Myocardial Perfusion in Patients With Transposition of the Great Arteries After Arterial Switch Operation

To the Editor:

Oskarsson et al. recently reported normal coronary flow reserve (CFR) in children with transposition of the great arteries after anatomic repair assessed by intracoronary Doppler FloWire (Cardiometrics, Inc.). CFR can be measured by several techniques, each one with distinct advantages and limitations. An important distinction is between techniques that measure coronary blood flow (eg, positron emission tomography) and those that measure blood flow velocity (eg, Doppler catheters), from which coronary velocity reserve is calculated. Under ideal conditions, there is a linear relation between flow velocity and flow, and therefore the peak-to-rest flow velocity ratio can be substituted for the flow ratio as a measure of CFR. However, coronary velocity reserve is affected by a number of factors, including rheological parameters, the entrance angle of the coronary arteries (which is important in patients after coronary reimplantation), and the shape of the flow profile. While basal coronary blood flow depends on the determinants of myocardial oxygen demand (heart rate, contractility, ventricular load), myocardial blood flow after maximal vasodilatation (adenosine, papaverine) is no longer autoregulated and seems to be unaffected by the parameters mentioned above. Under the condition of general anesthesia, which is necessary to perform invasive Doppler-flow measurements, the myocardial oxygen demand is on a lower level, resulting in low basal coronary blood flow and consecutively increased CFR, which can be expressed as the ratio of hyperemic coronary flow to basal flow. Positron emission tomography imaging is a noninvasive method that can be performed under normal physiological conditions; in comparison to the measurements under general anesthesia, myocardial oxygen demand and thus basal myocardial blood flow are enhanced (effect of the coronary autoregulation), resulting in an attenuated CFR. This observation might explain the different and unexpected findings of Oskarsson and colleagues.

Positron emission tomography, as the noninvasive method of reference for assessing CFR in humans, measures blood flow in as little as 10 g of myocardium; regional variations in myocardial flow on the basis of small vessel disease and endothelial dysfunction can be detected more reliably than by Doppler-flow measurements; a high percentage of patients with transposition of the great arteries after arterial switch operation show reversible perfusion defects, as mentioned by several authors.

In our opinion, the function of the coronary arteries remains a matter of concern in patients after arterial switch operation; the prognostic implications must be discussed, but close clinical follow-up is mandatory.

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Reply

We thank Dr Hauser and colleagues for their letter concerning our article. Coronary flow reserve (CFR) was assessed by intracoronary Doppler guidewire (IDGW) and intracoronary injection of adenosine in children treated with the arterial switch operation (ASO) for transposition of the great arteries (TGA). Mean (range) CFR was 3.7 (3.0 to 4.8) for the left anterior descending coronary artery and 3.4 (2.9 to 4.8) for the right coronary artery, which was comparable to CFR values obtained by the IDGW in healthy children. Dr Hauser and colleagues have published data in which global myocardial CFR as measured by the positron emission tomography (PET) technique was found to be reduced in children treated with ASO for TGA as compared with healthy adults, and thus, they find our results unexpected. We agree with Dr Hauser and colleagues that it is important to acknowledge the differences between the two methods (PET and IDGW) and that each method has advantages and limitations.

One of the limitations of PET measurements is the fact that basal myocardial blood flow is measured almost 1 hour before maximal myocardial blood flow, and during this period, hemodynamics may change substantially. A second major limitation is that PET does not give any information about anatomic coronary stenosis, which can occur at the ASO and reduce CFR.

The concern raised by Dr Hauser and colleagues regarding our study is that CFR was measured during general anesthesia. They argue that anesthesia may cause an overestimation of CFR. This theory is not supported by any data or references in the letter by Dr Hauser and colleagues.

The information that Dr Hauser and colleagues seem to be lacking at this point is: What is a normal CFR value measured by IDGW in healthy children subject to general anesthesia?

An answer can be found in one of the key references in our paper.

In the study by Giulia Gagliardi et al., a group of 10 healthy children served as a control group, and CFR was measured by IDGW during general anesthesia. CFR in the left anterior descending coronary artery was found to be 3.7 (±1.3), which is the same value that was found in that vessel in our study. This speaks strongly against the theory of Dr Hauser and colleagues.

With the available data, we find no reason to modify our conclusion. Our study indicates that CFR in children that have been treated with a successful ASO for TGA is comparable to what is found in normal subjects.

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