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Visualization of Intramuscular Left Anterior Descending Coronary Arteries During Off-Pump Bypass Surgery

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CASE REPORTS

In off-pump coronary artery bypass surgery, an appropriate method for intraoperative evaluation of grafts and vessels has been awaited. We report the usefulness of a 15-MHz linear transducer for this purpose. A 15-MHz linear transducer with a SONOS 5500 (Philips Medical Systems, Best, Netherlands) was applied epicardially in off-pump coronary artery bypass surgery patients. Vascular anatomy was easily discerned when the transducer was applied in an appropriate way. In 6 patients, intramuscular coronary arteries were easily detected, and in all of these patients, anastomoses were successful. The shapes of the anastomoses were very clearly shown, and the flow and its phase in the bypass graft or coronary artery were measured with synchronization of electrocardiograms in all patients. The total left internal thoracic artery (LITA) flow (28.4 ± 6.8 mL/s) and the pattern of the flow was dominantly diastolic in all patients. The 15-MHz linear transducer system (Philips) is very useful for detecting intramuscular left anterior descending coronary arteries and may become one of the standard tools for intraoperative evaluation in off-pump coronary artery bypass surgery.

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Off-pump coronary artery bypass surgery (OPCAB) has become a popular option for the surgical treatment of coronary artery disease. So far, however, during OPCAB, it has been difficult to expose the intramuscular left anterior descending coronary artery (LAD), which is deeply covered by fatty tissue and myocardium. In fact, the intramuscular LAD has been reported to be unsuitable for OPCAB [1]. In this report, we describe our efforts to make the intramuscular LAD operable using epicardial echocardiography with a high-speed linear probe.

Technique

Six patients who underwent OPCAB and grafting of the intramuscular LAD were reviewed. General anesthesia was induced using minimal fentanyl and intratracheal intubation. After a median sternotomy and pericardiotomy, the heart was inspected. After confirming that the LAD was not visible at all along most of the length, or at least proximally, its presence was confirmed by epicardial echocardiography using a 15-MHz linear transducer (SONOS 5500, Phillips Medical Systems, Best, Netherlands). Then a suction-type heart stabilizer was applied to the epicardial area so that the LAD was located approximately between the two arms of the stabilizer. During echo-data acquisition, a transparent, 5-mm thick echo-pad (SONAR-AID, Geistlich Pharma AG, Wolhusen, Switzerland) was applied to the epicardium. The exact location of the LAD was determined with reference to both arms of the stabilizer and depth from the epicardium (Fig 1). The LAD was exposed using a No. 15 surgical blade, and a bipolar electrical coagulator was used to control the bleeding from both the arterial and venous branches. After exposing the LAD, a rubber string was placed around it both proximally and distally. All distal anastomoses were performed with 7-0 polypropylene sutures (Prolene, Ethicon Co, Somerville, NJ) using a continuous running technique. When the anastomoses were completed, we checked their shape by two-dimensional epicardial echocardiography along both the short and long axes, and we measured the flow within the graft as well as the flow in the distal and proximal LAD as required.

Results

Echography detected the intramuscular LAD easily and clearly in all patients. The average depth of the LAD from the epicardial surface was 5.4 ± 0.4 mm (mean ± standard deviation). The LAD exposure and anastomosis under beating conditions were successful in all 6 patients. The 15-MHz linear transducer detected the shape of the anastomoses, which resembled an Arabic numeral 8 shape proximal to the anastomosis, a "snow human" shape at the level of the anastomotic heel, a large circle or

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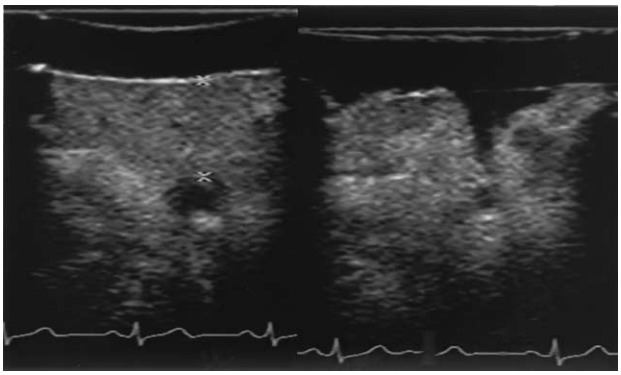

Fig 1. The left anterior descending coronary artery (LAD) was detected with reference to both arms of the stabilizer and depth from the epicardium (5 mm). The left view shows the LAD before preparation, and the right view shows the LAD after preparation (ie, exposed).

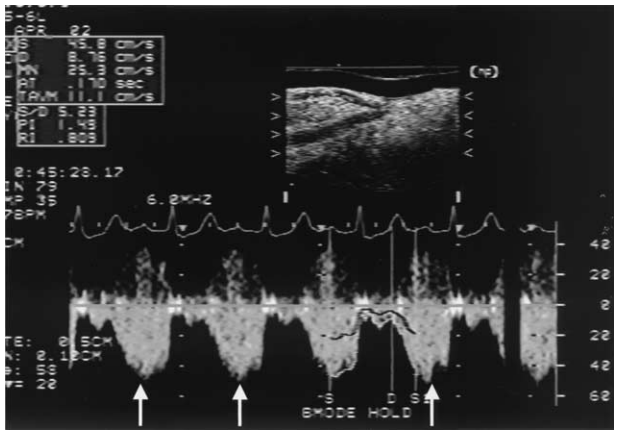

*Fig 3. The pattern of graft flow after anastomosis was dominantly diastolic (*arrows*).*

oval shape at the middle of the anastomosis, and a circular shape at the anastomotic toe or distal to it (Fig 2). The flow velocity in the graft after anastomosis (56 ± 10.4 cm/s), the total flow (28.4 ± 6.8 mL/s), and the pattern of the flow was dominantly diastolic in all patients (Fig 3). No complications related to the epicardial imaging occurred.

Comment

A safe and reliable method for surgical manipulation of the intramuscular LAD has been long sought. Recently, a study of CABG using a 13-MHz sector-type echo probe was reported [2], but this merely described visualization of the anastomoses and coronary artery. Furthermore, a sector probe as opposed to a linear one was used, and further limitation was the relatively slow speed of the echo-probe for evaluation of small coronary vessels. The results of the present study show that the anatomical information provided by the 15-MHz linear transducer facilitates safe and reproducible exposure of the intramuscular LAD. Moreover, flow measurement using the same system was shown to provide more comprehensive information on coronary blood flow (ie, flow within the graft as well as the coronary artery) than other flow measurement systems.

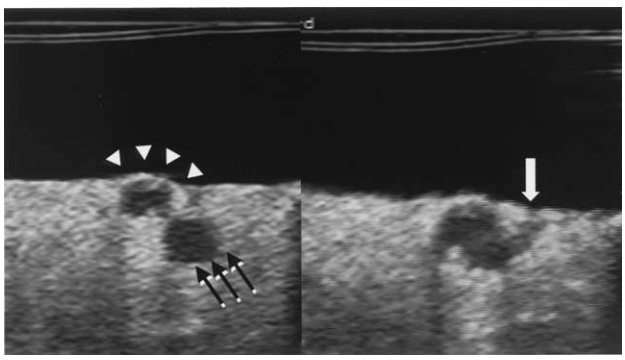

Fig 2. The 15-MHz linear transducer detected the shape of the anastomosis, which resembled an Arabic numeral 8 shape proximal to the anastomosis. The left panel shows a cross-section of the proximal site, and the right panel shows a cross-section located exactly at the site of anastomosis. White arrowheads *indicate the left internal thoracic artery (LITA),* black arrows *indicate the left anterior descending coronary artery, and a* white arrow *indicates the diagonal branch.*

So far, intraoperative assessment of graft flow has been reported using transit-time ultrasonic flow measurement [3, 4]. Bypass flow measurement by echocardiography after anastomosis has also been reported to be useful [5]. As previously described, we believe that our method has an advantage over other methods in that it can detect flow within the intramuscular native artery intraoperatively, and the information is more comprehensive (ie, not only flow within the vessels, but also the shape of the anastomosis and each vessel).

A safe bypass procedure for the intramuscular LAD using the present method would extend the usefulness of OPCAB. For example, when the proximal LAD is intramuscular and the distal LAD is well exposed, OPCAB for the proximal LAD would enable use of the more proximal part of the LITA, which is safer if the distal LITA is small-calibered. The method described here may also be useful for other intramuscular coronary arteries such as the intramuscular obtuse marginal artery, which surgeons occasionally encounter. Similarly the method may be of help in redo-bypass surgery or in cases of constrictive pericarditis when the target vessels are not well visualized.

In conclusion, the 15-MHz linear transducer system (Philips) is very useful for detecting intramuscular LADs and may become one of the standard tools for intraoperative evaluation in OPCAB.

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