nique. I have used the free right atrial patch for closure of atrial septal defects for 4 years now.[2] During a 6- to 36-month period of follow-up there has been no evidence of patch necrosis or residual shunt as a result of patch dehiscence. Evidence in 1 case suggests that the patch remains viable inside the atrium. Advantages are many. I have, however, not used this patch to close ventricular septal defects. I am not aware of any reports of a free atrial patch being used elsewhere in heart surgery.

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Future technologic innovations for intraoperative visualization of native coronary artery and graft anastomoses

To the Editor:

We read with interest the article entitled "Epicardial 10-MHz Ultrasound in Off-Pump Coronary Bypass Surgery: A Clinical Feasibility Study Using a Minitransducer" by Eikelaar and associates[1] in the October 2002 issue of the Journal. Epicardial echocardiography for intraoperative assessment of native coronary artery and graft anastomosis is not a new approach, and many investigations related to the technique have already been performed in conventional coronary artery bypass grafting (CABG).[2] Although the use of off-pump CABG has been increasing recently, performance of the graft-to-coronary anastomosis is definitely more difficult during the off-pump CABG procedure than during conventional CABG. Epicardial echocardiography therefore appears to be more valuable and effective in off-pump CABG than in conventional CABG.

The echocardiographic equipment that Eikelaar and associates[1] used was described as a 10-MHz linear array color Doppler minitransducer (UST5531; Aloka Co, Tokyo, Japan). Its precise properties, however, are 5.0-MHz to 10.0-MHz in B-mode and 5.0-MHz to 7.5-MHz in color Doppler mode. It never works at 10-MHz in color Doppler mode, and the description in the article is thus somewhat confusing.

Although Eikelaar and associates[1] scanned the native coronary artery and graft anastomosis in B-mode and color Doppler mode, the vessels run parallel to the echocardiographic probe, which may result in underestimation of the real lumen or the quality of the anastomoses because of artifacts. Power Doppler mode, on the other hand, is efficient in visualizing coronary arteries.[3] Power Doppler ultrasonography is based on the total integrated power of the Doppler spectrum and has several advantages relative to conventional color Doppler echocardiography. It is more sensitive to visualization of smaller vessels, is angle independent, and does not produce signal aliasing. For those reasons we used the B-mode and power Doppler mode in our previous study.[4]

The transducer that we used was larger than their minitransducer, and its size limited the visualization of the posterior and inferior coronary arteries because of the restricted working space. Thus, although Eikelaar and associates[1] used it only for the bypass for the left anterior artery, it would be more effective for visualization of the posterior and inferior coronary arteries.

We have been developing two new types of echocardiographic probes and systems, in cooperation with the research laboratory of Aloka Co. One probe is a higher frequency echocardiographic probe (7.5-13.0 MHz in B-mode) measuring $16 \times 6 \times 9$ mm, the same as the probe of Eikelaar and associates.[1] The high-frequency modality should enable more detailed visualization of the anatomy of the coronary artery and the quality of the graft anastomoses. The other probe is an original real-time 3-dimensional echocardiography system that reconstructs the power Doppler signals obtained from 2-dimensional image data into 3-dimensional image data sets.[5] The 2-dimensional imaging technique is time-consuming because all planes are not imaged simultaneously, and surgeons or sonographers require additional technical skills to acquire and evaluate the 2-dimensional images. Three-dimensional echocardiography is therefore expected to overcome these limitations of 2-dimensional echocardiography, although the time resolution to image distal anastomoses still needs to be improved.

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Reply to the Editor:

We appreciate the letter by Suematsu and Takamoto in response to our work[1] and share their view[2] that the introduction of beating-heart coronary surgery[3] warrants a renewed look at the potential diagnostic merits and limitations of epicardial ultrasonography with a high-frequency minitransducer.[1,2,4] They are correct in delineating the frequency band of the Aloka minitransducer in greater detail in its B-mode and its color Doppler mode.

One important feature of this transducer is its small size ($16 \times 6 \times 9$ mm). It fits in between the suction pods of the Octopus stabilizer in both longitudinal and transverse directions.[1,4] The versatile transducer easily reaches the posterior and inferior coronary arteries (unpublished observations in a pig model), in contrast to previously available transducers.

In the animal laboratory, we have been working with an experimental, identically sized, higher frequency Aloka probe (up to 13 MHz in B-mode) with higher echocardiographic element packing density. Both improvements provide a better image resolution than the probe used in the previous studies.[1,4] The 13-MHz miniprobe can be expected to answer in the operating room several pertinent questions before and after bypass surgery: location, depth, size, and grafting quality of the target coronary segment; absence of side branches in the segment to be isolated during grafting on the beating heart, to avoid profuse back bleeding that obscures the arteriotomy; geometry and quality of the anastomosis (absence of technical errors); quality of the distal runoff segment; and graft and coronary flows. It remains to be established which ultrasonographic modes yield the most useful information in the shortest scan time. Currently we favor the use of all three commonly available modes: conventional B-mode, directional color Doppler mode, and power Doppler mode. In color Doppler mode, the vessels are easily located, but artifacts caused by residual cardiac motion limit its accuracy in vessel dimension measurements.

Finally, we are reluctant as yet to share Suematsu and Takamoto's enthusiasm for power Doppler–based 3-dimensional image reconstruction.[5] In these images, diameter measurements are sensitive to turbulence and depend on the power gain setting. Thus diameters may be easily underestimated or overestimated. In the hands of Suematsu and colleagues,[2] however, anastomosis diameter measurements from 2-dimensional power Doppler and from angiographic images correlated remarkably well ($r^2 = 0.944$). The proposed method[5] is illustrated by 3-dimensional images from the proximal anastomosis. Suematsu and colleagues[5] did emphasize that the distal anastomosis cannot be visualized because of cardiac motion. Further judgment awaits a better time resolution.

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