The Importance of Intraoperative Flow Measurements During MIDCAB Procedures

K. Saatvedt* MD, L.Å. Øksenvåg CCP, M. Dragsund MD, K. Nordstrand MD, PhD
Department of Cardiothoracic Surgery
The Feiring Clinic, Norway

During a Minimally Invasive Direct Vision Coronary Artery Bypass (MIDCAB) procedure the blood volume flow in the left internal mammary artery (LIMA) to the left anterior descending artery (LAD) was measured using a CardioMed Flowmeter. The blood volume flow was measured to 5.4 ml/min with a high pulsatility index thus suspecting a technical error. After revising one stitch in the anastomosis, the volume flow and pulsatility index normalized.

PATIENT AND DIAGNOSIS
The patient, a 61 years old female, was referred to Minimally Invasive Direct Vision Coronary Artery Bypass Surgery (MIDCAB) after arteriographic findings of an occluded left anterior descending artery (LAD). The other coronary arteries were normal as evaluated by angiography. The patient was classified in New York Heart Association class III. The ejection fraction was within normal range. A catheter interventional procedure was attempted but failed and the patient was referred to surgical revascularization.

PROCEDURE
A limited anterior thoracotomy was made over the fourth intercostal space and no resection of the ribs was needed. The pericardium was incised and stay sutures placed. These traction sutures are important both for visualization of the LAD and for partly immobilization of the heart. The LAD was inspected and the level of the anastomosis was determined.

The LIMA was harvested under direct vision as far proximal as possible. A long ordinary cautery instrument was used for dissection of the internal mammary artery (IMA, also called the internal thoracic artery, ITA) pedicle. The IMA was treated with intraarterial papaverin. Heparin was administered (10000 IE). Use of the Visuflowâ instrument (Research Medical Inc., Utah, USA) to clear the coronary artery facilitates the anastomy procedure and no snare sutures were placed around the LAD. The heart rate was slowed by administration of esmolol. The anastomosis between IMA and LAD was performed using continuous polypropylene 7.0. The duration of the anastomy procedure was 6 minutes.

Because of a slight leakage from the anastomosis an extra stitch was placed carefully.

FLOW MEASUREMENT
The IMA volume flow was measured using a 3mm transit time probe connected to a Flowmeter (Medi-Stim AS, Oslo, Norway). After immersing the probe head in sterile gel, it was applied on a 15mm free-dissected portion of the IMA/ITA graft. The initial flow measurement revealed a mean flow value of 5.4 ml/min with a high pulsatility index (PI) of 5.6 as shown in figure 1.
The curve has a non-characteristic shape of the IMA flow to LAD, and the mean flow value falls outside the interval of 49.8±32.9 ml/min as documented by Walpoth et.al. The poor flow value combined with the abnormal pulsatility index indicates a technical error as described by Louagie. The pulsatility index is defined as the difference between the systolic (maximum) flow and the diastolic (minimum) flow divided by the mean value, i.e.

\[
\text{PI} = \frac{\text{Systolic flow} - \text{Diastolic flow}}{\text{Mean flow}}
\]

Louagie found that the normal pulsatility index for IMA to LAD is 2.25 ± 0.12 while increasing to 7.9 ± 2.3 in cases with technical error. The pulsatility index of a given flow curve is readily calculated by the flowmeter using the measuring and analysis (M&A) software package.

A technical error of the anastomosis was therefore suspected and the extra stitch was removed and replaced by another. After this procedure the flow instantly increased to 16 ml/min as shown in figure 2. The equivalent PI was reduced to 1.7 falling even below the range documented by Louagie.

The patient was during the whole procedure hemodynamic stable. The incision was closed leaving a chest tube for 24 hours. The postoperative course was uneventful.

Figure 1. Flow in LIMA to LAD during a MIDCAB procedure with technical error.

Figure 2. IMA flow after correction of the technical error.
DISCUSSION
The benefit of the internal mammary artery grafting as a long-lasting intervention for coronary artery disease is well recognized. Because of its less invasiveness, catheter based alternatives are usually chosen for one- or two-vessel disease. Although not a new method, mini-invasive techniques for coronary artery bypass surgery have been increasingly popular during the last few years. The methods may retain the benefits of conventional IMA grafting, while minimizing the operative trauma.

Whatever mini-invasive method chosen for myocardial revascularization, all results must be compared with the usually excellent outcomes when one or two vessel disease is treated by conventional CABG with sternotomy and cardiopulmonary bypass (CPB). We feel that intraoperative flow measurements are mandatory and this clinical case illustrates the importance of this procedure. In this case a low flow value combined with a relatively high pulsatility index indicated a technical error. Unless performing intraoperative flow measurements this technical error might have been missed.

CONCLUSION
This clinical case illustrates the importance of performing intraoperative volume flow measurements during Minimally Invasive Direct Vision Coronary Artery Bypass Surgery (MIDCAB) procedures.

References

*Please address all correspondence to: Dr. K. Saatvedt, Dept. of Cardiothoracic

Correspondence related to the Flowmeter should be forwarded to: Medi-Stim ASA, Marketing Dept., PB 4744 Nydalen, N-0421 Oslo, Norway, or by using e-mail: medistim@medistim.com.