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policy, regional economy and culture, doctors' philosophies, healthcare commercial activities, and patients' promotion and education levels.

By taking a look back at the developmental history of CABG, we can see more than half a century of vicissitudes. Some pursued and admired concepts have been washed away with time without a trace, whereas some classic concepts and technical means have survived and flourished. From 1962 when Sabiston pioneered CABG under the off-pump condition to the extensive application of extracorporeal circulation in coronary artery surgery to the revival of OPCAB by the end of last century, we have been through a long journey to understand this surgical approach.² In a sense, OPCAB has promoted the development of the entire coronary surgery, namely, this approach expands the indications of CABG and facilitates the maturation of minimally invasive CABG. Therefore, any unilateral exaggeration of its efficacy or complete rejection of its significance is inconsistent with the evidence-based spirit. Exploration of the pros and cons associated with OPCAB is likely to be one of the investigators' focuses of attention for many years to come. How to treat this surgical procedure will continue to be an important issue for the whole sector to address. However, one thing is certain: Only the rational use of off-pump technology can help coronary surgery to properly develop in China.

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THE BENEFITS OF OFF-PUMP CORONARY ARTERY BYPASS GRAFTING REQUIRE CAREFUL PATIENT SELECTION AND SPECIAL EXPERTISE

To the Editor:

Off-pump coronary artery bypass grafting (OPCAB) has been used clinically for nearly 20 years and has been the focus of debate as to whether it can achieve the same midterm and long-term results of Conventional on-pump coronary artery bypass grafting (CCABG) and also further decrease perioperative mortality and morbidity. In this innovative era, OPCAB was technically a new surgical option for coronary bypass surgery; however, it brought with it some new challenges: (1) OPCAB is technically more demanding for both cardiac surgeons and anesthesiologists. (2) Studies comparing the 2 techniques (OPCAB vs CCABG) have demonstrated that OPCAB may result in fewer bypass grafts (distal anastomoses), higher rates of incomplete myocardial revascularization, and lower graft patency rate. It is therefore essential to evaluate objectively the benefit of OPCAB (reducing such morbidities as stroke) and the risk of OPCAB (such as patency rate of grafts and incomplete revascularization) to ensure the highest quality of surgery.

It was shown in the Society of Thoracic Surgeons database that the proportion of OPCAB among all patients undergoing coronary artery bypass grafting surgery in the United States has been decreasing, from 23% in 2002 to 17% in 2012 (it never went higher than 25% in the last decade). In fact, only a minority of cardiac surgeons in the United States performed OPCAB on 90% of their patients. In contrast, the majority of cardiac surgeons in the United States used OPCAB for fewer than 10% of their patients in their daily practice.¹

Generally speaking, whether a novel technique can be widely accepted depends on 3 factors: effectiveness, learning curve, and ease of practice. The effectiveness of OPCAB has been questioned by the Veterans Affairs Randomized On/Off Bypass (ROOBY) study, in which both the number of bypass grafts and the patency rate were lower in the OPCAB group.² Most cardiac surgeons recruited in that study, however, had limited experience in OPCAB at that time. As OPCAB is used in more and more heart centers all over the world, several large, multicenter, prospective, randomized, controlled trials have been completed. The CABG Off or On Pump Revascularization Study (CORONARY) study recruited about 4500 patients, and all the cardiac surgeons in that study had experience with more than 100 OPCAB cases per year.³ In the German Off Pump Coronary Artery Bypass in Elderly (GOPCABE) study, most of the surgeons had experience with more than

500 OPCAB cases.⁴ All these studies demonstrated that, in the hands of experienced surgeons, OPCAB had similar outcomes to CCABG for mortality and the number of bypass grafts but also had advantages in reducing blood transfusion, time of ventilation, and the length of postoperative hospital stay. The long-term outcome (5 or 10 years) needs to be further explored. But we have to pay attention to the fact that the patients enrolled in CORONARY study (according to their inclusion and exclusion criteria) were required to be suitable for both OPCAB and CCABG by the operating surgeons. So it is difficult to tell from the CORONARY study how many patients were enrolled out of their total number of patients who underwent coronary artery bypass surgery during the same period. Because of this selection bias, the conclusions drawn may thus not be appropriate for our daily practice. On the other hand, OPCAB has a distinct learning curve and has higher demand on surgical skills. It takes time to master the new techniques for surgeons who have been accustomed to performing coronary bypass grafting surgery on nonbeating and bloodless hearts with cardiopulmonary bypass and cardioplegia. In fact, surgeon experience is the most important factor that could influence the surgical outcome of OPCAB.

It is noteworthy that some surgeons only apply OPCAB to high-risk patients, and this strategy may not be the best practice. They are using a technique that requires the most skill for high-risk patients, which may increase the surgical morbidity and mortality and result in worse outcomes. Smart surgeons should use their most familiar surgical techniques for high-risk patients to get the best results.

Clinically, OPCAB has some special strong indications. For those elderly patients with a heavy calcified ascending aorta and contraindications to cardiopulmonary bypass, OPCAB with bilateral internal thoracic artery may be the best option to decrease such complications as stroke. In contrast, CCABG may be the best technique for patients with small target coronary vessels, diffuse coronary artery disease, intramyocardial coronary arteries, or obviously dilated hearts that might not tolerate the cardiac manipulation required for OPCAB. Perioperative stroke is one of the most serious complications after coronary artery bypass grafting surgery, and it has been reported that OPCAB may result in lower stroke rates. There have been further studies demonstrating that the incidence of stroke was increased if a side-biting clamp was applied to the aorta for proximal anastomoses. The ideal strategy should be total arterial bypass grafting (bilateral internal thoracic arteries and radial artery) with OPCAB without manipulating the aorta, which may reduce the incidence of stroke caused by aortic manipulation.

In summary, not all patients undergoing coronary bypass can benefit from OPCAB, and this technique should be reserved for those surgeons who demonstrate at least

equivalent outcomes to CCABG. CCABG will continue to be the main option for most cardiac surgeons in the near future.

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Reply to the Editor:

It is time for the debate about on-pump versus off-pump CABG to be finally settled. Off-pump CABG was introduced with the hope of avoiding the morbidity of cardiopulmonary bypass, but randomized trials, including Veterans Affairs Randomized On/Off Bypass, Coronary Artery Bypass Surgery Off or On Pump Revascularization study, and the German Off-Pump Coronary Artery Bypass Grafting in Elderly Patients, have shown no clear advantage for off-pump CABG with regard to hard clinical end points such as mortality and stroke. The debate has been perpetuated because off-pump proponents continue to cite advantages associated with this technique, including reduced perioperative morbidity, particularly in the hands of experts. In contrast, critics of off-pump CABG cite reports of diminished graft patency, incompleteness of revascularization, and long-term implications.

In reality, there is little to debate about. In the best-case scenario for off-pump CABG, current data show no clear winner with respect to important early clinical outcome measures for the 2 surgical approaches. Because off-pump CABG is technically a more difficult operation, the on-pump technique is naturally the default approach for the majority of surgeons. This reality is reflected by the Society of Thoracic Surgeons National Adult Cardiac Surgery