Real-time microcirculation imaging during beating-heart coronary artery bypass grafting

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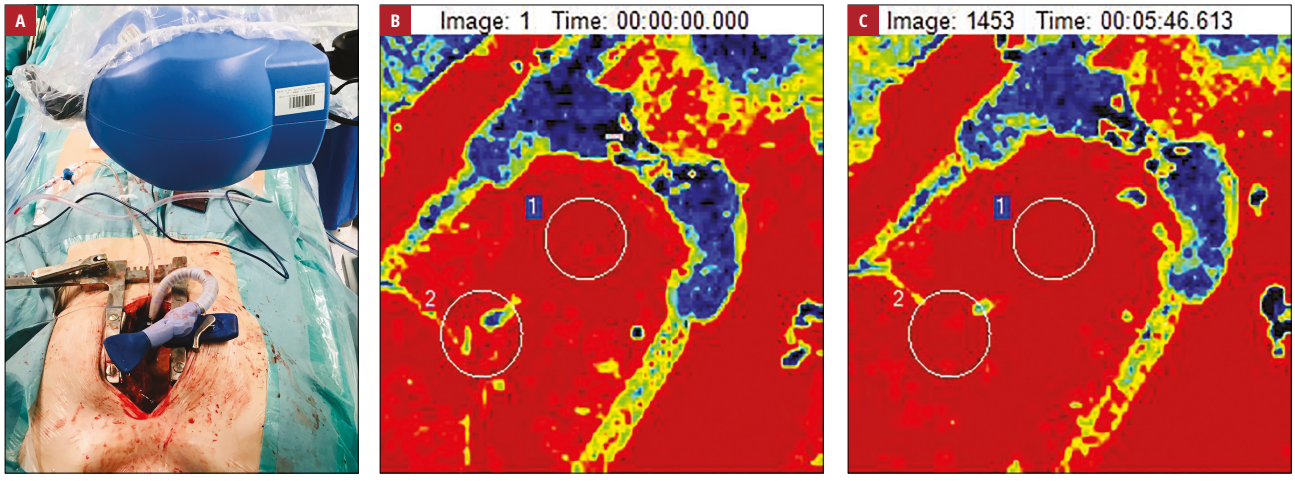

FIGURE 1 **A** – intraoperative photograph during median sternotomy: a heart stabilizer in the operation field used to perform left internal mammary artery (LIMA)–left anterior descending artery (LAD) anastomosis and a laser-speckle contrast imaging head situated 20 cm above the examined area; **B** – real-time microcirculation imaging by laser-speckle contrast imaging: blue shadow (no perfusion) presents both arms of the heart stabilizer with the LAD exposed to anastomosis, contrasting with high perfusion (red color) observed in the myocardial tissue before coronary anastomosis (LIMA-LAD); **C** – real-time microcirculation imaging by laser-speckle contrast imaging: higher perfusion in the myocardial tissue with extra blood flow from the LIMA to the LAD territory. Circles 1 and 2 are settled to calculate the perfusion values.

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Off-pump coronary artery bypass grafting (OP-CABG) remains the current surgical benchmark for coronary revascularization. However, cardiovascular complications, including arrhythmias, ischemia, hemodynamic instability, or acute myocardial infarction,[1] are still discussed. Therefore, real-time intraoperative assessment of coronary microcirculation is of paramount clinical value. In recent studies, a laser Doppler intramuscular probe has been validated to detect real-time oscillations in myocardial perfusion during beating-heart coronary surgery.[2] Although of significant clinical importance, this technique remains invasive and assesses blood flow over a small volume of the cardiac muscle.

Laser-speckle contrast imaging (LSCI) is a more recently developed modality based on speckle contrast analysis that provides an index of blood flow.[3] It allows for noninvasive, noncontact, and real-time imaging of microvascular perfusion over a wide area of the tissue. Of note, this technique is user-friendly and shows very good reproducibility as well as excellent spatial and temporal resolutions. In clinical studies, LSCI is mainly used to assess peripheral microcirculation.[4] Interestingly, quite recently, LSCI was applied intraoperatively to estimate parathyroid viability.[5] To our knowledge, there are no data or studies on LSCI and heart microcirculation imaging.

A 65-year-old woman with diabetes and coronary artery disease was referred for CABG

surgery because of significant left main stenosis. She underwent percutaneous coronary intervention of the right coronary artery in 2019. We decided to perform OP-CABG using the left internal mammary artery (LIMA) graft to the left anterior descending coronary artery (LAD). The intervention was performed in a typical way via midline sternotomy, and myocardial tissue stabilizer (Octopus, Medtronic, Inc., Minneapolis, Minnesota, United States) was applied to immobilize the target site of coronary anastomosis. Blood flow in the LIMA was routinely confirmed by transit-time flowmetry.

Here, we present the measurements of myocardial microvascular perfusion continuously assessed by LSCI (PeriCam PSI System, Perimed, Järfälla, Sweden) during beating-heart CABG (FIGURE 1A). Myocardial perfusion was evaluated based on speckle contrast analysis, with colors ranging from blue (no perfusion) to red (high perfusion) before coronary anastomosis (LIMA-LAD) (FIGURE 1B). Laser-speckle contrast imaging provides a perfusion index proportional to blood flow and enables an operator to record up to 100 images per second.[3] When anastomosis was completed, clamps were removed, and the native flow through the coronary artery was restored. We observed more intense microvascular perfusion in the myocardial tissue (FIGURE 1C).

To the best of our knowledge, the presented case is the first to document noninvasive real-time microcirculation imaging on the beating heart in a patient undergoing CABG surgery. Laser-speckle contrast imaging can be useful, together with coronary angiography and fractional flow reserve analysis, to precisely identify the need for surgical revascularization of the territory of a particular, stenosed coronary artery. It would greatly reduce the number of unnecessary and clinically irrelevant coronary grafts. Moreover, LSCI may be applied to predict myocardial ischemia during cardiac surgery.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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