Moreover, authors attempted to prove an improvement of their center performance due to the use of MIDCAB, and logistic EuroSCORE (European System for Cardiac Operative Risk Evaluation) is used for benchmarking. Unfortunately, the EuroSCORE tends to overestimate the risk, and this can have partially influenced the authors' conclusions.⁶

Finally, authors chose not to report on a control group of patients undergoing PCI. PCI represents the gold standard for the treatment of isolated LAD disease. Evidence from a recent meta-analysis showed a superimposable safety profile between MIDCAB and PCI,⁷ but further high-quality direct comparisons between the 2 revascularization strategies are needed to draw final conclusions on MIDCAB efficacy and safety.

To conclude, the authors should be congratulated for their excellent long-term results and their experience should stimulate other centers to emulate it and encourage a wider adoption of this technique.

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Commentary: Sometimes less is more. Should minimally invasive direct coronary artery bypass become the new standard for revascularization of the left anterior descending artery?

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CENTRAL MESSAGE

Minimally invasive direct coronary artery bypass appears to be a durable minimally invasive technique in low-risk patients with outcomes similar to those of conventional revascularization with sternotomy and cardiopulmonary bypass.

The left internal mammary artery (LIMA)-to-left anterior descending artery (LAD) bypass is the gold standard bypass for coronary revascularization, with >90% long-term patency and proven survival advantages.¹ The minimally invasive direct coronary artery bypass (MIDCAB) offers

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the possibility of a LIMA-to-LAD bypass via a left mini-thoracotomy without the use of cardiopulmonary bypass or sternotomy. This has obvious appeal for treating patients with proximal LAD disease or as a component in a hybrid coronary revascularization strategy. However, the long-term patency of LIMA-LAD anastomoses using the MIDCAB technique is not well defined, and given the excellent results with conventional coronary artery bypass grafting (CABG), widespread adoption has been sparse.

In their study published in this issue of the *Journal*, Davierwala and colleagues² evaluated 2667 patients who underwent MIDCAB with a 20-year follow-up. The procedures were performed in low-risk patients with primarily single-vessel proximal LAD disease not amenable to percutaneous coronary intervention (PCI). The postoperative complication rate was very low, with an in-hospital mortality of 0.9%. Overall survival at 5, 10, 15, and 20 years was 88%, 77%, 66%, and 55%, respectively. Interestingly, the reported survival for MIDCAB recipients was even higher than that of an age- and sex-matched German population.

This study has the largest MIDCAB experience in the literature with a 20-year follow-up.²⁻⁶ The survival results are similar not only to those reported in other MIDCAB studies,^{5,6} but also to those reported for conventional coronary artery bypass via sternotomy and cardiopulmonary bypass.⁷ Also encouraging was the lower revascularization rate for MIDCAB compared with PCI for proximal LAD disease (5.5% vs 20%-34%).

Patient selection was critical in achieving the outcomes presented here. As noted above, the patients had single-vessel disease with few comorbidities and a preserved ejection fraction. The interventions were performed in elective (91%), urgent (7%), or emergent (2%) settings. The thoracotomy interspace was chosen using the preoperative chest X-ray. Although not described here, computed tomography angiography with 3-dimensional reconstruction has been quite helpful in evaluating the conduit, localizing the distal target for bypass, and confirming the location for thoracotomy.⁸

The authors also demonstrated temporal improvement in outcomes with increased surgeon experience. As expected, technical errors with anastomoses were associated with an increased incidence of major adverse cardiac events (10.8% vs 1.1%). However, with improved experience, the number of bypass grafts requiring revision decreased

from 4.4% (earlier experience) to 0.8% (later experience). The use of adjuncts such as robotic mammary harvest, coronary shunts, or selective use of cardiopulmonary bypass may help improve adoption of the MIDCAB technique for surgeons.

Although this study serves as proof of principle that MIDCAB is durable in low-risk patients, application to higher-risk patients who would poorly tolerate sternotomy may be even more appropriate. Isolated proximal LAD disease represents a selected group of patients, and many patients present with multivessel disease. The hybrid approach (MIDCAB plus PCI) has been debated as an attractive option for these patients, and given the excellent long-term results achieved in this study and others, the hybrid approach merits further study.⁹ As the popularity of minimally invasive cardiac surgery grows, significant consideration must be given to patient selection, preoperative evaluation with imaging, and methods to increase adoption of the technique and improve training. Sometimes less is more, and less invasive options for myocardial revascularization can offer a durable solution.

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