

Editorial Commentary II

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In the past decade, many cardiac surgeons have focused on the development of minimally invasive coronary artery bypass grafting (CABG). As mentioned in Dr. Tsai et al's article, this includes two different strategies, one to eliminate the cardiopulmonary bypass, and the other to make the skin incision smaller. Off-pump CABG has progressed greatly since the invention and improvement of different types of tissue stabilizer.^{1,2} However, minimal skin incision or robotic-assisted CABG is still a challenge for cardiac surgeons and is limited to only carefully-selected patient groups.

There are several major concerns regarding robotic-assisted versus traditional CABG. The first one is the surgical technique. Less accessible space to the heart and less working space will make the surgery more difficult, and of course, the duration of anastomosis and myocardium ischemia will be prolonged as well. Though the da Vinci computer-enhanced, robotic-assisted telemanipulation system can greatly improve intracavity operative manipulation through 3-dimensional high-resolution display and its well-designed endoscopic instrument which emulates the human wrist, it still requires a considerable period of time for learning. Besides, many patients are excluded during operation due to difficult access to the target vessels. It has been reported that the intra-operative exclusion rate plus the open method conversion rate could reach 19%.³ Though most centers use a 6-8 cm minimal anterior-lateral thoracotomy to make the anastomosis easier and faster, the skin incision size is rather close to the wound size of "traditional" minimally invasive direct coronary artery bypass grafting (9-12 cm).⁴ The small difference between sophisticated robotic and traditional surgery makes the whole rationale for grafting left internal mammary artery to left anterior descending artery for single-vessel coronary artery disease patients a bit controversial. Another option to make the total endoscopic CABG possible is to bypass the occluded vessel under car-

diopulmonary bypass with arrested or beating heart, and that is what most hospitals perform in current practice. Thereby, we would say, for left anterior descending artery lesion-only patients, total endoscopic coronary bypass is feasible on the arrested heart but does not provide a major benefit over the minimally invasive direct method to the occluded coronary artery because cardiopulmonary bypass is still required.

The second concern over robotic-assisted CABG is its safety. Some reports showed results comparable with conventional CABG operation.^{3,4} The short-term morbidity and mortality rates were low. However, they also reported the problem of anastomosis quality. In their series, 3-month follow-up coronary artery angiography was performed in 76 patients, revealing significant anastomosis stenosis (> 50%) or occlusions in 6 patients. That means after completion of all these sophisticated computer-enhanced, robotic-assisted surgical procedures, the graft failure rate can reach as high as 9%. Of course, if the stenosis rate of a novel surgical technique for CABG operation is high, it would not be a surprise if the peri-operative complication is also high.

The ultimate goal for the development of such computer-enhanced, voice-controlled, tremor-free, and human wrist-emulating robots is to achieve "total endoscopic multi-vessel CABG". We found robotic-assisted multi-vessel CABG (hand-sewn anastomosis with mini-thoracotomy) had been attempted in several heart centers in recent years worldwide.^{5,6} Most of the patients received bilateral internal mammary artery or radial artery grafting to coronary arteries with pedicle graft or composite graft fashion. Though short-term results were favorable, with no significant increment of mortality or morbidity, the post-op re-open rate for checking bleeding seemed to be higher than that of conventional surgery.⁷

One further concern is the cost-benefit issue for the new machines. Most insurance companies and countries will not pay the additional expense for this robotic-as-

sisted CABG; in Taiwan, we have the same problem. Though the da Vinci robotic-assisted telemanipulation system could also be applied to a variety of operations among different fields, like urology and gynecology, in order to make the best use of it, without the full support from the hospital, it's not possible to proceed with such operations.

Therefore, the current scenario is, in spite of using many different new instruments, machines and surgical techniques for the completion of total endoscopic robotic-assisted CABG, multi-vessel procedure is still of great difficulty and outlines the current boundary of robotic-assisted CABG. Though the da Vinci robotic-assisted telemanipulation system for the patient who needs a CABG is still playing its role of "assisting" hand-sewn anastomosis, we believe total endoscopic multi-vessel CABG will be practically used in the near future.

Dr. Tsai et al harvested the whole length of left internal mammary artery with the assistance of robot, with a steep learning curve. Though they used minimal anterio-lateral thoracotomy to perform the anastomosis directly, their early experience of handling this machine and endoscopic instruments will eventually help them moving forward toward total endoscopic CABG operations.

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