventricular apical vent during staged perfusion and ventilation of the lungs, as envisaged in the article.[1] That is the reason that there was no significant difference between the 2 groups in the number of MES recorded on TCED in the first phase of cardiac de-airing (see Figure 1, before cardiac ejection).[1] However, on the basis of the results of this study, we have modified our technique of de-airing by using active suction on the aortic root before release of the aortic clamp. We have found this modification pertinent, especially in patients in whom the aortic root has been replaced by a vascular prosthesis.

We believe that left ventricular apical venting is an effective way of venting the left side of the heart and is routinely practiced by a majority of the surgeons at our center. All cardiac surgical procedures carry some risk, and that is also true for left ventricular, left atrial, and aortic root venting. We have, however, not noted any significant arrhythmias resulting from left ventricular apical venting so far. To the contrary, we have experienced arrhythmias as a consequence of a lack of effective venting of the left side of the heart. Moreover, perioperative bleeding from the left ventricular vent site is rare in moderately experienced hands. No patient from either group in this study had arrhythmias or bleeding complications as a result of left ventricular apical venting.

Pulmonary ventilation administered to the control group during the period of aortic crossclamping and de-airing is in accordance with the surgical routine that has been practiced in our center for decades and is being practiced on similar lines by a majority of cardiac centers in the world at present. In fact, the de-airing technique described by us addresses to these very details in pulmonary ventilation and perfusion. When orchestrated well, it can significantly reduce the de-airing time and the systemic microembolism.

We would like to congratulate Peter Svenarud and his colleagues for their pioneering work on developing the technique of carbon dioxide insufflation during open surgery.[2] In reply to their proposition that the MES recorded on TCED with carbon dioxide insufflation technique ought to be composed of carbon dioxide and not air, we would prefer to acquire data on TCED-recorded MES with carbon dioxide insufflation technique first before commenting on their proposition. However, with respect to the magnitude of systemic microembolism during the de-airing procedure itself (TCED based) and the rapidity with which the microemboli disappeared from the circulation after termination of cardiopulmonary bypass (TEE based), our results with the modified de-airing technique showed a trend similar to the one reported by Svenarud and his colleagues.[2]

We once again thank Peter Svenarud and his colleagues for reviewing our study and for their valuable comments.

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