Coronary artery bypass grafting surgery (CABG) is still the gold standard procedure for patients with multiple coronary artery disease and recommended as evidence level IA in Japan. Worldwide, the strategy for CABG has remained unchanged, meaning that conventional open-chest CABG has been used for the past decade. However, this situation has changed with the rapid popularization of percutaneous transluminal coronary angioplasty (PTCA) and the wide use of drug-eluting stents. The number of open-heart procedures in the United States fell from 500,000 in 1999 to 310,000 in 2004. Likewise in Japan, the annual number decreased from 21,000 in 2003 to 16,000 in 2010.

On the other hand, since the 1980s, endoscopic surgery has gained popularity in general and thoracic surgery and has recently become a standard procedure. The rapid progression in minimally invasive approaches in the form of laparoscopic and thoracoscopic surgery has stimulated cardiac surgeons to also apply these techniques to atrial septal closure, mitral repair and coronary revascularization utilizing smaller incisions. Although thoracoscopic ITA harvesting has become feasible, anastomosis using thoracoscopic devices is still a demanding procedure. Robotic surgical systems providing 3-dimensional visualization via dual-camera endoscopes, magnification, multijointed micro-instrumentation enabling multiple degrees of movement, and tremor filters have been used to carry out CABG. Robotic systems have been used in applications ranging from ITA harvesting to suturing of distal anastomoses. In this issue of the Journal, Ishikawa et al report on their use of the da Vinci robot.

Conventional CABG is performed using extracorporeal circulation (ECC), which is unfortunately associated with significant systemic complications, including hemodilution, systemic inflammation, stroke and aortic manipulation. Off-pump CABG (OPCAB) is a solution for ameliorating the disadvantages of using ECC. In Japan, off-pump CABG was introduced in 1992 and started becoming popular toward 2000. The ratio of OPCAB in CABG reached 61% in 2010, and that level has since been maintained.

As another approach for less invasive cardiac surgery with preservation of the sternum, minimally invasive direct coronary artery grafting (MIDCAB) was introduced. However, despite initial enthusiasm, the popularity of the procedure has decreased because of technical difficulties and suboptimal initial results. The major limitations for the general acceptance of MIDCAB included the technical difficulties in harvesting full-length, bilateral internal thoracic arteries (ITAs). In addition, postprocedural pain after spreading the ribs represents another problem with MIDCAB surgery.

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system (Figure) to harvest the ITA and perform direct-vision anastomoses through a minithoracotomy, namely ThoraCAB, on 35 patients with no mortality and no conversion. Loulmet et al reported the first case of totally endoscopic CABG (TECAB) on an arrested heart using the da Vinci system in 1998. Falk et al reported arrested-heart TECAB on 22 patients, and their rate of conversion to minithoracotomy because of anastomotic bleeding or graft issues was slightly high. Dogan et al also reported an initial conversion rate of 22%. Both the initial operative time even for single-vessel TECAB and ECC time was significantly long compared with conventional CABG. Srivastava et al have reported the largest series, with 150 patients undergoing robot-assisted bilateral internal mammary artery (IMA) harvesting and off-pump CABG with no mortality, little morbidity, and no conversions. A prospective multicenter trial of robot-assisted TECAB on cardiopulmonary bypass performed in 85 patients demonstrated TECAB as a safe procedure, and approval by the US Food and Drug Administration for the use of the da Vinci system for coronary revascularization was mainly based on that study.

Although robot-assisted CABG can provide a precise procedure for ITA harvest, meticulous coronary anastomosis, and good visualization, both the number of patients in whom this procedure could be completed and the number of surgeons desiring to continue this procedure appear significantly limited. Puskas asked Srivastava why this procedure has yet to become popular in a discussion. Srivastava answered honestly that it really requires a desire to overcome the technical challenges of the procedures, and sometimes this is not easy. He also noted that a user-friendly technology enabling the anastomosis is necessary, as Balkhy et al reported that a new anastomotic device was used safely and in a reproducible manner on 120 patients under TECAB.

The number of patients referred for single LAD artery anastomosis has dramatically decreased because not only the Japanese guidelines, but also the US and European guidelines recommend percutaneous coronary intervention (PCI) for revascularization in 1-vessel disease, rather than CABG. The number of candidates for robotic CABG would thus be limited. Only very few patients can actually benefit from TECAB. Surgeons should initially consider appropriate selection of straightforward cases. As another limitation, these robotic surgical procedures necessitate continuous 1-lung ventilation to evacuate the thoracic cavity, making oxygen desaturation a potential complication that may lead to hemodynamic instability.

Several methods, including OPACB, MIDCAB, thoracoscopic CAB, and sternum-preserving robotic CABG, are available to achieve minimally invasive CABG. However, the safety and quality of CABG should not be sacrificed by focusing solely on reducing invasiveness. Whether TECAB provides superior outcomes in comparison with conventional CABG regarding long-term results remains unclear. To date, more than 130 Da Vinci systems have been introduced in Japan, the second largest number in the world. The greatest growth in robotic procedures has been in urology for prostatectomy and gynecology. In Asian countries, the Da Vinci system is also utilized in gastrointestinal surgeries. To make robot-assisted CABG or TECAB a routine or standard procedure, refinements in anastomotic technology, automatic anastomotic devices, endoscopic stabilization and target vessel identification systems are necessary in the future.

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