OPCAB are by no means inconsequential; however, in the hands of experienced OPCAB surgeons, cardiac and survival outcomes have not shown clear indications of being negatively affected.

In fact, recent trends in coronary revascularization may be particularly amenable to OPCAB. Hybrid coronary revascularization, which implements a single LIMA-LAD bypass in conjunction with percutaneous coronary intervention, has been shown to produce similar 1-year survival and complication rates as CABG for multivessel disease.¹⁰ The use of multiple arterial conduits, which likely extends long-term survival by improving patency, offers a solution to the venous patency problem in OPCAB as well.¹¹ Alternatively, LIMA-LAD bypass with sequential saphenous vein grafts shows no difference, compared with total arterial revascularization, in major adverse cardiac events or survival at 5 and 15 years.¹² Lastly, improved intraoperative Doppler and transit-time flow-meter devices can confirm adequate anastomosis, potentially limiting the effects of the variability inherent in surgeon technique.¹³ In conclusion, OPCAB affords excellent clinical outcomes in experienced hands, and its utility as a less-invasive alternative to cCABG continues to evolve within the burgeoning arena of surgical innovation.

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BENEFITS OF OPCAB ARE NOT FOR EVERYBODY. COSTS ARE. Reply to the Editor:

In the present issue of the *Journal*, Haynes and Trachiotis comment on recent literature regarding on-pump

coronary artery bypass versus off-pump coronary artery bypass (OPCAB) surgery, including the data on graft patency from the Danish On-pump Versus Off-pump Randomization Study (DOORS).

It is correct when the authors claim that the angiographic follow-up data from the DOORS were not complete because only 56% of the surviving patients consented to have the examination performed.¹ However, as pointed out in the accompanying editorial by Smith,² an extensive statistical analysis was performed to ensure the balance of both perioperative and patient-related risk factors of graft occlusion. Therefore, we consider the observations to be valid. We confirmed the findings of a number of earlier investigators who found graft patency to be inferior.^{3,4} Even in smaller series performed by excellent OPCAB enthusiasts,⁵ there was a trend toward inferior graft patency after OPCAB, although the statistical power to conclude was not present. The number of grafts received by patients undergoing OPCAB is consistently lower than the number of grafts received by patients undergoing conventional coronary artery bypass grafting (cCABG) in most trials.

It is probably safe to assume that the majority of cardiac surgeons consider their own skills to be above average. Nevertheless, when performing an anastomosis, a bloodless, immobile field is an advantage in the hands of everyone, and even the surgeon who performs well without cardiopulmonary bypass is likely to perform even better when using it. It seems that with the current knowledge, the question that remains is not whether the grafts are better when performed with the use of cardiopulmonary bypass and cardioplegic arrest, but rather to which extent the advantage is clinically relevant and outweighs the risks.

In the DOORS, after 6 months follow-up, we found no significant difference between the OPCAB and

cCABG groups with regard to survival or self-assessed, health-related quality of life.⁶ In addition, the number and duration of secondary admissions to hospital within this period tended to be lower among OPCAB cases.⁷ These findings seem to suggest that even if the graft patency indeed was poorer and the number of grafts was lower, this did not have any clinically relevant effect on the patients. However, results from other studies point in the opposite direction. In the CABG Off or On Pump Revascularization Study (CORONARY)⁸ and German Off Pump Coronary Artery Bypass in Elderly (GOPCABE)⁹ trials, the risk of need for reintervention was increased after OPCAB, and, most disturbing, in the Randomized On/Off Bypass (ROOBY) trial even cardiac mortality was higher after 1 year.³ Long-term mortality also seemed to be higher in the recent meta-analysis by Tagaki and Umemoto,¹⁰ although this conclusion was not based on randomized, controlled trials.

So, when the efficacy of OPCAB is inferior to that of cCABG in terms of completeness of revascularization, need for reintervention, and risk of cardiac death, the argument to pursue this strategy should be that the risk of complications is lower with OPCAB than with cCABG.

The use of OPCAB originally was promoted on the basis of the belief that cardiopulmonary bypass led to a very high incidence of postoperative cognitive dysfunction, a syndrome known colloquially as “pump head.” In a few early randomized trials with a short follow-up (7 days to 10 weeks), patients undergoing cCABG scored significantly worse postoperatively compared with patients undergoing OPCAB when subjected to neurocognitive tests.^{11,12} In the Octopus trial,¹³ a significant difference in favor of OPCAB was found after 3 months, but not after 1 year or after 5 years of follow-up. At the 5-year follow-up, a more than 50% decline in scores at

neurocognitive testing was found in both groups. The ROOBY trial showed small, statistically but probably not clinically significant differences at 1-year follow-up.³ Cognitive decline is also common after noncardiac surgery, especially in elderly patients.¹⁴ In addition, patients in need of cCABG have a high prevalence of risk factors, such as diabetes mellitus and hypertension, which also predispose them to neurocognitive decline. In fact, a similar rate of neurocognitive decline has been found in nonsurgical controls and in patients who underwent cCABG after the 3-year follow-up,¹⁵ and in a randomized study of elderly patients, the postoperative neurocognitive decline tended to be more severe in OPCAB than in cCABG cases.¹⁶ Generally, it seems that the “pump head” argument is less valid than originally anticipated. A large number of other differences in minor or surrogate outcomes carry less weight.¹⁷

However, one important argument in favor of OPCAB does remain: Less manipulation of the ascending aorta potentially diminishes the risk of periprocedural stroke. In 2012, Afilalo and co-workers¹⁸ performed a meta-regression analysis. Including all the major randomized controlled trials from which data were available at this time. Their analysis comprised 30-day follow-up data from 8961 patients in 59 trials. They found a significant 30% reduction in stroke rate with OPCAB compared with cCABG. In the DOORS, we did not have the statistical strength to document a significant difference in stroke rate between groups according to the principle of intention to treat, but most of the strokes in the OPCAB group were related to conversion to the on-pump technique or the use of a side-biting clamp when making the proximal anastomosis. Because the periprocedural risk of stroke is very low in younger patients, it seems that this argument for accepting the lower

efficacy of OPCAB is valid only in elderly patients with increased risk.

As pointed out by Sabik¹⁹ in his recent editorial, the implication of the evidence is that “...we routinely cannot do as good a surgical revascularization off pump as we can do on pump.”

This means that we should probably reserve off-pump operations for patients who are at an increased risk of stroke, and in these cases, the use of the off-pump technique should be accompanied by the principle of no-touch aorta for the patients to experience the benefit.

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CAN WE DISCUSS BILATERAL INTERNAL THORACIC ARTERY GRAFTS WITHOUT EMBRACING SKELETONIZATION?

To the Editor:

We read with interest the editorial from our North American colleagues on the issues hampering widespread implementation of multiple arterial

grafting in our part of the world.¹ Whereas our European contemporaries seem to have heard the message, there are still unexplained roadblocks to fulfilling this strategy for our patients.

The editorial emphasizes the disparity between what we should be doing and what is actually being done. All of us seem to recognize that surgeons' concerns regarding mediastinitis play a key role in the decision not to embrace more aggressive use of bilateral internal thoracic artery (BITA) grafts. We do not believe, however, that this dialog can occur in isolation without also discussing the strategy of using skeletonized internal thoracic arteries.

We believe that successful BITA grafting programs are likely to be programs that embrace the technique of skeletonization. Our own studies have shown definitively that skeletonization results in preservation of blood flow in the healing sternum² and that it is associated with a markedly decreased incidence of sternal wound infection, especially in high-risk patients undergoing BITA.³ Furthermore, there have been no definitive studies that have challenged long-term outcomes with the use of skeletonized BITA grafts.

We agree that our North American colleagues must get with the times and embrace multiple arterial grafting. Now that we know what to do with regard to how many arterial grafts to use, should we not embrace skeletonization as a means to help us to achieve that goal safely?

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FOCUSING ON THE SECOND ARTERIAL CONDUIT

Reply to the Editor:

We appreciate the comments of our Canadian colleagues and support the adoption and use of skeletonized bilateral internal mammary artery (BIMA) harvest for multiarterial grafting. Compared with pedicled harvest, skeletonization of internal mammary artery conduits has been shown to preserve sternal blood supply,^{1,2} reduce postoperative chest wall dysesthesia,^{1,3} and most importantly, may reduce the incidence of postoperative sternal complications,^{4,5} especially in higher risk patient cohorts.

However, we believe that our charge to the cardiac surgical community to use an additional arterial graft has a broader reach and effect if we do not impose strict limits or guidelines on how these conduits are harvested. Instead of introducing 2 novel technical challenges to practicing cardiac surgeons (ie, BIMA use and skeletonization), encouraging either the right internal mammary artery for appropriately selected patients or the radial artery for those with appropriate lesions and unfavorable risk profiles for sternal complications has the potential for more widespread adoption among practicing surgeons. Mandating that all patients undergo skeletonization of both internal mammary arteries may discourage surgeons from adopting this approach.

Therefore, we agree that skeletonization may ultimately be the most